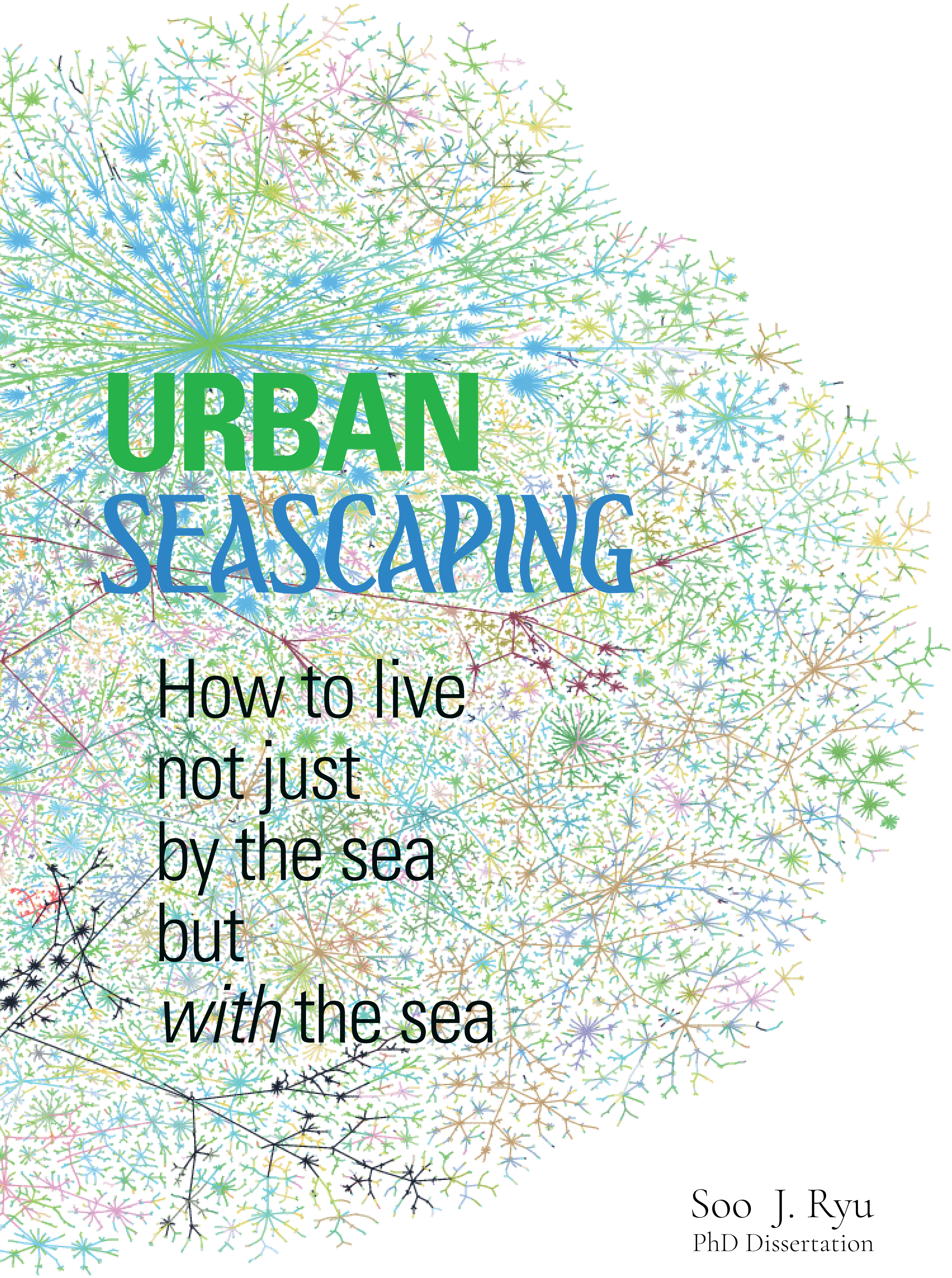

URBAN SEASCAPING

How to live not just by the sea but *with* the sea

Soo J. Ryu

PhD Dissertation

Urban Seascaping

CHANGES TO THE ORIGINAL DOCUMENT

April 2023

The following content below is the edits from the original dissertation document submitted (19/12/22) to the PhD School at the Aarhus School of Architecture:

- **On page 154, section 3.1.4: The following sentence is crossed out as it is a repeated paragraph:** ~~Furthermore, the current dominant hard approaches as a solution for coastal protection, such as seawalls, dikes or locks, also impedes the survival of these coastal natures. First, it interferes with the local hydrology, sediment flows and nutrient exchange from land to the ocean and vice versa, which can deprive many existing coastal ecosystems – such as coastal wetlands, salt marshes, eelgrass, and seaweeds – of needed nutrients for survival by trapping them within the physical structures (Pilkey and Young, 2011; Quintana, Kristensen and Petersen, 2021) (see Figure 58). Second, these hard structures can prevent coastal ecosystems (mainly meadows and marshes) from migrating upland as the sea level rises (termed "coastal squeeze"), effectively removing their vital contribution to biodiversity, carbon sequestration, water filtration, wave attenuation and so on, as shown in Figure 59 (Ebbensgaard et al., 2022b). Third, these hard approaches often remove the existing coastal habitats, which play a critical role in the ecological connectivity between land and water (Bishop et al., 2017) (see Figure 58).~~

- **The following references are missing from the References list in the original document:**

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Urban Seascaping

How to live not just by the sea but with the sea

By Soo Jung Ryu

PhD Dissertation
Aarhus School of Architecture

Urban Seascaping - *How to live not just by the sea but with the sea*
Seaweed as a catalyst for coastal urban transformation in the age of the Anthropocene

PhD dissertation (monograph) submitted on the 19th of December 2022
to the Aarhus School of Architecture (AAA)
in fulfilment of the requirement of the degree of Doctor of Philosophy by:

BAS, BArch (Hons), MArch, MSc

Primary supervisor: Professor Tom Nielsen from AAA
Project supervisor: Associate Professor Katrina Wiberg from AAA
Assessors: Associate Professor Nancy Couling from Bergen School of Architecture and Associate Professor Gillian Lawson from Lincoln University
Internal assessor (chairwoman): Associate Professor Urszula Kozminska from AAA

Cover image: Hal Burch and Bill Cheswick (1999)
Cover design: Soo Jung Ryu
Copy editor: Nicolai Skiveren

DEDICATION

Dedicated to my parents and grandmother (1932-2022), who used to make the most delicious Korean seaweed soup ("Miyeok Guk" 미역국).

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Tusind tak til alle!

CONTENTS

SUMMARY (ENGLISH VERSION)

Urban shorelines are markers of the contested site between the city and the sea. For centuries, coastal cities have expanded their influence further into the sea in the form of land reclamation (also termed "ocean sprawl"), which is responsible for habitat loss, decrease in biodiversity and water pollution. The sea has increasingly become a backdrop to support the growth of business-as-usual (B-A-U) urban developments that are not conducive to the changing climate nor capable of moving beyond the exploitative and superficial engagement with the sea that most cities practice today. However, the consequences of climate change are challenging the sprawl, as the sea is pushing back onto coastal cities in the form of sea level rise and frequent storms. The dominant way coastal cities have responded to this encroachment has been defence-driven mechanical handling of water via sea walls and pumps, a symptom of a reactive rather than proactive response in addressing the climate crisis.

In response, this PhD research develops an initial hypothesis and a critical proposition called "Urban Seascaping" as an alternative way to re-envision urban coastal developments by exploring the potential of marine nature as an active part of the sociocultural cityscape and its future resilience. Nature-based solutions are emerging as a key component in coastal adaptation and mitigation strategies as climate change mitigation. Furthermore, the green transition of coastal cities is becoming paramount in addressing the rapidly approaching IPCC deadlines/Paris Agreement. The benefits of nature-based solutions are myriad, as they lessen not only the impact of storm surges or coastal erosion but also their capacity to capture carbon, produce oxygen, filter water pollutants, and increase biodiversity as habitats, to name a few. Thus, the research asks: *How can coastal cities of Denmark integrate the sea and its lifeforms to contribute towards re-envisioning urban development in light of a sea level rise and frequent storm surges?*

Too often, issues regarding the changing interface between the city and the sea have been the domain of applied science (i.e. coastal engineers) and natural science (i.e. marine biologists/ecologists) with an emphasis on defence and marine restoration. There has been a lack of engagement from the spatial design disciplines, which might offer a transdisciplinary holistic approach to re-envisioning the entanglements between cities and the sea. However, in the past decade, emerging practices such as Blue urbanism, Coastal urbanism and Urban Ecology have gained traction as a framework for coastal urban development. Therefore, to explore further the role of spatial design disciplines in aiding the increasing complexities and the need for the synthesis of transdisciplinary approaches, the second and third sub-research question of this project asks: *How can design research methods and practice from the spatial design disciplines of LUDP contribute to responding to the changing spatial boundary between city and sea, human and nonhuman, due to climate change? What ways of thinking and doing (i.e. world views, representational and analytical tools) can help the spatial design disciplines of LUDP address the aforementioned research questions?*

Much of the existing research on how to integrate marine nature-based solutions in coastal cities by the spatial design disciplines has largely focused on eelgrass restoration, salt marsh and meadows. In contrast, very little attention has been paid to seaweed, the potential of which remains understudied in the field. This is a problem because the different species of seaweed have several unique and positive characteristics that may contribute to marine nature-based solutions. Seaweed

can provide not only beneficial ecosystem services but also influence human culture, for instance, as local cuisine in the form of a sustainable and healthy form of food or in its many applications in medicine, cosmetics, and bio-material, to name a few. Therefore, this project focuses on seaweed as a representative of marine nature in the context of urban coastal development. With seaweed as the lens to investigate the research questions, the project develops the concept of Urban Seascaping, which invites the idea of "seascaping" with seaweed in coastal urban environments, much like the way we landscape with trees and flowers. Ultimately, the intention of this conceptual proposition is to find alternative ways of reconceptualising the current dualistic relationship between the city and the sea that characterise B-A-U developments.

Furthermore, the concept of Urban Seascaping has been developed to present a set of guidelines and perspectives that together provide a framework that can aid in assessing and making informed design decisions for waterfront developments. In the project, four main propositions are put forward. The first proposition departs from an emerging approach called "Multispecies Urbanism" by Debra Solomon, which suggests that cities should not be designed only for human occupation but for other (nonhuman) species. In the context of this research, this means extending the design thinking to include marine life (i.e. seaweed) as a design client and as a rightful resident of coastal cities that people need to learn to coexist with. The second proposition involves a more radical approach to coastal development, which suggests inviting the agency of the sea into the cities. This means departing from the current approach to constantly expand further out into the sea in the form of land reclamation and to embrace the rising sea level with the intention of transforming the waterfront areas into a more hybrid and dynamic place. The third proposition emphasizes the need to go beyond the current preoccupation with "the edge" in favour of "a zone" when implementing nature-based solutions. This means addressing the interconnected networks of water that expand further into the landscape and out into the seascape, effectively challenging the conventional conception of a site. The last proposition highlights the importance of making visible marine lifeforms that are otherwise imperceptible to the human residents of coastal cities. This proposition addresses the longstanding exclusion of marine lifeforms in urban development and planning and thus seeks to engage in a spatial design approach that can bring them to the foreground and make their presence more known.

Putting the Urban Seascpaing propositions to the test, the project investigates the case study context of Vejle, a coastal city in Denmark listed under the flood risk zone assigned by the EU Coastal Directives. Due to its location at the bottom of a river valley where it meets the fjord, the city faces increasing issues with rising sea levels and storm surges. Therefore, in 2020, Vejle Municipality placed an open call for a design competition called "Kanten/The Edge". It invited practitioners from the field of art, architecture, landscape architecture and urban design to redesign two main "edge" conditions between the city and the fjord using innovative nature-based solutions to protect Vejle from future scenarios of sea-level rise and storm surge. Kanten/The Edge competition marked the start of a green transition in the waterfront towards a public space that is accessible, recreational, artistic and adaptative. In short, the competition sought to provoke alternative perspectives and engagements with the water.

Guided by these four propositions, the dissertation presents an in-depth analysis of the case competition itself – along with its design entries and winners. In this way, the competition is used in the project as a source for design "data" analysis and thereby as a way to provide answers to the research questions mentioned above. The analysis demonstrates that engaging with fluid entities such as water necessitates going beyond the neat boundaries of conventional design sites (i.e. the edge condition). Ultimately, this meant exploring beyond the confines of the site allocated by Kanten/The Edge competition to one considering multiple scales, long-term timeframes and different perspectives. In short, a deep reading of the complex entangled characteristics of the context was needed. To accomplish this, the dissertation develops a multiscalar network mapping tool that can effectively visualise the relationship between the history of urban development and its interconnection to the landscape-seascape continuum. Specifically, three maps were developed, each of which presents a different set of relations across time and space that seek to situate Vejle in various contexts and timeframes, from the microscopic to the global. This act of mapping exemplifies the dissertation's use of the research-through-design methodology, which offers itself as a helpful tool in formulating possible projections of design solutions in Vejle. Finally, the method of mapping proved to be an apt medium to translate the four propositions of Urban Seascaping into general applicable design principles and parameters through a legible common visual language.

As a result of the map-driven deep site analysis guided by the Urban Seascaping propositions of the Kanten/The Edge entries, the project reports several findings and suggestions for both the Vejle context and urban coastal development in general. The broadest and most important of these findings is the need for the LUPD disciplines to foreground relationality and transdisciplinary collaboration in their engagement with the urban shoreline. In engaging with the fourth Urban Seascaping proposition of "making the invisible visible", it became apparent on a micro-scale that seaweed on the waterfront remains imperceptible and difficult to thrive due to the poor water clarity of the fjord, which inhibits the success of marine nature-based solutions. Following the multiscalar network, the map demonstrates a causal relationship between the murky water and the significant amount of floating nutrients discharged from agricultural runoffs, thus illustrating a move from the micro-scale to the watershed scale. In turn, looking at the watershed scale necessitates limiting the sources of water pollution from a landscape perspective by engaging with wetlands next to the watercourse to capture the pollutants as much as possible before they are dispelled into the fjord. While Vejle Municipality is already implementing these wetland restorations, Kanten/The Edge could exemplify this green-to-blue, upstream-to-downstream transition in the waterfront area, tying the water's network through walking trails and spatial design. The research findings also found that engaging with marine nature-based (with seaweed) requires a much larger scale of engagement to be effective in mitigating the impacts of climate change beyond the confines of an edge condition (i.e. a "blue line").

Kanten/The Edge's winning proposal engaged with the second proposition to invite the agency of the sea by allowing the water to transform the waterfront area into an aquatic terrain. Another winning proposal engaged with the third proposition to go beyond the edge conditions by expanding the nature-based solutions out into the water in reference to the coastal areas lost previously from the land reclamation process. Both proposals demonstrated expanding the conception of an edge to a larger zone by conceiving the larger waterfront area as a buffer zone. Therefore, the landscape approach in the winning entries of Kanten/The Edge demonstrated a long-term plan to gradually transform the waterfront into a new form of blue commons. Here stone reefs, rock pools, and floating platforms would be placed out into the water, and the design of a landscape-to-seascape transition could provide a tactile and visual-spatial experience. This formation of a blue urban commons would open up the current inaccessible harbourfront to the public, providing an opportunity for a much more democratic meeting place between humans and nonhumans, fostering multispecies coexistence (i.e. the first proposition). The winning proposals from Kanten/The Edge integrated art into rethinking the entire waterfront, for instance, by introducing a sculptural house fit for a fish by flipping the perspective upside down. Although Kanten/The Edge is a small precedent in an emerging alternative blue-green transition for coastal cities, the dissertation suggests that the competition has generated several pioneering examples and insights that can lead to imagining better practices.

Lastly, engaging with long-term scenarios beyond this century showed that with extreme sea level rise and storm surge events, suburbs on top of the river valley in Vejle would be safe, while the current city centre at the waterfront would be completely submerged. This scenario sediments the fact that it no longer makes sense to keep developing B-A-U in the risk zone. Thus, the research suggests opting for a sensible long-term retreat plan that diverts the developments on higher grounds, providing room for more visionary solutions on the waterfront that mutually benefit people and coastal ecosystems. If a meaningful transition to net zero is expected by 2050 (as outlined in the IPCC report), a more radical rethinking of the current boundary between city and sea is needed. This involves conceptualising the site in question as a multiscalar, temporal, hybrid and interconnected zone that can address the challenges of climate change more effectively. Hence, Urban Seascaping serves as a critical proposition to induce transdisciplinary discussions on the value of integrating the forgotten and invisible agency of the marine realm into the visible urban realm for an equitable meeting place between humans and nonhumans. It contributes to the emerging field of blue urbanism and coastal urbanism from the lens of seaweed. That being said, it is not only a story about seaweed, but an ongoing and unfinished story of relations, entanglement, response-ability and extending our understanding beyond our immediate borders. Urban Seascaping with seaweed presents a small yet significant piece of the puzzle in addressing the climate crisis and the role the spatial design disciplines can play in coastal urban development.

SUMMARY (DANISH VERSION)

Den urbane kystlinje er et omstridt sted, der markerer mødet imellem hav og by. I århundreder har kystbyerne udvidet sig og overtaget områder, hvor der engang var hav. Disse landvindinger har ødelagt habitater for planter og dyr, mindsket biodiversiteten og ikke mindst forurenet vandet. Havet har med andre ord været et sted, som den gængse form for byudvikling har kunnet udnytte til egen vinding. Imidlertid er et endnu mere grundlæggende problem med vores nuværende udvikling af kystbyernes havnefronter, at de ikke er i stand til at imødekomme de vandstandsstigninger, der opstår som konsekvens af klimaforandringerne. Hertil kommer også det faktum, at vores måde at planlægge mødet mellem by og hav ikke fordrer andre måder at forholde sig til havet på. I dag er et nyt vilkår dog det, at havet nu er begyndt at svare igen med vandstandsstigninger og hyppigere stormfloder som opstår på grund af klimaforandringerne. Indtil videre har den primære måde at håndtere denne udfordring bestået i at bygge forsvarsorienterede og mekaniske kystsikringer, der kan kontrollere vandet ved at holde det ude, som man eksempelvis ser det med havnemure og pumper. Disse tiltag er alle symptomer på den reaktionære – snarere end proaktive – tilgang, der karakteriserer vores måde at adressere klimaforandringer i byerne på.

Som et alternativ til denne reaktionære form for kystsikring præsenterer nærværende ph.d.-afhandling konceptet 'Urban Seascaping' i et forsøg på at gentænke byudvikling ved kysterne fundamentalt. Intentionen med projektet er at udforske, hvordan havets egen natur kan gøres til en aktiv del af det sociokulturelle bylandskab og dets fremtidssikring. I øjeblikket er naturbaserede løsninger på klimatilpasning i fremvækst, ligesom den grønne omstilling af vores havnebyer er blevet mere vigtig end nogensinde før – særligt i lyset af de hurtigt fremstormende deadlines, der er givet af IPCC og Parisaftalen. Her er fordelene ved natur-baserede løsninger mange. De kan reducere de værste effekter af stormfloder og erosion ved kysterne. De kan også indfange CO_2 og producere oxygen. Og de kan filtrere forurenet vand og dermed skabe habitater for biodiversitet. Med dette afsæt søger nærværende ph.d.-afhandling at svare på følgende spørgsmål: *Hvordan kan kystbyer i Danmark integrere havet og dets livsformer på måder, der kan bidrage til at gentænke byudvikling i lyset af vandstandsstigninger og hyppigere stormfloder?*

I den eksisterende forskning på området er det typisk fagfolk som ingeniører eller biologer/økologer, der har beskæftiget sig med den omskiftelige kontaktflade mellem by og hav. Afhængigt af hvem af de to grupper, man spørger, vil fokus typisk ligge på enten kystsikring eller naturgenopretning. Til gengæld er forskning fra designdisciplinerne sværere at få øje på. Og det er et problem, eftersom der netop er behov for kompetencer, der kan igangsætte den trans-disciplinære og holistiske tilgang, som udviklingen ved kystlinjen kalder på. Som svar på dette videnshul er der i de seneste årtier blusset en række nye forskningsfelter op som *blue urbanism*, *coastal urbanism* og *urban ecology*. I sit forsøg på at udforske, hvad disse discipliner kan tilbyde kystudviklingen i byerne, stiller afhandlingen følgende to underspørgsmål, der netop fokuserer på, hvordan den trans-disciplinære tilgang kan imødekomme vandstandsstigningernes kompleksitet: *Hvordan kan forskning i designmetoder og de rumorienterede designdiscipliner ("spatial design disciplines") som eksempelvis landskabsarkitektur, byplanlægning og design bidrage til håndteringen af den omskiftelige rumlige grænse mellem by og hav, menneske og ikke menneske, i lyset af klimaforandringer? Hvilke*

repræsentationsorienterede analyseværktøjer kan disse discipliner benytte sig af i forsøget på at adressere dette spørgsmål?

I afhandlingens kapitel 3 gives der en indføring i den eksisterende forskning inden for naturbaseret kystudvikling. Indtil videre har denne forskning primært fokuseret på potentialet i at genetablere ålegræs, saltmarsk og eng. I modsætning eksisterer der nærmest ingen forskning i potentialet af tang i denne kontekst. Dette er et problem, eftersom tang besidder adskillige positive egenskaber, herunder dens mange såkaldte ecosystem services (tang renser vandet, luften og miljø). Hertil kommer tangs indflydelse på menneskers kultur, hvor tang blandt andet benyttes i gastronomiske sammenhænge som sund og bæredygtig kost samt i medicin, kosmetik og bioplastik for at nævne et par eksempler. Af denne grund spørger afhandlingen særligt ind til, hvad tang kan bringe til bordet, når det kommer til vores udvikling og gentænkning af kysten i byen. Således er en af grundtankerne i begrebet 'Urban Seascaping' spørgsmålet om, hvordan tang kan integreres på lige fod med blomster, træer og andre elementer i kystbyens designede landskab. Hensigten med netop dette eksperiment består dermed i at finde nye måder, hvorpå vi kan udfordre den dualisme, der adskiller kystbyens befolkning fra det hav, der omgiver dem.

I denne forbindelse er det vigtigt at nævne, at 'Urban Seacaping' ikke skal forstås som en æstetisk øvelse. Begrebet introducerer nemlig også en række vigtige rettesnore og perspektiver, der tilsammen udgør en ramme, som kan være givtig, når der skal træffes informerede beslutninger om havnefronternes udvikling. I projektet fremstilles der således fire centrale principper. Det første princip har afsæt i et spirende felt og praksis ved navn *multispecies urbanism*, som er udviklet af Debra Solomon. Dette felt fremhæver, at byer ikke blot bør designes efter en menneskelig befolkning, men altså også alle de ikke-menneskelige arter (dyr og planter), der bor i vores byer. I denne forbindelse søger afhandlingen at udvide parametrene for vores designtænkning, således at de også inkluderer havets arter (herunder tang). Tang og andre ikke-menneskelige livsformer adresseres således i afhandlingen som en art 'design client' og som en retmæssig borger i kystbyerne. Det andet princip involverer en mere radikal tilgang til kystudvikling. Med dette forslag argumenterer afhandlingen for, at det er på tide at tilsidesætte den gængse tilgang til byudvikling, hvor landvindinger tager områder fra havet, og i stedet invitere havet – dets arter og dets kræfter – *ind* i byerne. Hermed er tanken at omdanne havnefronterne til hybride og dynamiske steder, hvor både land og hav kan være til stede. Det tredje princip består i at erstatte vores nuværende forståelse af havne*kanten* med en *zone*. Det indebærer blandt andet, at man må adressere de mange forbindelser og netværk, som vandet udgør på land i form af åer og vandløb. En afladt konsekvens af dette princip består dermed i, at den konventionelle idé om et 'site' som et afgrænset område, hvori der skal interveneres, ikke længere er gangbar. Det fjerde og sidste princip fremhæver vigtigheden i at gøre det usynlige synligt. For mange menneskelige byboere er havets natur ikke tilgængeligt for det blotte øje, hvorfor det ofte ender med at blive ignoreret. Dette princip udfordrer således den tendens, man har i den nuværende byplanlægning til at ekskludere havets væsner fra vores beslutninger, for i stedet bringe disse til syne, således at de kan medtænkes i vores udviklinger langs kysten.

For at teste gangbarheden af disse principper præsenterer afhandlingen en analyse af et casestudie. Dette casestudie fokuserer på Vejle, som er en kystby i Danmark, der blandt andet er listet i EUs *Coastal Directives* som værende i overvejende risiko for oversvømning. Grundet byens placering i bunden af en ådal, der løber ud til fjorden, står Vejle over for en række udfordringer med hyppigere stormfloder og vandstandsstigninger mere generelt. Af denne grund igangsatte Vejle Kommune i 2020 en konkurrence (ved navn 'Kanten'), der inviterede fagfolk inden for kunst, arkitektur, landskabsarkitektur og urban design til at gendesigne to af de såkaldte 'kanter' mellem by og fjord. Opslaget specificerede at forslagene skulle benytte sig af naturbaserede løsninger, som kunne beskytte Vejle mod fremtidige vandstandsstigninger og stormflod samt omdanne kanten til et offentligt rum, der kunne tilgås for rekreative, kunstneriske og klimatilpasningsrelaterede aktiviteter. Kort sagt søgte konkurrencen at igangsætte et alternativt perspektiv og engagement med vandet ved byen.

På baggrund af de fire principper analyserer afhandlingen konkurrencen og de fire vindende forslag. På den måde udgør konkurrencen altså projektets "design data", som udforskes med henblik på at give svar på forskningsspørgsmålene stillet ovenfor. Analysen demonstrerer blandt andet, at udviklingsarbejdet med et flydende parameter som eksempelvis vand indebærer en ny forståelse af, hvad der udgør et 'site'. Analysearbejdet fordrede altså at man måtte se ud over de to specifikke lokationer, som konkurrencen havde nedsat, og i stedet undersøge casestudiet i Vejle i lyset af forskellige skaleringer og på tværs af tid og rum. Som konsekvens af dette behov udvikler afhandlingen et netværksbaseret kortlægningsredskab, der kan drage forbindelser på tværs af forskellige skaleringer (lokal, regionale, national, globale, osv). Mere konkret kortlægger afhandlingen tre netværk, der forsøger at placere Vejle i forskellige kontekster ((1) i forhold til andre case studies, (2) i forhold til dets omgivelser og (3) i forhold til handlinger i fortiden, nutiden og fremtiden). Denne kortlægningsstrategi udgør således projektets brug af den såkaldte 'research through design' metode, som afhandlingen benytter til at formulere mulige projekteringer og designløsninger i Vejle-casen. Slutteligt har kortlægningsmetoden også vist sig at være et givtigt redskab til at oversætte Urban Seascapings fire principper til mere generelle og brugbare designkoncepter og parametre i et forståeligt og fælles visuelt sprog.

Igennem disse analyser fremstiller afhandlingen en række konklusioner og forslag. Den bredeste og vigtigste konklusion er, at det er absolut afgørende, at designdisciplinerne formår at håndtere kompleksitet og have øje for relationer i deres arbejde med kystudvikling i byerne. For eksempel kan man – i forlængelse af det fjerde princip om at gøre det usynlige synligt – fremhæve, at det ikke er muligt at *se* tangen i Vejles fjord grundet de dårlige vandforhold, hvilket begrænser adgangen og muligheden for at benytte tangen til forskellige naturbaserede løsninger. Ved at følge noderne i netværkskortet bliver det imidlertid hurtigt synligt, at der er et kausalt forhold imellem landbrugsafstrømning og de dårlige forhold i fjorden, hvormed en relation imellem det mikroskopiske (vandets transparens) og det regionale (landbruget i området) optegnes. I den regionale skalering af netværkskortet fremhæves således vigtigheden af at eliminere forurenende stoffer, før de når fjorden. På denne måde demonstrerer afhandlingen, hvordan forskellige forhold – på tværs af tid og rum – er nødvendige for at forstå det 'site', som konkurrencen ønsker at intervenere i. I mere praktisk forstand kan netværkskortet således også vise, hvorfor det er nødvendigt for en konkurrence som Kanten at relatere de to sites til andre vandforhold, såsom områderne, der ligger længere oppe af de vandløb, der løber langs byen, og som eventuelt kunne forbindes yderligere via stier og andre designløsninger.

Vigtigheden af det andet og tredje princip (henholdsvis idéen om at gå fra en 'kant' til en 'zone' og idéen om at 'invitere vandet ind') kom også til syne i analysen af de forskellige designforslag. I denne forbindelse fremhæver afhandlingen potentialet i de design, som forsøgte at give plads til vandet og lade det forme omgivelserne. Flere af de vindende forslag i konkurrencen projekterede udviklinger, hvor kystlinjen blev omdannet til et nyt blå fællesareal. Stenrev, flydende platforme og stenpytter ville blive skabt i vandet, som kunne sammentænke landskabet med vandet og give adgang til et mere demokratisk mødested for både mennesker og ikke-menneskelige livsformer. Dermed relaterer det tredje princip sig til det første princip, der fremhæver *multispecies co-existence*. De vindende forslag integrerede kunst i deres gentænkning af vandkanten, eksempelvis ved at skabe en skulptur, der kunne fungere som et hus for fisk, hvormed perspektivet skifter fra menneske til dyr. Selvom Kanten selvfølgelig kun udgør et lille skridt i den rigtige retning mod den blå-grønne transformering af vores kystbyer, har konkurrencen – med sine innovative designløsninger – genereret ny viden og indsigt, der med tiden kan lede frem til at vi kan forestille os bedre måder at udvikle vores kystbyer på.

Slutteligt viser afhandlingens projekteringer i et langtidsperspektiv, at forstæderne i Vejle – på toppen af ådalen – vil være sikret mod vandstandsstigninger, hvorimod det nuværende bycentrum vil blive komplet oversvømmet. Dette fund sedimenterer vigtigheden af ikke at forsætte den gængse byplanlægning i riskozonen. Således foreslår afhandlingen altså at en rationel tilbagetrækningsplan bør udformes, hvor byens menneskelige beboere kan flytte mod de højereliggende lokationer. Denne plan ville således også kunne inkludere visionære løsninger, som kunne imødekomme både mennesker og de kystlige økosystemer. Ifølge IPCC skal vi som verdenssamfund reducere vores kulstofudledninger i 2050 og netop denne udfordring kræver, at vores forhold mellem by og hav skal forandres. Urban Seascpaing præsenterer én løsning på, hvordan denne forandring kan og bør finde sted. Med dets designevaluerings- og kortlægningsværktøj demonstrerer afhandlingen – her med et særligt fokus på tang – hvordan forskellige velovervejede og designede forandringsprocesser i vores kystbyer kan udgøre en mindre, men stadig betydelig brik i det puslespil, der tilsammen udgør den klimakrise, der definerer den Antropocæne tidsalder, vi lever i.

DEFINITIONS OF KEY TERMS

Here are some key terms used throughout this research for the novice reader.

Actor	An actor refers to any entity that can be described as the source of a given action. While this conventional use of the notion of an actor is still widely used in everyday language, scholars such as Bruno Latour (2007) have actively sought to complicate this model of the actor, suggesting the term "actant" instead, which in his view, include "any entity that does things" (Jackson, 2015, p.31), meaning that they can both be human and nonhuman. Latour's mode of actor-network-theory emphasizes that any process of action will always be enabled by networks of actors that may be enabling (e.g. a door handle making possible the opening of a door) or obstructing each other (e.g. a speedbump restricting cars from speeding).
Affect	Conventionally speaking, affect as a verb – *to affect* – is used to refer to the act of producing an effect (usually emotions) in someone (Merriam-Webster, n.d.). When used as a noun, affects may refer to "a set of observable manifestations of an experienced emotion" (Merriam-Webster n.d.). Generally speaking, there are two primary uses of the term that can be identified within philosophy. On the one hand, the definition of affect signifies a body's capacity to affect and be affected. It is usually pre-personal and pre-cognitive (Massumi, 1995), meaning that we do not experience affect; rather, affect is what comes *before* our conscious experience of emotions. On the other hand, some do not insist that affect qualitatively differs from personalised emotion (Wetherell, 2013).
Affordance	The concept of affordance was first coined by psychologist James Gibson (1979), who developed the concept in *The Ecological Approach to Visual Perception*. In this work, Gibson defined the concept as follows: "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary; the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment" (Gibson 1979, p.127). As a psychological theory about perception, Gibson's concept of affordance was developed to arrive at a fuller understanding of the interactions that take place between a subject and its environment. In this context, Gibson's concept emphasizes the significance of the various potential trajectories of actions that any given environment might present to the perceiving subject, whether human or nonhuman.

Agency

The notion of agency is commonly used to denote "the capacity, condition, or state of acting or of exerting power" (Merriam-Webster, n.d.). This capacity may take on very concrete meanings (e.g. if a person is able to move freely around a given space, the person can be said to have some degree of agency) as well as more abstract meanings (e.g. if citizens are able to influence the planning decisions of the city they live in, they can also be said to have some degree of agency). Accordingly, if someone can do neither of these things, they can be said to *lack* agency. While these two uses of agency emphasize the capacities of human individuals, recent developments within the fields of posthumanism and new materialist philosophy have sought to actively complicate this understanding of agency. Notably, Jane Bennett (2010) has called attention to the fact that nonhuman entities (whether it be an algae species or a rock reef) also embody some form of agency (as seen in the capacity of seaweed to sequester carbon dioxide). Importantly, this theorization of the nonhuman agency should not be construed as synonymous with the view that nonhuman entities (such as seaweed) enact their agency with the same kind of intentionality that underwrites the examples with humans offered above, see *affordance*). Rather, what is at stake in much of the recent writing about the nonhuman agency is a redefinition of what we might normally mean by this term.

Anthropocene

Ecologist Eugene Stoermer first coined Anthropocene in the early 1980s and again by chemist Paul Crutzen in 2000 (Crutzen and Stoermer, 2000). The Anthropocene is the new concept of geological time that proposes humanity as the main geological force and agent. It argues that human activity (namely, extraction of resources and burning of fossil fuels) is the main reason behind the fundamental transformation of the biosphere (Moore, 2016). There are several propositions about when the Anthropocene period began (i.e., the onset of the industrial revolution). However, in 2016, the Anthropocene Working Group agreed that the Anthropocene began in the year 1950 when the exponential increase in human activity (population growth, resource consumption, etc.) took off, called "The Great Acceleration", which started to affect the entire planet (National Geographic Society, 2019).

Anthropocentrism

According to Encyclopaedia Britannica, anthropocentrism is a "philosophical viewpoint arguing that human beings are the central or most significant entities in the world. This is a basic belief embedded in many Western religions and philosophies. Anthropocentrism regards humans as separate from and superior to nature and holds that human life has intrinsic value while other entities (including animals, plants, mineral resources, and so on) are resources that may justifiably be exploited for the benefit of humankind" (Boslaugh, 2016).

Algal/Algae bloom	An algal bloom or algae bloom is a rapid acceleration in the population of algae in marine or freshwater systems. The term algae include many different types, both microscopic unicellular organisms like cyanobacteria and macroscopic multicellular organisms like seaweed. Algal bloom commonly refers to the rapid growth of microscopic algae, not macroscopic algae. An example of a macroscopic algal bloom is a kelp forest (Barsanti and Gualtieri, 2014). See also "eutrophication".
Bathymetry	Bathymetry is the study of the underwater depth of ocean floors, lake floors, or river floors. Bathymetry is the underwater equivalent of topography (NOAA, 2021).
Coastal ecosystem	"A coastal ecosystem includes estuaries, coastal waters, and lands located at the lower end of drainage basins, where stream and river systems meet the sea and are mixed by tides. The coastal ecosystem includes saline, brackish (mixed saline and fresh), and fresh waters, as well as coastlines and the adjacent lands… Shorelands, dunes, offshore islands, barrier islands, headlands, lagoons, and freshwater wetlands within estuarine drainages are included in the definition of coastal ecosystem since these interrelated features are crucial to coastal wildlife and their habitats. A variety of animals and plants complete the ecological system" (Convertino et al., 2013).
Coastal Wetland	Coastal wetlands are in the coastal (transition) zone between land and sea, where it is regularly inundated in fresh, brackish, or saline water all or part of the year that contains a variety of vegetation and animals that are uniquely adapted to those conditions (Hatvany, 2009).
Dredging or clapping (*klapning* in Danish)	Dredging is the act of excavating to clear things like mud, weed, beds, and soils from a sea or a riverbed. Clapping restructures the seabed morphology by depositing the dug-up materials elsewhere, especially into the sea (i.e. Danish coastal areas). It is a necessary practice for creating and maintaining land-reclaimed ports (Plesner and Flindt, 2022).
Ecological connectivity	Life on land and sea are closely connected by a network of estuaries and coastal ecosystems which are strongly dependent on each other. Marine life forms move back and forth and exchange energy and materials that make up the ecological connection of this boundary zone between land and sea (Belletti et al. 2020). The ecological connectivity among streams and coastal waters as well as among coastal habitats such as continuous zones of salt marshes, seaweeds, and seagrasses, is critical for species to feed, reproduce, distribute over large spatial scales and assure recruitment of next populations (Bishop et al. 2017).
Ecological infrastructure	According to Kate Orff (2016), "ecological infrastructure refers to naturally functioning ecosystems that deliver valuable services to

people. Within urban environments, this type of system can be amplified to help create resilient cities" (Orff, 2016, p.220).

Ecosystem services

According to Encyclopedia Britannica: "Ecosystem services, outputs, conditions, or processes of natural systems that directly or indirectly benefit humans or enhance social welfare. Ecosystem services can benefit people in many ways, either directly or as inputs into the production of other goods and services" (Johnston, 2018).

Eelgrass (seagrass)

Although eelgrass is not seaweed, it is commonly mistaken for seaweed in Denmark and is inaccurately categorised. Eelgrass (ålegræs in Danish) is a species of seagrass (havgræs in Danish) are considered a plant with roots, stems and leaves, while seaweed is multi-cellular algae (Mouritsen, 2019; Høgslund and Holmer, 2022).

Eutrophication

Eutrophication is a process of pollution that occurs when a water body has excess nutrients in the water from runoffs from fertilisers, pesticides and wastes from animals and humans. As a consequence, it becomes overgrown with algae and other aquatic plants that decompose and rob the water of oxygen, killing marine animals (European Environmental Agency, n.d.). See "algal bloom".

Fjordbyen

Fjordbyen in Danish translates to "The Fjord City," which indicates the waterfront and the harbourfront district in the city of Vejle, Denmark, which includes the Lystbådehavn (Marina) area on the waterfront.

Geovisualisation

Geovisualisation (short for geographic visualisation, also known as cartographic visualisation) refers to a set of tools and techniques supporting geospatial data analysis through interactive visualisation. "Geovisualisation provides an opportunity for the creator or user of the visual (i.e. map) to explore data and reveal previously hidden patterns, unknowns, and marginalized perspectives. Geovisualisatopm can therefore provide unique perspectives while opening up new possibilities to manipulate and interpret the visual. By extension, GIS and geo visualisation make it possible to 'see' the spatial dimensions of complex urban social and ecological relations in ways conventional mapping cannot" (Jung and Anderson, 2017).

GIS

"A geographic information system (GIS) is a system that creates, manages, analyses, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). This provides a foundation for mapping and analysis that is used in science, industry and academia. GIS helps users understand patterns, relationships, and geographic context" (Esri, 2022).

Kelp (forest)

"Kelp ecosystems (also known as kelp forests) span from temperate to polar regions on rocky substrates worldwide and have been estimated to cover a quarter of the global coastline. Dense populations of kelps (large canopy-forming brown macroalgae) are the engineers of structurally complex and highly productive submerged ecosystems in the shallow areas of continental shelves (< 50 m depth), supporting high marine biodiversity, from invertebrates to fish and marine mammals" (Williamson and Guinder, 2021). The common names for the most recognised kelp species (brown macroalgae in the *Laminariaceae* family) in Denmark is called "sukkertang", "palmetang", and "fingertang" (Lundsteen and Nielsen, 2019a).

Kumu

Kumu is a powerful data visualisation platform that helps you organize complex information into interactive relationship maps. The main use cases for Kumu are stakeholder mapping, systems mapping, social network mapping, community asset mapping and concept mapping (Kumu INC, 2011; Sage Ocean, 2022).

Land reclamation (*landvinding* in Danish)

"Land reclamation is the process of creating new land from the sea. The simplest method of land reclamation involves simply filling the area with large amounts of heavy rock and/or cement, then filling with clay and soil until the desired height is reached. Draining of submerged wetlands is often used to reclaim land for agricultural use" (Stauber, Chariton and Apte, 2016). See "ocean sprawl".

Late Capitalism

Late capitalism, or late-stage capitalism, was first popularized by the Marxist scholar Werner Sombart as a way to capture the economic boom that occurred from WWII to the 1970s. Later uses of the have resisted this periodisation with the emergence of "postmodernism" from the 1990s and onwards (Jameson, 1990). According to Fredric Jameson's *Postmodernism, or, the Cultural Logic of Late Capitalism* (1990), this link between economy and culture is, made tangible by the fact the fully globalised post-industrial economy that we find ourselves in today itself holds the same contradictions and ironies that we find in postmodern art (or architecture). In this respect, the term late capitalism is used as a way to call attention to the contradictions, perceived absurdities, climate crises, injustices, inequality, and exploitation created by modern business development that defines the contemporary moment.

Littoral zone

In coastal environments, the littoral zone extends from the high-water mark, which is rarely inundated, to shoreline areas that are permanently submerged. It is "a marine ecological realm that experiences the effects of tidal and longshore currents and breaking waves… The zone is characterised by abundant dissolved oxygen, sunlight, nutrients, generally high wave energies and water motion, and, in the intertidal subzone, alternating submergence and exposure… Consequently, the littoral fauna taken as a whole involves an enormous number of species and every major phylum, although the number of individuals may vary widely with the locality" (Britannica and Editors of Encyclopaedia, 2019).

Micro and Macroalgae (seaweed, *tang* in Danish)

"Algae are organisms that perform photosynthesis; that is, they absorb carbon dioxide and release oxygen… and live in water or in humid places. Algae have great variability and are divided into microalgae, small in size and only visible through a microscope, and macroalgae, which are larger in size… and have a greater diversity in the oceans" (Pereira, 2021). "Macroalgae ("seaweeds") belong to either one of three groups of eukaryotic algae: the *Rhodophyta* (red algae), *Chlorophyta* (green algae), and *Phaeophyceae* (brown algae) or to the prokaryotic colony-forming *Cyanobacteria/Cyanophyta* (blue-green algae)" (Littler and Littler, 2011).

Marine Protected Area

"Marine protected areas (MPAs) are geographically distinct zones for which protection objectives are set. They constitute a globally connected system for safeguarding biodiversity and maintaining marine ecosystem health and the supply of ecosystem services. Marine reserves form a subset of MPAs in which impacts from human activities such as resource extraction and fisheries are not permitted. Networks of MPAs or marine reserves operate together at various scales and cover a range of protection levels, which work towards objectives that individual MPAs cannot achieve" (European Environment Agency, 2018).

More-than-human

The term more-than-human is often used to deliberately avoid the dualistic connotations tied to the terms "human" and "nonhuman". The term was first coined by the environmental philosopher David Abram (1997), who coined the phrase "the more-than-human world" in *The Spell of the Sensuous* as a means of referring to what is commonly described as "nature". Since then, several thinkers have adopted the term in an effort to describe the varying degrees of subjectivity that may be associated with beings and environments that are not exclusively human (see, for instance, (Braidotti, 2006; Haraway, 2016; Jaque et al., 2020). In this project, the term will be used interchangeably with "nonhuman" to refer to the marine world, particularly seaweed, as the main representative marine species.

Multispecies coexistence

Multispecies coexistence, multispecies future, multispecies cohabitation, and multispecies response-ability are some of the many terms that deal with the need for co-existing with other species in a more equitable and mutually beneficial manner in the age of the Anthropocene. There are many scholars and proponents of this theory; one of the prominent scholars who made this term well known is Donna Haraway (Haraway, 2007; 2016).

Natura2000

The term is used to refer to a network of protected nature areas in the EU. The areas need to maintain and protect rare and endangered animal and plant species that are characteristic of the EU countries (European Commission, 2021a; Miljøstyrelsen, 2022e).

Nature-based solutions (NbS)

The official EU definition of nature-based solutions "are inspired and supported by nature, which is cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more and more diverse nature and natural features and processes into cities, landscapes and seascapes through locally adapted, resource-efficient and systemic interventions. Hence, nature-based solutions must benefit biodiversity and support the delivery of a range of ecosystem services" (European Commission, 2021b).

Node

A point in a network or diagram at which lines or pathways intersect or branch. It is referred to in this research on the Kumu maps, where the nodes host various information and can be connected to other nodes.

Ocean literacy

Ocean literacy is an understanding of society's impact on the ocean and vice versa. For instance, an ocean-literate person understands fundamental concepts about how the ocean functions and thus is capable of engaging in discussion about the ocean in an informed manner that could also lead to decision-making about how the ocean and its resources should be handled (Kelly et al., 2022).

Ocean Sprawl

Ocean sprawl is the act of expanding human activity out into the ocean near the coastal areas by reclaiming land from the sea for human use by dredging and draining the water to make space for industrial, commercial, residential and recreational activity. Duarte et al. (2012) are the first to coin the term (Pilkey and Young, 2011; Firth et al., 2016). See "land reclamation".

QGIS

QGIS is a free open-source cross-platform that functions as geographic information system software that allows users to edit, analyse and compose spatial information. Additionally, exporting graphical maps for viewing and printing (QGIS, 2022).

Rights of Nature

According to IPBES, "Rights of Nature is a legal instrument that enables nature, wholly or partly, i.e. ecosystems or species, to have inherent rights and legally should have the same protection as people and corporations; that ecosystems and species have legal rights to exist, thrive and regenerate. It enables the defence of the environment in court – not only for the benefit of people but for the sake of nature itself" (IPBES, 2018).

Salt Marsh

A salt marsh is a coastal ecosystem in the upper coastal intertidal zone between land and open saltwater or brackish water that is regularly flooded by the tides. It is covered with dense salt-tolerant grass-like plants that traps and bind sediments. Since soil is consistently wet from flooding, marshes are extremely nutrient-rich

	and can support a wide variety of plants and animal life while also providing coastal protection (Adam, 1993).
Salt Meadows or Wet Meadows (*eng* in Danish)	"A wet meadow is a type of wetland with soils that are saturated for part or all of the growing season. Unlike a marsh or swamp, a wet meadow does not have standing water present except for brief to moderate periods during the growing season. Instead, the ground in a wet meadow fluctuates between brief periods of inundation and longer periods of saturation… Wet meadows therefore do not usually support aquatic life, such as fish. They typically have a high diversity of plant species, and may attract large numbers of birds, small mammals, and insects" (Los Huertos, 2020).
Seascape	"[S]patially heterogeneous and dynamic [marine] spaces that can be delineated at a wide range of scales in time and space (Pittman, 2017, p.6).
Terrestrial bias	Terrestrial bias is a situated perspective that responds to the fact that humans live on land and thus is bound by gravity and experience daily life as such (i.e., immersion in the air rather than water). This parameter restricts human thinking and experiences to the ones on land, thus lending to biased ways of thinking, perceiving and decision-making to prefer the terrestrial realm as the norm. This can be problematic when dealing with the watery realm of the sea with different parameters and conditions that require human stakeholders to depart from the anthropocentric and terrestrial way of doing things (Jue, 2020).
Tilling	Tilling is the act of preparing the soil for agricultural purposes via machinery to enact digging, stirring, and overturning. Deep tilling was possible due to the invention of powerful machines, which were able to reach deep depths into the geological layer to mix clay with the topsoil, which resulted in contributing to the suspended particles of water bodies as rain washed away these "lighter" soil such as clay (SSSA, 2008; Organo Quintana, 2020).
Topobathy	Topobathy integrates topography (land elevation) and bathymetry (water depths) (ARCGIS, 2022).
Urban Commons	The term urban commons represents shared material and immaterial resources (i.e. land) that belong to or impact the whole community in an urban environment (Hardt and Negri, 2009). It is founded on the guiding principle of equity that fundamentally reconceptualises how we view spaces and entities as something that affects all.

ABBREVIATIONS

AAA	Aarhus School of Architecture (Arkitektskolen Aarhus)
AU	Aarhus University
B-A-U	Business-as-usual
DKK	Danish Kroner
DMI	Danish Meteorological Institute
DTU	Technical University of Denmark (Danmarks Tekniske Universitet)
EPA	Environmental Protection Agency
ES	Ecosystem services
GHG	Greenhouse gas
GIS	Geographic information system
IEA	International Energy Agency
IOC	Intergovernmental Oceanographic Commission
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPLCs	Indigenous People and Local Communities
ISC	International Science Council
IUCN	International Union for Conservation of Nature
KU	University of Copenhagen (København Universitet)
LUDP	Landscape Architecture, Urban Design and Planning
MPA	Marine Protected Area
NIMBY	Not-in-my-back-yard
NbS	Nature-based solutions
QGIS	Quantum Geographic Information System
RCP	Representative Concentration Pathway
RQ	Research question
RtD	Research-through-design
SDU	University of Southern Denmark
SLR	Sea-level rise
S-O-T-A	State-of-the-art
SROCC	Special Report on the Ocean and Cryosphere in a Changing Climate
SRQ	Sub research question
SS	Storm surge
SSTA	Scaled System Thinking Approach
TBC	To be confirmed
UN	The United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USS	Urban Seascaping
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

PREFACE

The purpose of this preface is to explain to the reader the inner workings of the PhDs in the Danish context (especially at the architecture schools), which may differ from other traditions in different countries[1]. The Preface is intended as a reader's guide to the monograph.

Aarhus Architecture School's PhD Call

This research is conducted from 04/09/19 to 19/12/2022 as set out by the requirement of the Danish PhD[2] model of three years. The PhD call is in the interdisciplinary fields of landscape architecture, and urban design (to a lesser extent, urban planning), with the expectation to use design-based research methods (such as research-through-design/research-by-design). The PhD call[3] sets out the point of departure in establishing the primary research question, "How can coastal cities of East Jutland utilise sea-level rise as a power of transformation that positively contributes to rethinking and informing existing urban structures?"

Realdania research network and involvement with Vejle Municipality

This PhD call encouraged collaboration with various stakeholders and researchers (more common in Danish PhDs). Denmark tends to foster more inter-and transdisciplinary collaboration to question the entrenched disciplinary structures, such as pre-established methods and solutions in the spatial design disciplines. I was fortunate enough to be involved with Realdania's[4] research network through my supervisors (Professor Tom Nielsen and Associate Professor Katrina Wiberg, along with other research initiatives from the Technical University of Denmark (DTU) and the University of Copenhagen (KU). The Realdania research network seeks to create and share knowledge and contribute to new research on climate scenarios, risk minimisation and urban development (Realdania, 2019). The main intention behind this network is to strengthen the work across disciplines. The researchers cover many disciplines, including urban planning, architecture, engineering, economy, law, anthropology, political science and biology (Realdania, 2019). The

1 For a text-based dissertation, the length of the written part of the dissertation, excluding footnotes, appendices and bibliography, should be in the proximity of 100,000 words.
Furthermore, if anyone should feel their rights of ownership to any of the images used have been violated, please contact me at: sooryu1984@gmail.com

2 The conditions for a PhD for the Aarhus School of Architecture involve 420hours of teaching, 420hours of dissemination, 30 ECTS points from PhD courses and research stay at a foreign institution for minimum of three months as a requirement that usuallyf needs to tie in with the research.

3 This PhD was a call with a specific research question that the participants were asked to address as part of their proposal.

4 Realdania is a private charitable association in Denmark which supports projects in the built environment through architecture and urban planning. It was established in 2000. See their website https://realdania.dk/ for more information.

involvement in this research network was vital in having access to numerous resources such as relevant academic reports, expert feedback from other disciplines, knowledge exchange with other researchers and stakeholders [5], various lectures/workshops related to my research, and opportunities for collaboration and networks with relevant stakeholders.

Vejle Municipality invited me to get involved with one of the pilot projects from the "Cities and the rising seawater[6]" initiative, funded by Realdania. They asked me to be involved in an open design competition to rethink coastal adaptation and protection systems in Vejle for the future (see section 1.4.1 Vejle's 'Kanten/The Edge' design competition for more details). My involvement[7] and learnings from working with Vejle Municipality became part of my case study site, which was the testing ground to investigate my research questions.

5 See Appendix 12: Realdania network

6 There are seven pilot projects as part of the "Cities and the rising water" initiative from Realdania started in 2018 to address the increasing threat of sea level rise in Danish coastal cities. There are many other similar coastal adaptation initiatives happening in various risk cities in Denmark under the Realdania sea level rise pilot project (Realdania, 2019; Realdania and KU, 2020).

7 The majority of the meetings with Vejle Municipality were conducted in Danish, and due to my limited Danish language skills, there were content that was lost in translation.

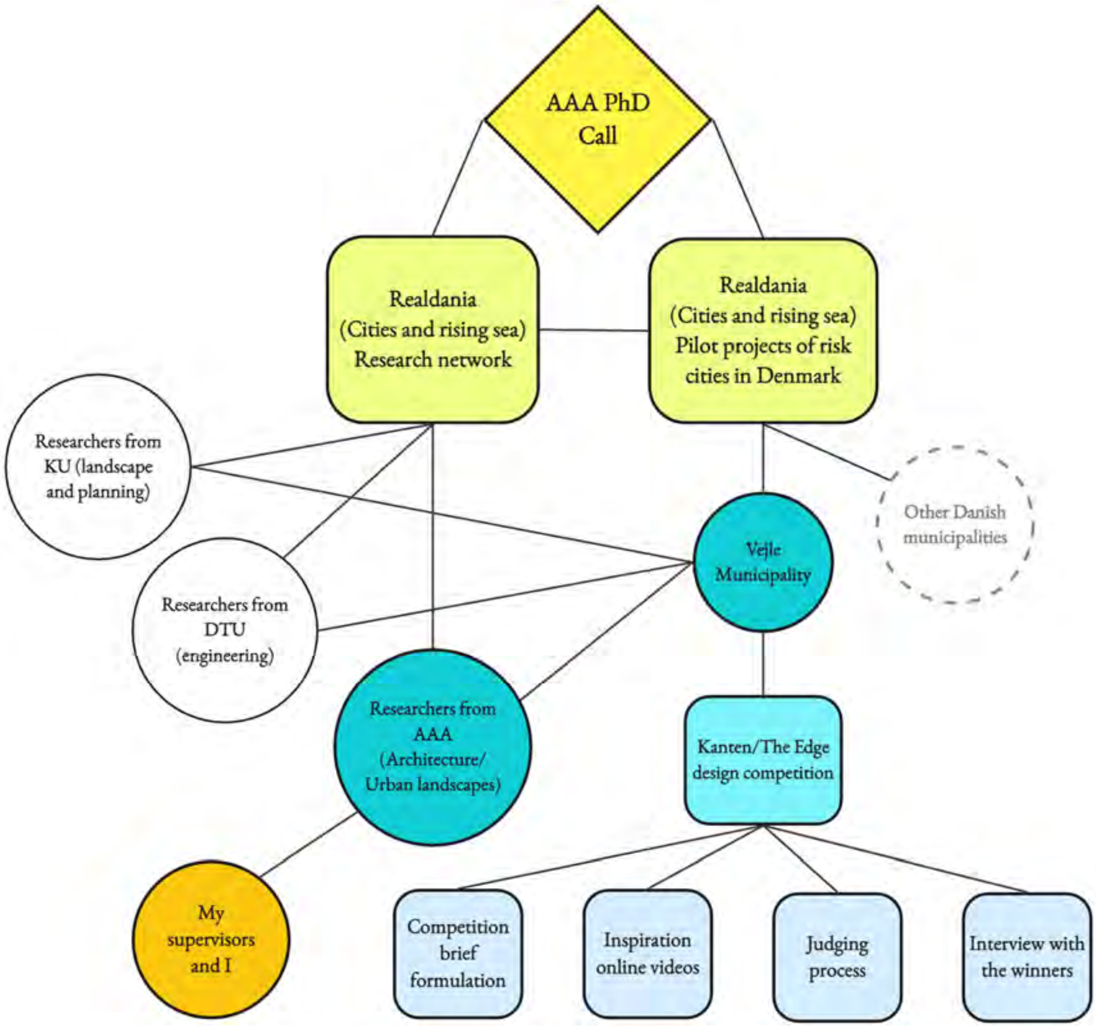

Figure 1. Diagram of this PhD's associated research network, collaborators and case study city of Vejle (i.e. my involvement with Vejle Municipality and Kanten/The Edge design competition). My involvement and direct associations are the nodes that are coloured.

The expert peer review process and access to data

The work with the research network from Realdania, Vejle Municipality and other relevant encounters gave me access and exposure to "behind-the-scenes" workshops, meetings and informal peer review processes from various experts and stakeholders in the network (see Appendix 13). These encounters are not strictly like a semi-structured interview; however, they were able to provide other types of "soft" data through participating in and observing workshops and meetings. Therefore, I have had the opportunity to have reasonably frequent feedback from other experts throughout my research, which has helped in dealing with aspects of this research that I am not familiar with or an expert in. One of the key figures is the marine biologist/researcher from the Kanten/The Edge design competition with Vejle Municipality, with whom I also co-wrote a paper and an opinion article. I established good relations with a marine biologist (also an advisor to the judges), who became an informal expert advisor of marine biology for my research.

Field(s) of study in the Danish context

This research is based on the Danish context, focussing on the impact of water due to climate change on the Eastern coast of Jutland (the specific case study is set in the city of Vejle), embedded in its educational, institutional and commercial context. As such, municipalities, architectural practices and educational institutions work in a more integrated, interdisciplinary and collaborative manner, where, for instance, the field of landscape architecture and urban planning are relatively integrated in Denmark (Wiberg, 2018). This is due to the Danish educational system, where architecture schools like the Aarhus Architecture School train future architects, landscape architects and urban planners/designers in a hybrid format between the three. A similar thing applies in municipalities and commercial offices, where these three disciplines are less compartmentalised into silos and collaborate into one broad working field (Wiberg, 2018). Henceforth, the PhD will depart from Denmark's integrated and hybrid tradition of landscape architecture and urban design with a special focus on the interface between landscape architecture, urban design/planning and marine biology.

Research motivations

The initial inspiration to answer the PhD call came from a personal and intuitive place of rethinking how we landscape the boundary between the city and sea from the perspective of marine lifeforms. As a researcher and a practitioner, I have always wondered why there was a strong emphasis on landscaping our cities with trees, flowers and plants but very little, if at all, has been done with seascaping with marine lifeforms such as seaweed, eelgrass and mussels in urban contexts. I was fascinated with the potential of seaweed as the representative "seascaping" element to re-envision how we think about our edge conditions and educate and create awareness about the numerous qualities of seaweed, both instrumental and intrinsic, especially to tackle the current climate and biodiversity crisis. I believe that coastal cities are a critical site of intervention as urbanisation continues to increase because first, this is where most of the impact will be to bridge the interface between humans and nonhumans; second, this is the epicentre of the need to address our current unsustainable habitation for the future.

Moreover, having grown up and lived in various countries with a strong attachment to the coast due to its proximity to the sea (i.e. South Korea, New Zealand[8], United Kingdom and Denmark[9]), I questioned our current dominant superficial and overt instrumental relationship to the sea and its continual exploitation. Nevertheless, my Korean heritage inspired me to place a particular emphasis on and fascination with seaweed as it has had a strong holdfast on Korean cuisine and

8 I have a South Korean heritage and a New Zealand nationality (I have also grown up in the UK) with seven years of experience in architectural practices and have been based in Denmark since 2017.

9 Although, my Danish language competency is limited (Level: Danskprøve 3 – Beginner to intermediate level) and my understanding of the Danish context, I hope to contribute my broad international experience both in practice and in academia to bring "new" perspectives and approaches to the Danish landscape architecture and urban design.

culture. I saw the potential of reviving seaweed in the European context, where these cultural traditions around seaweed have been somewhat lost and forgotten. There was a unique opportunity to contribute to original research by exploring the potential of seaweed as a catalyst for urban transformation on the coast.

For whom is the monograph written, and on behalf of whom?

This PhD monograph tries to represent the perspective of seaweed (and the sea) as much as possible in its potential contribution to urban transformation; however, it inescapably is from the human perspective – particularly, myself as a researcher in the field of landscape architecture, urban planning and design. The intention of this research is for those who influence the way our urban coastal shorelines are developed, be it municipal regulators (who in turn communicate with citizens, developers and politicians) or practitioners (landscape architects, urban planners and designers) or fellow researchers and educators (for teaching and research). Although this is still an academic endeavour that needs to fulfil certain criteria as a PhD dissertation, I wrote with the stakeholders in mind, who may use the document to rethink our current B-A-U practices and normative values to instil more alternative solutions. Thus, the academic jargon or technical terms have been defined as footnotes in the section: "Definition of Key Terms." It is to ensure that non-experts can also approach the research.

Finally, the monograph intends to capture and filter the immense complexity and richness of the topic at hand while facilitating different points of departure for readers, who can then follow this research journey from hypothesis through analysis to possible future strategies.

Reader's guide to the monograph

The overall structure of the monograph is in five parts, as outlined below, following a well-established IMRaD format (Introduction, Methods, Results (analysis) and Discussion as the organisational structure of the research, albeit modified slightly.

PART I: INTRODUCTION (RQ AND CONTEXT)

Introduction to the context and the research questions addressing the main wicked problem of climate change on coastal cities and harbourfront/waterfront developments. Identifying the research gap through the hypothesis "Urban Seascaping" with seaweed. A single case study site is established as the city of Vejle with the involvement of the design competition called Kanten (translated to "The Edge" in English). This section sets the research scope and limitations.

PART II: METHODOLOGY

Case study site of Vejle is established to employ mixed methods especially, research-through-design methodology via mapping to investigate the research question at hand. The research is embedded in a transdisciplinary context with expert advice from marine biologists (in the form of interviews and workshops). The section addresses the approaches behind knowledge creation, which consists of a mapping tool that can consolidate and curate the different disciplinary knowledge and mediums of representation and analysis via a networked online mapping tool.

PART III: STATUS QUO AND ALTERNATIVES

A detailed investigation into the current wicked problems of coastal urban development. This is followed by the state-of-the-art analysis of the alternative emerging practices and modes of thinking that depart from the current status quo of coastal protection and adaptation. A literature review of the various theories and frameworks referred to in this research is presented.

PART IV: URBAN SEASCAPING (RESEARCH-THROUGH-DESIGN)

Combination of territorial and network mapping as analysis for Vejle and Kanten/The Edge design competition entries. The research-through-design multiscalar and temporal-projective mapping is used to generate future projective landscape, urban planning and design of seascape strategies.

PART V: CRITICAL REFLECTIONS

Discussions on the learnings from Urban Seascaping with seaweed in Vejle, Denmark. The section critically discusses the shortcomings of the research and its contributions to research. Future research avenues are indicated. Finally, conclusions on the summary of the main findings.

Figure 2. A general structure of the PhD dissertation/monograph for the reader to follow.

The online format of the research – Website and Kumu map

The PhD monograph is presented in two mediums – static (paper format) and interactive (website format). The static version is presented in accordance with the rules and regulations of the PhD programme at Aarhus Architecture School. However, in this particular research, due to the use of an interactive website-based mapping tool (i.e. Kumu), the static medium is reductive in representing the complexities and nuances of the mapping tool developed for this research (refer to section 2.3 for more details on the network mapping tool). Therefore, to view and interact with the online mapping tool developed for this research, a website version of the PhD dissertation is also published for viewing and assessment. This online format is particularly relevant for the Part IV chapter, where the online Kumu maps are "embedded[10]" (hosted) into the website to allow the reader to interact with the Kumu maps directly. It allows the reader to click and engage with the many interconnections between different nodes in the multi-scalar and temporal maps, which is the purpose of making this type of map (e.g. the nodes can be isolated to highlight certain connections – see Figure 3). Because this type of direct interaction is not possible in a static medium, I would highly encourage the readers to engage with the website version of the monograph (especially Part IV). Most images (figures) shown throughout the monograph are embedded in the Kumu map, which has been extracted to be represented in the static format[11]. Therefore, the readers are encouraged to view the online format of the PhD, especially in Part IV of the research, where the contents from the Kumu maps are used the most.

Furthermore, the website format of the monograph enables direct hyperlinks to sources, such as direct access to videos and audio material created for teaching and dissemination throughout this PhD.

The online and interactive format of the research is curatorial and representational as a research-for-design outcome, reflecting the complexity of information and the digital age. The online format is a way to visually address the need to think in systems and networks as a curatorial tool and as a way to synthesise different material from different sources, scales, and periods. The website aspect of the PhD also becomes more than just a medium of submission but a curation of Urban Seascaping. The website is an ontological and visual narrative, with each "node" representing a different part of the Urban Seascaping story.

The basic "how-to" of navigating around Kumu is explained in Part II and Part IV of the dissertation. You can also view more detailed instructions on the website:
www.urbanseascaping.com - password: tang (or https://ateliersoo.wixsite.com/urbanseascaping).

10 Embedding refers to the integration of links, images, videos, GIFs and other content into web media. Embedded content appears as part of the website and supplies a visual element that encourages increased click through and engagement.

11 Therefore, the maps developed via Kumu have numerous information that is not showcased in this monograph.

Go to: www.urbanseascaping.com (password: tang)

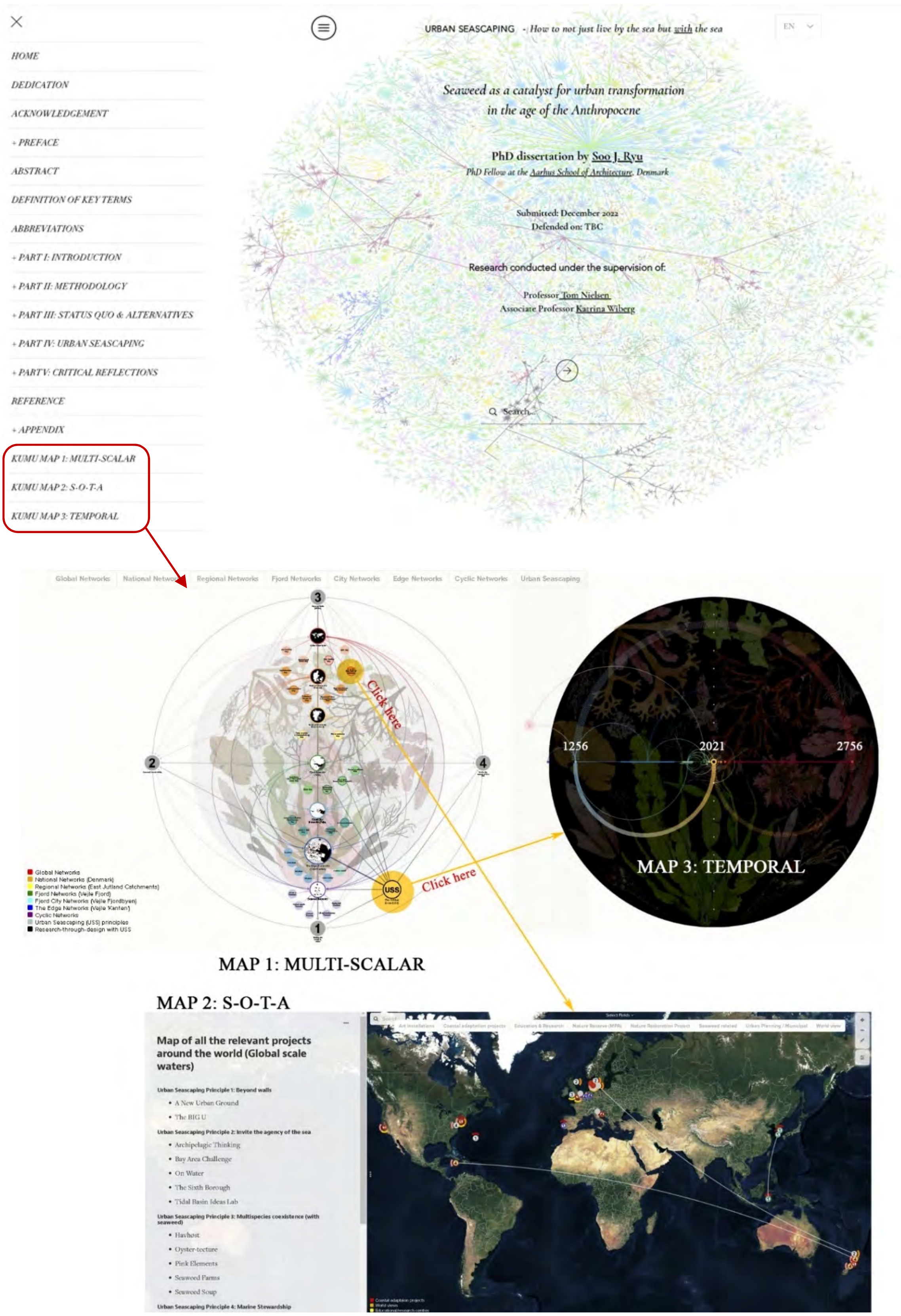

Figure 3. The PhD monograph intends to be read in digital format, especially for Part IV – research-through design via network Kumu mapping.
(Top image) - The screenshot of the main PhD monograph as a website version.
(Mid and bottom images) – The screenshot of the three Kumu maps developed for this research.

Articles written (and published) during the PhD

Moreover, during the PhD project, I published two peer-reviewed articles. Some of the contents of the articles have been based on the monograph.

- Ryu, S.J., 2021. Urban seascaping: Seaweed as a catalyst for urban shoreline transformation in the age of the Anthropocene. Linc. Plan. Rev., Lincoln Planning Review 11, 3–35. https://www.researchgate.net/publication/358834353_Lincoln_Planning_Review_Volume_11
- Ryu, S.J., Quintana, C.O., 2023 (T.B.C). Seaweed as the denizens of the new commons in the Anthropocene, in: Critical Plant Studies, Algae. Brill (yet to be published).

Other online dissemination materials

Other non-academic digital (i.e. a podcast, an opinion article and short videos) dissemination was conducted throughout the PhD. They are embedded into the website version of the PhD.

- Inspiration video for the competition entrants of Vejle Municipality's Kanten/The Edge design competition on Urban Seascaping - 24th of April, 2020 https://vejle.citizenlab.co/da-DK/projects/idekonkurrencen-kanten
- Interviewed for the podcast "Talking in this Climate" (as part of the 2021 Sustainable Living Festival in Australia) - 17th of February, 2021 https://anchor.fm/titc/episodes/Ep-7-Below-the-surface---language-of-maps-and-nature-e1k3oo0
- The Aarhus School of Architecture video of Urban Seascaping - 13th of June 2022 https://aarch.dk/en/inviting-the-sea/
- A three-part interview with Arka Video platform - 23rd of June 2022 https://arka.video/articles/why-should-we-only-design-cities-for-human-benefit-soo-jung-ryu
https://arka.video/articles/water-walls-and-seaweed-fences-soo-jung-ryu
https://arka.video/articles/the-meeting-zone-between-water-and-land-soo-jung-ryu
- Opinion article for Byrummonitor.dk (in Danish) written with Cintia Organo Quintana, titled: "Arkitekt-ph.d. og biolog: Vi skal væk fra de hårde havnebydele, der ødelægger kysten" – 12th March 2021 https://byrummonitor.dk/Debat/art8088476/Vi-skal-v%C3%A6k-fra-de-h%C3%A5rde-havnebydele-der-%C3%B8del%C3%A6gger-kysten

Language use

Active and personal voice of the researcher

Unlike the typical science-based writing styles where personal pronouns, careful use of personal voice and creative expressions are discouraged, spatial design disciplines like LUPD can accommodate a more active and personal voice of the researcher. The researcher's voice is particularly relevant when dealing with qualitative research methods and ethical contexts, such as responding to the climate crisis or exploring the inclusion and representation of nonhuman/more-than-human agencies (such as marine life forms) in our coastal cities. Therefore, where appropriate, I express my agency as a researcher by writing in an active voice through personal pronouns and intend to be clear about my research intentions and values.

Use of terms in the thesis

The research acknowledges the current discourse on the use of normative terms that have contributed to perpetuating current binaries and dualistic thinking, such as the term "nonhuman" rather than the emerging term "more-than-human" (or "nature" rather than "ecology"). These discussions emphasise the need to address more inclusive and systems thinking – i.e. the interrelationship and entanglements of different systems rather than a more delineated, hierarchical and reductive way of understanding the world. While these discussions on language use are important, this debate is far from settled, and I have decided that it is more productive for the purpose of this monograph to use the more recognised terms that are more familiar to the general readership, which still plays an important role in establishing a common conception to the reader. Therefore, this monograph will use these terms interchangeably, with the intention that these terms refer to both. For instance, when I use the term "nonhuman", it is with the term "more-than-human" in mind (see definitions page for more details).

Keywords/search terms for this dissertation

Urban Seascaping, coastal adaptation, sea-level rise, East Jutland coastal cities, climate change adaptation, blue infrastructure, blue urbanism, coastal urbanism, blue urban commons, seaweed, marine landscape architecture, nature-based solutions, hybrid mapping, network mapping,

PART I: INTRODUCTION

Introduction to Part I

The coastline is a contested site. Due to climate change, the sea is encroaching on our coastal cities, and designers face the challenge of future scenarios with the increasing presence of water and other interconnected issues, such as biodiversity loss and increasing water pollution due to anthropogenic activities. The complex entanglements between land and sea and human and nonhuman agencies pose challenges that require a new way of thinking and doing in increasing transdisciplinary complexity in the Anthropocene. In response, this research develops a critical proposition and initial hypothesis called Urban Seascaping, which seeks to engage with and integrate a designed response to nature-based approaches to coastal development as an integral part of place-making. Urban Seascaping is a new neologism that refers to a set of propositions and a concept to present seaweed as one of the potential main representatives of the marine world to bridge the physical and cultural chasm that currently segregates our cities from their marine environments. I develop a case for seaweed as a potential actor for re-envisioning waterfront developments and coastal adaptation strategies. The research is a response to a gap in knowledge, thus, an original contribution. Seaweed will be the focal lens (albeit not the only one) to navigate the complexity surrounding the research by presenting opportunities and barriers for integrating seaweed.

Part I serves as an introduction to my research's foundational context and overarching position departing from the initial PhD call by the Aarhus School of Architecture and the development of the call into three research questions. The research is situated in its broader context through the relevant global and local events, policy changes, and developments that have informed and influenced my research, especially within the past three years of this PhD. Second, I address my intention to investigate my research questions through a single case study site of Vejle in Denmark. I was able to be involved with Vejle Municipality's recent nature-based design competition that became a critical part of my research data, which sought to rethink the boundary between the city and the fjord to protect the city from future sea-level rise and storm surges.

1.1 PhD Call – Research questions

It is important here to differentiate between a design question and a research question. While a design question remains specific to a design project, a research question raises 'a fundamental issues related to human experience in the world' (Findeli, 2010, p.296). And since human experience is a complex 'entanglement of various interrelated dimensions and values ... an ideal design research question would thus be one that uncovers and emphasizes the complex interdisciplinary of the specific anthropological experience that is at stake in a design question' (ibid. p.297).

Martin Prominski, *Design research as a non-linear interplay* (Prominski, 2019, p.36).

The research departs from the initial PhD call from the Aarhus School of Architecture (AAA) in 2019. The call asked the following main research question, "How can coastal cities of East Jutland utilise sea-level rise as a power of transformation that positively contributes to rethinking and informing existing urban structures?" The call is to rethink our current business-as-usual (B-A-U)[12] urban development models and coastal protection systems to respond to the increasing impacts of climate change. The call mainly focuses on water issues, such as the rise in sea level and its contribution to the worsening inundation of cities due to more frequent and violent storm surges. More importantly, the research call asks to investigate how the phenomenon of rising sea levels can be included as a driver of a paradigm shift in urban development in coastal cities as an alternative means of living with the boundary between land and water. I interpreted the research call as a quest to explore the role of the sea as an actor in urban transformation, encompassing the agency of the marine animals and plants in the sea. Thus, the initial research call is restructured to include other nonhuman (i.e. marine life forms) actors in aiding urban transformation and depart from the utilitarian phrasing to an inclusive one (i.e. utilise to integrate). Thus, the main research question (RQ) becomes;

> *How can coastal cities[13] of Denmark (especially the East coast of Jutland) integrate the sea and its lifeforms to contribute towards re-envisioning urban development in light of a sea level rise and frequent storm surges?*

The main research fields are landscape architecture and urban design/planning (LUDP). The practice of LUDP is embedded in drawing from many different types of knowledge fields, which requires transdisciplinary collaboration between relevant stakeholders (Wiberg, 2018). Moreover, including the sea as an actor and the phenomenon of sea-level rise and storm surges in urban

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12 This B-A-U wicked problem will be discussed in detail in section 3.1 The Scale of the Problem.

13 Coastal cities can represent all stakeholders (decision-makers), such as relevant municipal members, citizens, researchers, practitioners and developers – i.e., every person involved in constructing and maintaining a coastal city.

coastal landscapes requires drawing from other disciplines, such as marine ecology, hydrological engineering and geology (see section 2.1 for more detail). Traditionally, the realm of coastal protection and restoration projects is primarily in the hands of engineers or marine biologists without including spatial design disciplines[14] (and vice versa) (Pilkey and Young, 2011; Orff, 2016; Organo Quintana, 2020). Therefore, research in the spatial design disciplines can help develop a subfield that addresses the threat of rising sea levels in urban environments that includes marine lifeforms through creative spatial interventions to adapt to the changing climatic conditions that will motivate more restorative relations between cities and the sea. Henceforth, to address the main research question, the next sub-research question calls for transdisciplinary collaboration, specifically investigating the potential of design research and the role of designers in facilitating and synthesising the interconnected networks and dynamic processes that highlight the constant synergy between the urban and marine realm (Orff, 2016). Thus, the first sub-research (SRQ1) question pertains to:

> *How can design research methods and practice from the spatial design disciplines of LUDP contribute to responding to the changing spatial boundary between city and sea, human and nonhuman, due to climate change?*

Lastly, the final sub-research question addresses the increasing complexities involved in designing in a transdisciplinary context with nonhuman forces (i.e. climate change as a phenomenon and the role of marine life in aiding climate mitigation) and the need for better representational and analytical design tools and ways of thinking that help us move past our current B-A-U practices. Moreover, issues surrounding sea-level rise are not isolated phenomena as it is entangled with a myriad of complex issues, such as global warming due to rising greenhouse gases, biodiversity loss, and anthropogenic pollution. These impacts go beyond traditional notions of scale and timeframe, and decisions to respond to these issues require new ways of doing and thinking about how to re-envision coastal cities for the future. Thus, the second sub-research (SRQ) question pertains to:

> *What ways of thinking and doing (i.e. world views, representational and analytical tools) can help the spatial design disciplines of LUDP address the aforementioned research questions? (RQ1 and SRQ1?)*

In sum (see Table 1), the main research question asks about alternative solutions to move past B-A-U urban development and the current wicked problems of climate change. It is then followed by sub-research questions asking who can/should contribute to the solutions and how these potential solutions can be executed in a more complex and interconnected world.

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14 In this research, the spatial design disciplines mainly refer to landscape architecture and urban design with also, at times, references to architecture, urban planning and public art.

The core purpose of the question	Research Questions (RQ)	Wicked problems it addresses
What are other solutions to move past B-A-U practices and wicked problems?	**Main RQ:** *How can coastal cities of Denmark integrate the sea and its lifeforms to contribute towards re-envisioning urban development in light of sea-level rise and frequent storm surges?*	▪ Sea level rise ▪ Storm surge ▪ B-A-U urban development models ▪ Ocean sprawl ▪ Water pollution
Who can contribute to the solutions (and in what way)?	**SRQ 1:** *How can design research methods and practice from the spatial design disciplines of LUDP contribute to the changing spatial boundary between city and sea, human and nonhuman, due to climate change?*	▪ Lack of biodiversity ▪ Siloed thinking and practice ▪ Limited depiction and understanding of the sea ▪ Terrestrial bias
How can the solutions (explorations) be executed?	**SRQ 2:** *What ways of thinking and doing (i.e. world views, representational and analytical tools) can help the spatial design disciplines of LUDP address the aforementioned research questions?*	▪ Anthropocentrism ▪ Increasing transdisciplinary complexity

Table 1. All the research questions (main RQ and the sub RQs) – the emphasis on the main RQ and the following sub-research questions to help answer the main RQ.

In the proceeding section, I present some of the key events during my PhD to situate my research in the current political, economic, social, cultural, and environmental climate that greatly influences my ethical and critical positions in the research.

1.2 'Situated Knowledge': During my PhD research from 2019 to 2022

The scale of the problem

During my three years as a PhD fellow in Denmark, I witnessed and experienced some noteworthy events that may serve as key indicators of the current societal and environmental challenges in which my research is situated. The era in which my research belongs sets the mood and the scene for the opportunities and barriers I have to work with as a product of its time. According to the feminist anthropologist Donna Haraway (1988), it is paramount to situate one's knowledge in its contextual and historical specificity, providing the background for its potential contestability. In other words, "situated knowledge" is a call toward "epistemic humility," an 'acknowledgement of the conditions of possibility from which a point of view emerges' (Jue, 2020, p.9). It critiques "the myth of objectivity" in research and acknowledges the reality of the "partial perspective" of the researcher (ibid).

Therefore, to situate my research in its broader context, I noticed that within the relatively short period of three years, the negative impact of climate change reared its ugly head, making it very clear that we are increasingly headed towards the point of no return. I have witnessed several water-related catastrophes with the hottest years on record[15] (Met Office/WMO/WCRP, 2019; Copernicus, 2022; Milman, 2022), leading to severe ocean warming in North America, resulting in the death of one billion mussels, clams, kelp and endangered salmon being cooked alive in the summer of 2021 (Dalton, 2021; Williams, 2021). In the same month, an extreme flood event[16] in Western Germany and Belgium completely swept towns and people due to heavy rain (Cornwall, 2021). Moreover, not even a year later, a similar catastrophe occurred on the east coast of Australia after record-breaking rainfall, where Australia declared its first-ever national emergency due to severe flooding (BBC News, 2022). Furthermore, there was a continual stream of climate change-related catastrophes in 2022, with the worst heatwaves ever recorded to date in China (Le Page, 2022) and, at the same time, the worst flooding in history, killing thousands of people in Pakistan and destroying millions of homes, livestock and crops (Brandon Miller et al., 2022; Harrison, 2022). It is clear that these extreme weather events are becoming more frequent and extreme (UNDRR, 2020). At the beginning of this year (January 2022), Northern Europe also experienced its first major storm called "Malik", which passed by without any casualties but reached Category 3[17] (very dangerous weather) level in certain parts of Denmark (DMI, 2022b). Although Malik did not cause damage at a catastrophic level, the (storm surge) water level rose very close to the inundation level in many Danish coastal cities (see Vejle and Aalbæk Harbour's water level rise due to Storm Malik,

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15 Last year in 2021 saw the hottest ocean temperatures in recorded history (Cheng et al., 2022; Milman, 2022). "As the world warms from fossil fuel based human activity, more than 90% of the heat generated over the past 50 years has been absorbed by the ocean" (Milman, 2022). Denmark also reached its highest recorded temperature for the month of July in 2022 (Abildgaard, 2022)

16 The German Weather Service reported that the quantity of rain in some areas of Germany was the highest in over 100 years, possibly higher than any seen in the last 1,000 years (Watts, 2021).

17 Three different levels of severe weather in Denmark by Danish Meteorological Institute (DMI): Category 1: Severe weather, Category 2: Dangerous weather, and Category 3: Very dangerous weather - Be prepared that there is a high risk that weather development can affect one's surroundings and disrupt the functions of society (DMI, 2022b).

in Figure 4). Storm Malik indicated that the current elevation above sea level in many coastal cities in Denmark is too close to its tipping point.

Figure 4. (Top image) The impact of Storm Malik on the city of Vejle, the water level in the fjord peaked around 11 o'clock at 144 centimetres above the average water level, which is not enough to inundate the city of Vejle in Denmark but close to its tipping point (Anholm, 2022; DMI, 2022a). The current elevation above the normal water level in Vejle is roughly around 150-160cm (SCALGO, n.d.). Image credit: (DMI, 2022a).
(Bottom image) Before and After Storm Malik's photo in the town of Aalbæk, Denmark, where water levels reached above the 'tipping point' over the harbour pathway (Payne, Anker Pedersen and Fonseca, 2022). Image credit: (Bottom Left) Jørgen Larsen /ANB (Bernhus, 2014) and (Bottom Right) Inger Nielsen (Payne, Anker Pedersen and Fonseca, 2022).

But more alarmingly, scientists gathered at the end of 2021 to declare a grave warning that a major ice shelf in Antarctica, the size of Great Britain, coined the "doomsday glacier" (Thwaites glacier[18]), is in a fragile condition to "fracture and collapse possibly within five years or less" (Vidal, 2021; International Thwaites Glacier Collaboration, 2022). Thwaites glacier contains enough water to raise global sea levels by more than half a metre, rendering the efforts of current coastal protection plans insufficient (ibid). And there are new research forecasts that predict worsening sea level rise, superseding previous predictions due to accelerating glacial melt (and employing

18 There is an "International Thwaites Glacier Collaboration" made up of scientists from various countries. Scientific articles on the Thwaites Glacier can be found on: https://thwaitesglacier.org/resources/publications

different methods of prediction) that even with emissions reduction, it is too late to prevent sea level rise (Shao, 2022). Evidence indicates that the current global efforts are insufficient to limit warming to 1.5ºC (Matthews and Wynes, 2022). However, perhaps the biggest catastrophe of them all is the continual insufficient commitment to tackling the climate crisis from the world leaders at the UN Climate Change Conferences (UNFCCC, 2021). During my research, the IPCC[19] released its sixth assessment report in 2021 (released every six years). The summary of their recent findings emphasised that the "new estimates of the chances of crossing the global warming level of 1.5ºC in the next decades, finds that unless there are immediate, rapid and large-scale reductions in greenhouse gas emissions, limiting warming to close to 1.5ºC or even 2ºC will be beyond reach[20]" (IPCC, 2021a). The IPCC's warnings are loud and clear. We are in the most crucial decade in human history to make significant changes to ensure the security of human and nonhuman well-being, and we are simply running out of time.

However, unexpectedly, the overall global growth patterns came to a grinding halt, and the earth stood still six months into my PhD as the COVID-19 virus took the world by storm. A global pandemic that posed a much more immediate and comprehensible threat to human well-being resulted in aeroplanes being grounded, shops closed, people working from home, and everyone unanimously staying enclosed inside for the virus to be put at bay. However, when experts analysed the world's GHG trajectory during the lockdowns (or semi-lockdowns) disrupting the global supply chain, we are still on an uphill trajectory of our global emissions. Global fossil CO_2 emissions peaked in 2019, followed by a drop of 5.6% in 2020 due to the COVID-19 pandemic (Met Office/WMO/WCRP, 2019). Nevertheless, in 2021, global CO_2 emissions rebounded to reach their highest annual level – a 6% increase from 2020 (IEA, 2022). A global crisis opened a window of opportunity for systems change we desperately needed, yet not much changed, and we are right back on track to business as usual (B-A-U). Even a global halt of all activities for a few months only resulted in reducing 5% in emissions, still far from the 50% of global GHG reductions needed by 2030 (IPCC, 2018).

What do these events all mean for my research? It highlights that political, social, and economic factors hinder addressing the global climate crisis. Numerous complex factors are at play, both predictable and increasingly unpredictable. The past three years highlighted the growing impacts of the climate crisis, especially in the form of water-related catastrophes and the current infrastructures at the brink of tipping points. The inertia of our current political and economic structures prevents paths to addressing these issues at a rapid and large-scale pace. Furthermore,

19 The Paris Agreement in 2015 agreed to keep global warming below 2 degrees and ideally at 1.5 degrees Celsius in order to avoid irreversible impacts of global warming. It means halving (45%) global GHG emissions by 2030 and net-zero by 2050 from 2010 GHG levels to stay within the recommended limit of 1.5ºC of global average temperature rise (IPCC, 2018).

20 The IPCC has been urging drastic action for a while, so this statement is nothing new. Even the last IPCC's fifth assessment report (Climate Change Synthesis Report) released in 2014 states that "stabilising temperature increase to below 2ºC relative to pre-industrial levels will require an "urgent and fundamental departure from business as usual" (IPCC, 2014).

other issues are taking our attention away from the climate crisis, be it wars[21], pandemics, refugee crises or fake news, delaying further our ability to address the emergency of the climate crisis.

There is little doubt that humanity has made a huge impact on the fundamental transformation of the biosphere, threatening the planet's life-supporting capacities. This reality is encapsulated by the ever-increasing popular term "The Anthropocene", which proposes to define the current geological age as the age of the human. This concept has been influential in bringing forth questions about how humans and organisations and various processes, such as urbanisation, fit within the network of life and reshape the planet (Moore, 2016). However, as important as this term might be in setting off the alarm, as pointed out by Moore (2016), it is also quite limiting in its capacity to explain exactly how these alarming changes have originated. As Moore writes: "Questions of capitalism, power and class, anthropocentrism, dualist framings of 'nature' and 'society,' and the role of states and empires – all are frequently bracketed by the dominant Anthropocene perspective" (Moore, 2016).

21 This is in reference to the war in Ukraine that started on 20th February 2022 by Russia.

1.3 The age of the Anthropocene - Capitalocene

Late Capitalism's political economy in the exploitation of "Cheap Nature[22]"

Much of the argument for the start of the climate crisis of the Anthropocene has been focused on the onset of the industrial revolution in the late 19th century (due to the use of fossil fuels and the rapid increase of resource extraction during the mid-20th century). However, scholars such as Moore (2017) critique the shallow periodisation of the Anthropocene. While Moore (2017) agrees that human-induced environmental impact accelerated drastically after the industrial revolution, he argues that the Anthropocene disregards the onset of the origins of "today's crises in the epoch-making transformations of capital, power, and nature[23]", especially of "early capitalism's environment-making revolution, greater than any watershed since the rise of agriculture and the first cities" (Moore, 2017). Therefore, Moore argues the importance of addressing the historical pattern of the modern world as the "Age of Capital", established four centuries earlier than the Industrial Revolution in the 16th century (ibid.). This was an era where power, class, capital, dualistic framing of nature and culture, commodification, roles of empires and nation-states laid the groundwork of late capitalism. Thus, Moore (and other notable scholars such as Justin McBrien and Donna Haraway, to name a few) call for the term Capitalocene as the age we are currently living in to bring focus to how capitalism's systems of global power and relentless goal of profit through the exploitation of natural resources and human labour is driving the extinction of both of living beings and cultures (Moore, 2016). The Capitalocene does not only stand for capitalism as an economic and social system. Rather, the Capitalocene indicates capitalism as a way of classifying and conceiving nature as a whole that reinforces the co-production of nature in the pursuit of power and accumulation of capital (Hartley, 2016; Moore, 2016). Anthropocene also fails to differentiate between the different "Anthropo" (i.e., man[24]) and inequalities associated with the contributors of climate change, but more importantly, the economic and political systems that have taken an agency of their own, almost to the extent that humans struggle to halt the wheels of its force.

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22 "Cheap Nature" is a term used by James W. Moore (2014), in his article: "The End of Cheap Nature. How I Learned to Stop Worrying about The Environment and Love the Crisis of Capitalism". It discusses how the capitalist model that "puts nature to work on the cheap" causing "biospheric instability reveals modernity's accomplishment as premised on an active and ongoing theft: of our times, of planetary life, of our and our children's futures" (Moore, 2015; 2016).

23 Nature here is in reference to the common western notions of nonhuman aspects of the living world.

24 For instance, it is inaccurate to point the blame to all of mankind as a whole, as the ecological footprint of different nations and communities have significantly different impacts on the planet, indicating the inequalities in the contributors of the climate crisis (European Environment Agency, 2021).

Who will pay for it[25]?

The importance of acknowledging and focussing the attention on capitalism in this research becomes progressively clearer as one delves deeper into the complex workings of urban development in the age of the climate crisis. Any form of action and thinking that does not fit within the dominant capitalist[26] culture and structures are met with the common retort, "who will pay for it? There is no market demand for that (green solution); therefore, it cannot be done[27]". However, as we start to initiate the true cost of "climate change, massive biodiversity loss, toxification, epidemic disease, and many other biophysical costs" (Moore, 2016, p.11), questioning the increasing ecological debt, new movements are emerging. They not only challenge capitalism's unequal distribution and its core value of the attainment of capital at the expense of nature but also "the very way we think about *what* is being distributed" (ibid.).

Considering the difficult challenges posed by these contextual issues, the current research occupies an inherently compromised position of suggesting actions and strategies that may not fit the current capitalist paradigm. However, there are possibilities for proposals to be implemented within the Capitalist system to incite incremental change while critiquing its barrier to more meaningful change (i.e., systems change). The structures of the Capitalocene have an impact on the limits and opportunities of what can be implemented in coastal cities, and thus, stakeholders responsible for making decisions at the coast and citizens who occupy these spaces need to be wary of design solutions and narratives that perpetuate the status quo packaged as a green solution. Therefore, researchers need not shy away from acknowledging and discussing the subject of the Capitalocene, especially when engaging with meaningful solutions and strategies for the future.

Nevertheless, going forward, I will continue to use the term Anthropocene due to its broad recognition in the general discourse, which has an important role to play (despite the critique mentioned above). Moreover, it is worth acknowledging how the other various -cenes[28] (such as Chulucene[29] by Haraway (2016)) play an important role in contributing to transforming the contemporary discourse around the climate crisis. Thus, the intention of this section is not to point out the relevance of one over the other but to emphasize the profound influence these complex

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25 "It" refers to sustainable measures (green transition) that will help drastically reduce GHG emissions to 1.5-2 degrees Celsius of warming and measures protecting and restoring crucial ecological systems critical to the survival of many living beings.

26 According to Moore (2016), current efforts to limit and surpass capitalism in any egalitarian or sustainable manner are hindered due to our economic and political structures that confine reality into discrete categories of nature and culture.

27 The common retort is heard from various experiences dealing with stakeholders responsible for implementing strategies towards green transition. It is important to note that there are complexities surrounding who should be responsible for paying for costs (for green transition) due to different expectations from various stakeholders and current regulatory and funding frameworks.

28 Furthermore, there have been many other less popular terms other than the Anthropocene dealing with a different focus on the current epoch – Anthrobscene, Econocene, Technocene, Misanthropocene, *Man*thropocene, Plantetocene, Kleptocene and Wastocene (Moore, 2016; Armiero, 2021).

29 For instance, Donna Haraway also presents a critique of the too anthropocentric focus of the Anthropocene. She claims it displays a level of human-centric arrogance that humans are the only real impactful agents in this age. There are microbes and viruses invisible to the human eye that have the power to put humans at a standstill, as there are agents beyond human control (i.e., natural disasters). She also points to the Chulucene as a way forth from the doom and gloom of the Anthropocene to acknowledging the current and future role of nonhumans (Haraway, 2016).

bigger systems hold for what remains possible in today's context of urban transformations in which economic growth holds importance for what proposals get implemented and what does not.

Moving forward - My research stance

The last three years have taught me about the persisting forces that seek to maintain B-A-U as we edge closer to the climate deadline. The very idea of being "too radical" stands short of the increasing urgency of the climate crisis as these "radical ideas" are increasingly becoming the necessary steps that we are reluctant to take. Fortunately, as we face greater climate-related catastrophes, these instabilities open a new window for regime change by destabilising dominant frameworks and making space for innovative speculation and, thus, room for transformation. For instance, there is progress in recognising other non-normative voices in academia, such as the values of marginalised groups (i.e., the indigenous people) and representing voices of nonhumans in the way we practice envisioning future cohabitations.

Furthermore, even though we have been talking about the climate crisis and the impact of humans for half a century, we have only recently grappled in the past decade with the exponential increase in complexities in this entangled information age. This paradigm is made especially salient by the fact that "the interrelated nature of urban and natural systems at all scales is still only becoming apparent to landscape architects" (Ervin, 2014; Chen and Lee, 2015, p.344). Moreover, inter-and transdisciplinary thinking is becoming more of a norm, reflecting the increasingly intertwined mesh of knowledge and problems addressed in my research questions. Thus, there is a call to the research community to explore new ways of thinking and new ways of doing to reflect our changing realities, bearing in mind that there is no single, universal, black-and-white solution. My research will not be able to solve the big, wicked problems I seek to address but is a contribution to the ongoing dialogue and exploration of how to live not just by the sea but *with* the sea in the age of the Anthropocene.

1.4 Single case study context: The city of Vejle as a representative of East Jutland

The initial PhD call from AAA asked the applicants to investigate the relationship between coastal cities and sea-level rise from the Eastern Jutland context. Initially, two case study sites, Vejle and Randers, were chosen from the European Union's Coastal Directives' risk cities in Denmark (i.e. a total of 14 cities/areas at risk) due to threats from flooding, sea-level rise and storm surge (as shown in Figure 5) and another coastal city called Middelfart. They all are part of Realdania's "Cities and the rising seawater" pilot project cities[6] (as outlined in the Preface). These three coastal cities represent a variety of geological and physiological conditions to represent other coastal typologies in East Jutland (and Denmark). However, due to COVID-19, the involvement with Middelfart Municipality became reduced and limited the original intention of the engagements to be more interactive and participatory (via workshops). The data gathered with Middelfart Municipality was insufficient to derive a more meaningful and useful analysis that could be compared with what I was doing with Vejle. Furthermore, the city of Randers was more of a river city than a coastal city, where the salinity level was too low to consider marine life forms like seaweed. Therefore, both of these cities as case study sites were dropped to pursue Vejle as a single case study site. The case study method is based on real-world problems in a context-driven process (see Methodology section Figure 29). It is a method that conducts an in-depth investigation into a real-world contemporary phenomenon over which context is likely to be pertinent (i.e., sociocultural, historical, economic, political, ecological, geological and hydrological factors). The essence of the case study is to try and understand a set of design and planning decisions: why they were taken, how/if they were implemented, and with what result (Yin, 2017). Understanding the complex reality of the entangled relationship between the phenomenon (i.e., sea level rise) and context (i.e., coastal cities of Denmark) is crucial in this research, making a case study method relevant.

Moreover, the city of Vejle[30] represents one of the most vulnerable and most common coastal typologies in East Jutland. For instance, according to a study by COWI (2017), Danish cities have four main coastal typologies, as shown in Figure 5. One of the coastal typologies that are most vulnerable to the impacts of water is the deep fjord with river estuary and the bay with the low-lying hinterland like Vejle. Vejle, therefore, is a type one[31] (as shown in Figure 5) in which similar conditions and characteristics exist in other cities of East Jutland, such as Horsens and Kolding (another risk area). Learnings from Vejle could provide insights relevant to many other coastal cities in Denmark.

30 The city of Vejle (Danish pronunciation: [ˈvajlə]) is located in the region of Southern Denmark (Syddanmark in Danish) in the south-eastern part of the Jutland peninsula at the end of the Vejle Fjord where the Vejle river and the Grejs river and their valleys meet. It is considered one of the most beautiful areas in Jutland due to the view of the Fjord and the river valley (Visit Vejle, 2021a).

31 Another common coastal typology of East Jutland is Type 2 and 3 – Bay with low-lying and elevated hinterlands such as Middlefart, Fredericia and Juelsminde (Faragò et al., 2018). Middelfart (Type 2) and Randers were dropped as case study sites due to the complications from COVID-19 and other factors (see research scope and limitations in section 1.7 for more details).

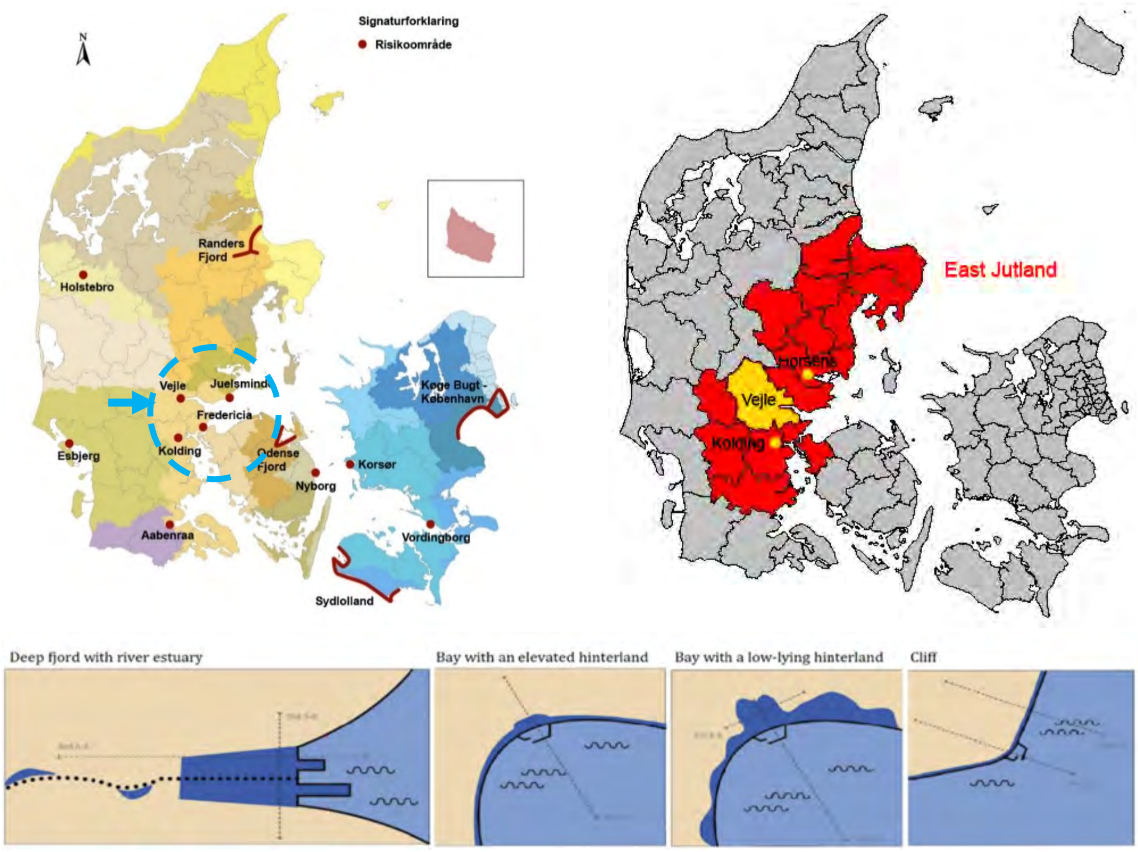
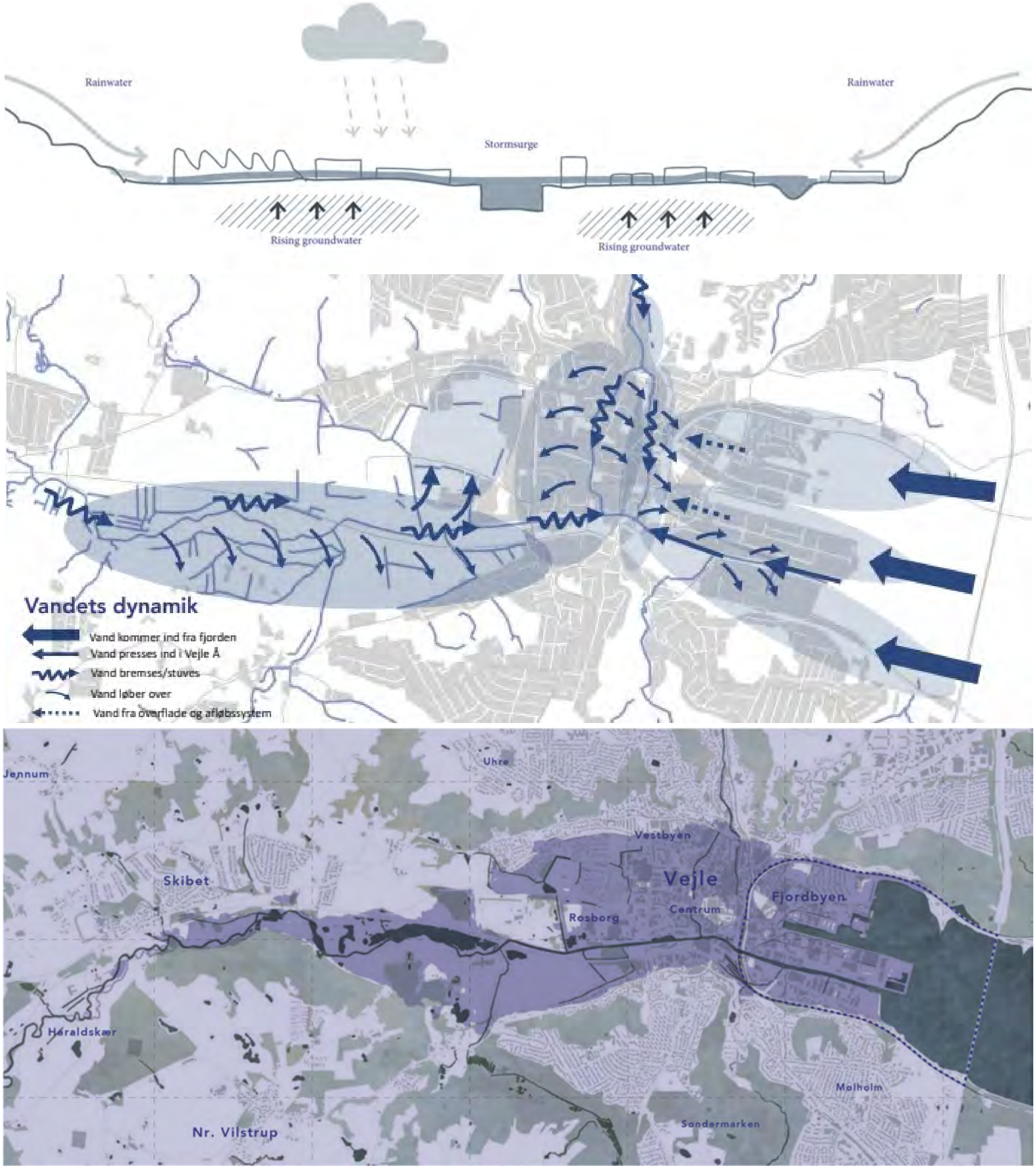


Figure 5. (Top left image) A map showing the 14 risk areas in the EU's coastal directives (mainly concentrated around the middle of the South-Eastern part of Jutland, Denmark, outlined in a blue dashed circle) Image credit: Danish Coastal Authority/Kystdirektoratet (2019) and Miljøministeriet Kystdirektoratet (n.d.).
(Top right image) The municipality of Vejle is highlighted in yellow, among the East Jutland area is in red. Image credit: Edited from Ita (2008).
(Bottom image) There are four main Danish coastal typologies: Coastal typologies in relation to storm surge type (COWI 2017). From left to right: Type 1 – Deep fjord with river estuary (in Danish Tragten); Type 2 – Bay with elevated hinterland (in Danish Skålen); Type 3 – Bay with low-lying hinterland (in Danish Den diffuse skål); Type 4: Cliff (in Danish forhøjningen) Image credit: (Faragò et al., 2018)
(Information extracted from the Kumu Multiscalar map – National scale node).

Vejle also has various conditions that can be considered a typical urban context of Eastern Jutland, with its B-A-U development[32] of harbourfront and waterfront areas similar to other Danish coastal cities (see section 3.1.5 for more details). However, Vejle also has a unique set of conditions at the bottom of a river valley with a relatively higher elevation of the hills and a deeper intrusion into the land by the fjord. Vejle is a particularly vulnerable city due to its landscape characteristics and its exposure to water from the fjord, the surrounding streams, the rising sea, and groundwater, as shown in Figure 6. Moreover, Vejle has been relatively frequently hit by

32 Currently, these new developments are inept at adapting to changes in climate due to inflexible construction that is not designed for inundation with hard surfaces that are not permeable, which worsens the impact of flooding.

cloudbursts, floods and storm surges[33] (Vejle Municipality, 2020a). Future forecasts predict that Vejle is vulnerable to future storm surges, which will inundate all of the city centre called "Fjordbyen" and the river valley (translated to "The Fjord City" in English - a district in Vejle where the town meets the fjord) (see Figure 6) (Vejle Municipality, 2020a).



33 Some of the key historical storm surge events in Vejle: In 1872, Vejle fjord's water level rose +2.15 meters above the normal water level. In 2006 Vejle fjord water level rose +1.68 meters above normal water level. In 2013 (called Storm Bodil), the Vejle fjord water level rose +1.52 meters above the normal water level (Vejle Municipality, 2020a). Future predictions for Vejle are: a 100-year storm surge event in 2050 is likely to be +2.0 meters above normal water level, and a 100-year storm surge event in 2100 is likely to be +2.44 meters above normal water level (ibid.).

Figure 6. (Top image) Vejle faces several water issues from the fjord/sea in the form of storm surges (exacerbated by sea-level rise), rise in groundwater and the water coming down from the hills due to its location at the bottom of the river valley where the two rivers/streams meet. Image credit: Vejle Municipality (2020a).
(Second-row image) A diagram showing the dynamic of the water in Vejle. There is water coming in from the fjord, which presses into the Vejle stream and also causes the stormwater drainage system to overflow and spill over. The water coming down from uphill through the streams spill over onto the land in a storm surge and cloudburst event. Image credit: Vejle Municipality (2020).
(Third row) The Coastal Directorate's delineation of the risk area in Vejle in 2018 in blue shows the entire river valley as a vulnerable area to flooding. Fjordbyen is one of Vejle town centre's four main boroughs. Image credit: Vejle Municipality (2020a).
(Bottom image) A visualization of Vejle at a 100-year storm surge event in 2050 inundating most of Fjordbyen, calculated to cost more than 750 million Danish kroners for damages (equivalent to 100 million euros) (Vejle Municipality, 2020a). Fjordbyen, like many other Danish waterfront/harbourfront developments, has been undergoing major transformation; where the past decade, there has been continual construction of new high-density housing, businesses, infrastructure and recreational areas. These newly developed areas pose challenges from rising sea levels and storm surges and are critical areas that can be challenged for testing alternative ways to co-exist with water. Image credits: Vejle Municipality (2020a).
Extracted from the Kumu Multiscalar map – Kanten and Fjordbyen scale node.

Another reason Vejle Municipality is a good contender for a single case study site is due to being one of Denmark's cities known for being at the forefront of climate adaptation strategies. Its various involvements provide a variety of rich sources of strategic documents[34] that indicate Vejle

34 Every six years, Vejle is required to draw up a risk management plan. The risk management plan aims to come up with proposals for how Vejle needs to protect the city from flooding. The goal is a resilient city where citizens' health, well-being and values are protected against, among other things, the negative impacts of climate change. In 2017, Vejle City Council decided to draw up a storm surge strategy to clarify how the city should deal with the

Municipality's overall vision for climate adaptation and mitigation. Some key documents are its "Storm surge Strategy"[35] and "Resilient City Strategy" as part of the global "Resilient Cities"[36] network. Moreover, I was presented with a unique opportunity to work on their coastal adaptation pilot project funded by Realdania's "Cities and the rising seawater", called "Kanten" (translated to English as "The Edge"), an open design competition (Realdania, 2019; Vejle Municipality, 2020a). As an advisor to the judges, I provided critical feedback to the brief formulation[37] and the deliberation process of the competition entries (see next section 1.4.1). The analysis of the design entries was an opportunity to shed empirical and qualitative light on some key theoretical concepts and design principles that reinforced and challenged my research questions/hypothesis. I had the opportunity to engage with all the winners through interviews, which led to insights that contributed to the research. I presented an online inspirational video on the status of my research[38] for the participants, especially the role of marine nature in urban transformation. I was asked to give feedback[39] on the design competition brief and attend the four deliberation meetings from August 2020 to September 2020. My role in the meetings was to present what I thought should be important (based on the design brief), gave my informed opinion on which entries were the most deserving of the winning title, and participate in the discussions. I was able to observe the deliberation process and the various values and opinions held by different players from the judges (see Appendix 11D: Meeting Minutes from the deliberation meetings). I also conducted my site

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increasing frequency and strength of storm surges, combined with the constant rise in seawater. Vejle is in one of the most vulnerable situations in Denmark (Vejle Municipality, 2020a).

35 Vejle's storm surge strategy ("Stormflodsstrategi" in Danish) is called "Storm surge protection that grows with the city" which began in 2017 and was adopted on 9 December 2020 by Vejle Municipality after a public consultation period from February to September 2020. The purpose of the storm surge strategy is to designate a direction for how Vejle Municipality plans for integrating urban development and storm surge protection to go hand in hand and that the strategy is adaptive, which means that it can be developed along with the new forecasts and new technical solutions. The storm surge strategy identifies a number of criteria and principles for how storm surge protection can be designed so that it contributes to plural values for the entire municipality and maintains a good encounter with the water with new recreational opportunities but also ensures future investment and property value (Vejle Municipality, 2020c; 2020a).

36 Vejle was selected to join the 100 Resilient Cities (100RC) global network in 2013. Cities from across the world have developed a resilience road map and share best practices to tackle the physical, social and economic challenges facing the 21st century. The partnership with 100RC has been a major driving force for the development of Vejle's resilience strategy, the first of its kind in Denmark. The Resilient Cities document introduces the Municipality of Vejle's resilience strategy for 2016-2020. The resilience strategy consists of a range of existing actions and new actions and supports the values for co-creation (citizen involvement), innovation and sustainable growth. The actions are structured around four strategic pillars and 12 goals (Vejle Municipality, n.d.). Visit: www.vejle.dk/resiliens and https://resilientcitiesnetwork.org/networks/vejle/ for more information.

37 Along with my supervisors.

38 Due to COVID-19, the initial plan of a start-up workshop for the competition was replaced by a series of small inspirational videos from the presenters (see Appendix 11). These inspirational videos were rather influential for the entrants and their proposals. For instance, the presentation video by the biologist of the "Sund Vejle Fjord" project gave ideas on how to incorporate mussels and eelgrass plantations to improve the quality of the water and about the various contextual conditions of the Vejle fjord (Vejle Municipality, 2020b). These videos included talks from the city architect of Vejle Municipality, an artist, and presenting my research on Urban Seascaping. See https://vejle.citizenlab.co/da-DK/projects/idekonkurrencen-kanten for my inspiration video on 24 April 2020.

39 The feedback was on the draft design competition brief on February 2020, where I placed an emphasis that while the competition may be called "The Edge" (Kanten), it needed to communicate clearly that it is not an edge but an interconnected zone, especially when working with water and marine lifeforms.

observations (Vejle's waterfront) and contextual analysis to make an informed judgement on the competition entries (see Part III and IV for more details on the contextual analysis).

My involvement with Kanten/The Edge competition led to important resources, networks and data for analysis as part of a single case study. Therefore, I decided that looking closer at Vejle as a single case study would reap richer research insights and be sufficient to adequately answer the research questions rather than focus on other cities in East Jutland[40].

1.4.1 Vejle's 'Kanten/The Edge' design competition

We are not going to build high walls to protect Vejle... Storm surge protection that grows with the city.

Excerpts from Kanten/The Edge design competition brief by Vejle Municipality (translated from Danish)
(Vejle Municipality, 2020a, p.218).

Water as a threat, resource and potential – Competition brief

On the 1st of April 2020, Vejle Municipality announced an open design competition called "Kanten". The competition invited architects, landscape architects and artists to develop innovative, nature-based and recreational proposals to protect Vejle from future storm surges. A total of 25 proposals[41] were submitted 3.5 months later, on the 15th of July 2020 (entries from Denmark and abroad). Vejle Municipality wanted to invest in future large-scale projects that might provide artistic and innovative solutions to future storm surge protection that is nature-based, attractive, and adaptive. The brief invited entries that might facilitate good access to the water can invoke another perspective on the water (Vejle Municipality, 2020a). Moreover, as part of adhering to its green vision, Vejle Municipality is currently working on investigating ways to reduce 70% of CO_2 emissions to meet its goal by 2030; thus, Kanten/The Edge projects need to be considered as part of this vision (Vejle Municipality, 2020a).

The purpose of the competition is not to receive ready-made proposals that could be immediately built. Instead, the intention was to raise the common understanding in the city of alternative ways storm surge protection can contribute toward livability, identity and green transition. In other words, Vejle desired to move beyond the business-as-usual solutions (which are most often favoured), which can negatively affect city life and climate resilience (Vejle Municipality, 2020b).

40 However, it is important to note that there are many other similar initiatives happening in various risk cities in Denmark under Realdania's "Cities and the rising seawater" pilot projects, which also could have been explored as a comparative study; however, the timeline for these projects did not align.

41 The project brief was written in Danish, and submission was required in Danish (Vejle Municipality, 2020a).

Kanten/The Edge design brief asks the participants to demonstrate the design proposals in detail at the two main zones allocated called "The urban zone" at Havnepladsen and "The nature zone" at Tirsbæk Strandvej (see Figure 7). Both of these areas are places where land meets water – places that, in addition to being key sites for creating storm surge protection, can be conceptualised as zones where recreational activities may occur (Vejle Municipality, 2020a).

The submission criteria for the design of the Kanten/The Edge needs to contain thorough contextual analysis, spatial illustrations, drawings and models that describe the design of the proposal and a description of Kanten/The Edge's main requirement for a protective, recreational and nature-based solution considering nature above and under the water.

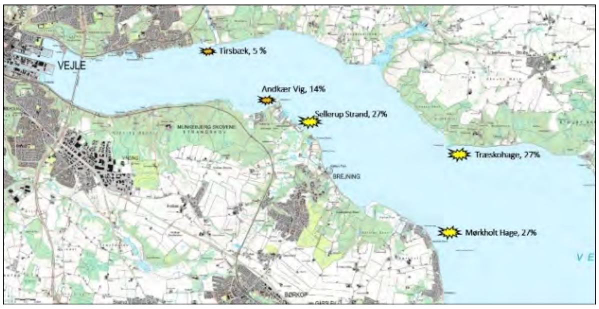
Figure 7. The two zones and edge conditions were allocated for intervention by Kanten/The Edge design competition brief. The security line in Fjordbyen are green lines, and the two zones are: The Urban Zone (Havnepladsen – Habour Square) and The Nature Zone (Tirsbæk Strandvej – Beach Road). Image credit: (Vejle Municipality, 2020a). (Extracted from Kumu Multiscalar map – Kanten scale node).

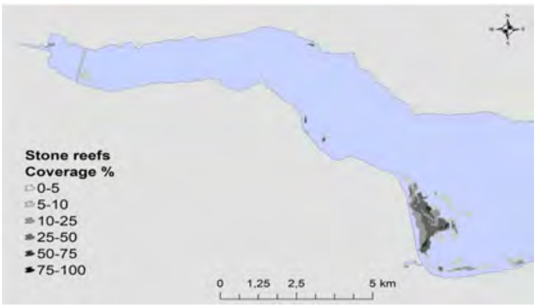
Figure 8. (Top half of the images) Underwater photos from the Sund Vejle Fjord project to revive the fish population, reinstate stone reefs, restore eelgrass, clean the polluted water via blue mussels on the seabed and as floating lines. Sund Vejle Fjord mainly works with areas closer to the coastline, in the mid-outer part of the Vejle fjord, where it is less prone to eutrophication and shows more signs of life as the shallow depth allows the marine life forms better access to sunlight[42]. Image credit: Sund Vejle Fjord (n.d.).
(Bottom half of the images) 70-hour underwater footage from the Sund Vejle Fjord project largely shows the condition of the Vejle fjord as a dark, largely lifeless, muddy desert with old fishing lines and an unbalanced food chain. Image credit: Sund Vejle Fjord (n.d.). (Extracted from Kumu Multiscalar map – Fjord scale node).

42 According to the marine biologist, people used to be able to see 10m deep into the Vejle fjord before the ecological collapse of the fjord in the 80s (especially on the outer fjord). Now the visibility is a maximum of 3m deep, on a good sunny day. The mud can be, on average, 3m deep, making the water brown when it rains (Fjeldsø Christensen, 2021).

Running almost in parallel with Kanten/The Edge competition is the "Sund Vejle Fjord" (translated as Healthy Vejle Fjord), a marine restoration project that also started in 2020. It is a five-year project funded by the Velux Foundation and Vejle Municipality (totalling 25million Danish kroners, approximately 3.4million euros) in close collaboration[43] with the University of Southern Denmark (SDU) (Sund Vejle Fjord, 2022; Vejle Ådal & Fjord, 2022). First of its kind in Denmark, the main goal of Sund Vejle Fjord is to restore the existing poor ecological condition of Vejle Fjord (see Figure 10) and strengthen the ecosystem services lost in the fjord to revive the fish population. Currently, Vejle Fjord suffers from water pollution, a decline in biodiversity, an imbalanced food web[44], depleting fish population, algal bloom, and eutrophication, to name a few (Center for Marin Naturgenopretning, 2022). Additionally, the visibility of the fjord is poor due to the sea bed being mainly covered by a thick layer of mud (see Figure 10) and excessive fertiliser runoff from agricultural activity (Vejle Municipality, 2020a). Therefore, Sund Vejle Fjord is replanting the original eelgrass that has been significantly reduced due to the murky water (see Figure 8). It is also re-establishing stone/rock reefs[45] to create habitats for mussels and seaweeds, which filter the pollutants in the water, capture CO_2, dampen the waves' impact on the coastline and stabilise the seabed along with many other inherent qualities (see Figure 9 for the location of the new stone reefs and see section 1.5.2 for details on ecosystem services).

It is expected that Kanten/The Edge's design in both zones will contribute to an increase in biodiversity in parts of the Vejle Fjord's coastline. The design needs to consider the time it takes for nature to establish itself. Furthermore, implementing new and innovative nature-based landscape designs such as Kanten/The Edge will increase the chance of hosting new animals and plants than we see today (Vejle Municipality, 2020a).



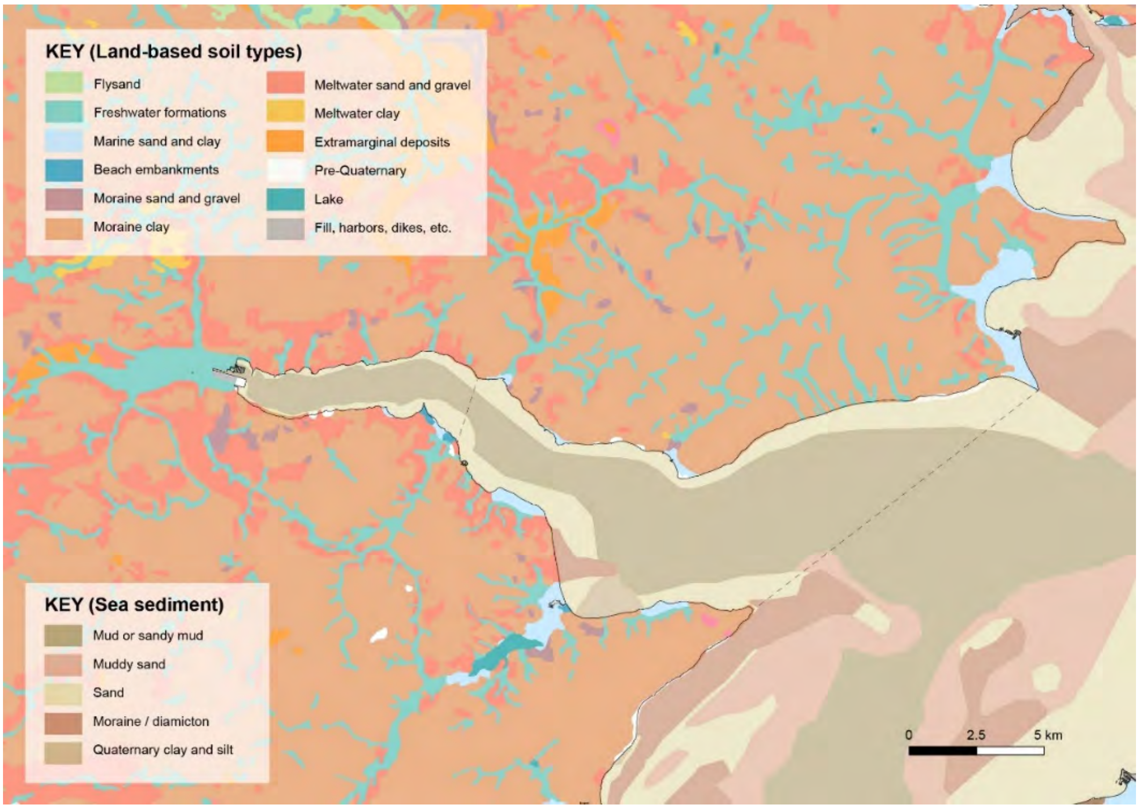


43 Sund Vejle Fjord project is also working with voluntary associations, research units, state institutions, local schools, diving clubs, fishing associations and municipal networks using marine instruments based on reputable research methods (Sund Vejle Fjord, 2022; Vejle Ådal & Fjord, 2022).

44 Currently, Vejle fjord suffers from an explosion of crab and starfish populations due to the absence of predators (large fish population). This is due to the lack of nurseries for fish as a result of poor water quality that hinders the formation of habitat-forming vegetation such as eelgrass and seaweed and the lack of stone reefs. The issue with the explosion of crab and starfish populations is that they consume eelgrass, mussels and seaweed, which is needed to establish nurseries for fish and clean the water. Currently, the crabs are actively fished out in order to prevent them from destroying the eelgrass replantation (Fjeldsø Christensen, 2021).

45 Approximately 8 hectares of stone reefs (equivalent to 15 football fields) have been reinstated into Vejle Fjord's mid-outer areas from July 2022 (Center for Marin Naturgenopretning, 2022).

Figure 9. (Top left image) Current projects by Sund Vejle Fjord to reinstate the stone reefs are highlighted in yellow. Image credit: Sund Vejle Fjord (n.d.).
(Top right image) The current limited stone reef status (before Sund Vejle Fjord Project) in the fjord. Image credit: Vejle Municipality (2021).
(Bottom image) Most forms of coastal vegetation are sparsely spread out in the shallower waters near the coastline. Image credit: DHI (2019).
(Extracted from Kumu Multiscalar map – Fjord scale node).



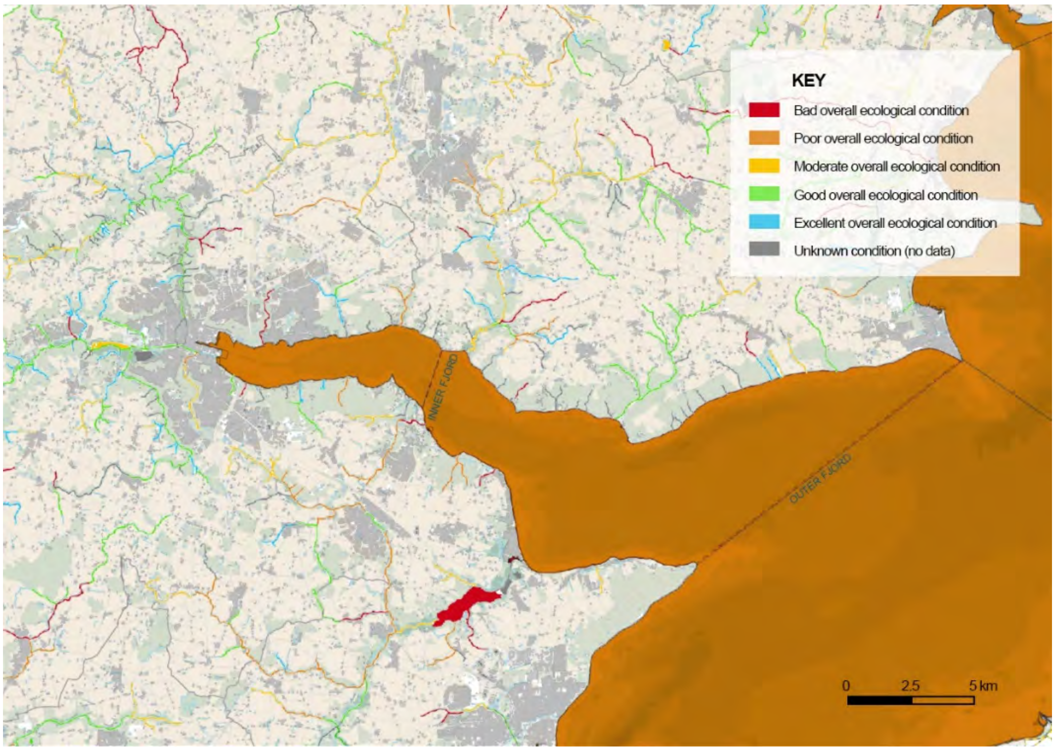


Figure 10. (Top image) The sediment map of Vejle fjord shows that it is largely a mud substrate making it difficult for marine life to grow (the mud also makes it easily murky when it rains). Maps created by Soo Ryu, GIS data from: GEUS Dataverse (Jakobsen, 2022; Jakobsen, Tougaard and Anthonsen, 2022a; 2022b).
(Bottom image) Vejle Fjord is currently in poor overall ecological status based on several quality measures[46] *(data from July 2021 (Miljøstyrelsen, 2021). The streams and rivers are based on data from June 2016 (Miljøstyrelsen, 2016). The fjord is in poor condition because there are agricultural fields surrounding the fjord (Hedrup, 2021). Maps created by Soo Ryu, GIS data from: Miljøstyrelsen (2016, 2021).*
(Extracted from Kumu Multiscalar map – Fjord scale node).

1.5 Research gap – Seaweed as a representative of the marine realm

Many ecosystems in our cities have not been studied in enough detail to suggest clear plans of action. It is critical to gain on-the-ground information about urban ecosystems in order to understand the systemic impacts that potential design interventions could have on cities before enacting them.

Kate Orff, SCAPE Studio, Toward an Urban Ecology
(Orff, 2016, p.218).

46 They are the ecological condition of phytoplankton, rooted plants, benthic invertebrates, environmentally hazardous pollutant (MFC) and chemical status of the EU's list of substances. There is very little data on the oxygen and light levels of coastal waters which will also impact the ecological condition (Miljøstyrelsen, 2021).

1.5.1 Why Seaweed? – The forgotten actor

My initial proposal in response to the PhD call was to look through the research call from the lens of seaweed based on an initial hypothesis and a research gap of "Urban Seascaping with seaweed" – i.e., "What if we urban landscaped/seascaped our boundary between city and sea, with seaweed and mussels as we do with flowers and trees on land?" (Refer to Preface – Research motivations). Therefore, the research project argues that macroalgae, more commonly referred to as seaweed, is an overlooked and undervalued coastal ecosystem in the LUDP disciplines[47] that deserves more attention[48]. Much of the focus and research has been on other coastal ecosystems, such as salt marshes, meadows, eelgrass, and wetlands, for restoration or inclusion as part of coastal cities' protection, adaptation and mitigation strategies (Scott, Frail-Gauthier and Mudie, 2014; Caçador et al., 2016; Narayan et al., 2017; Wiberg, 2019; Zhu et al., 2020; Fairchild et al., 2021; Quintana, Kristensen and Petersen, 2021). For instance, in various state-of-the-art projects related to coastal adaptation projects (i.e., via nature-based solutions), seaweed is either missing or put on the back burner in both the main narrative and implementation[49]. And when there is a focus on seaweed, it is usually for its utilitarian function as food, feed and fuel (see section 1.5.3 Current barriers to integrating and utilising seaweed). Despite occupying a crucial land-to-sea transition space (i.e. the intertidal zone) and providing a range of critical ecological and socio-economic services, seaweed remains under-acknowledged in relation to its important role in tackling the negative impacts of anthropogenic climate change (see section 1.5.2 for more details). Regardless of the importance of these marine ecosystems, the integration and protection of these vital marine habitats are often disregarded at the expense of prioritising the urban environment and its future developments (Galland, Harrould-Kolieb and Herr, 2012; Filbee-Dexter and Wernberg, 2018a; Frontiers, 2018) (refer to the section 3.1.6 "Terrestrial bias). For instance, coastal urban development in the past century in Denmark has prioritised the act of expanding the city out into the sea (refer to section 3.1 for more information). This act has not only increased Danish coastal cities' vulnerability to the impact of rising sea levels but also led to the destruction of former marine

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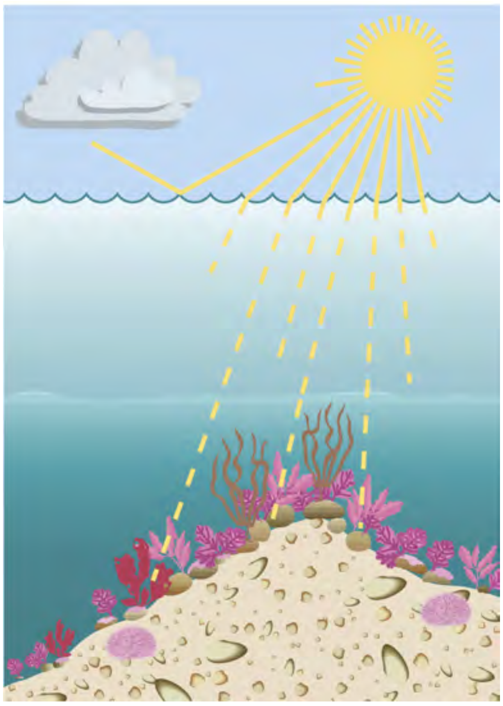
47 Of course, much of the research on seaweed is dominated in the field of marine biology, especially, phycology, the branch of botany concerned with seaweeds and other algae.

48 In 2010, the Danish Ministry of Food, Agriculture and Fisheries released a report called "The sea - an untapped resource". The report concluded that seaweed is an underutilised, under-researched resource in Denmark and Europe with great potential for the future for its wide range of applications that can be produced in a sustainable way with little environmental impact, such as renewable energy to ease our dependence on fossil fuels and for sustainable food as an alternative to overfishing (Danmark and Ministeriet for Fødevarer, Landbrug og Fiskeri, 2010; Holdt, n.d.).

49 From the literature review of the most well-known state-of-the-art (S-O-T-A) coastal adaptation projects around the world have either a stronger focus on salt marshes and wetlands than seaweed as "soft approaches/soft infrastructure" with little or no mention of seaweed. The literature review of the S-O-T-A projects covered are (and not limited to): "Rising Currents" – Project for New York's Waterfront (Bergdoll et al., 2011), "On the Water" – Palisade Bay' (Nordenson, Seavitt and Yarinsky, 2010), "Rebuild by design" – The Hurricane Sandy Design Competition for New York (Gendall et al., 2015), "Structures of Coastal Resilience" (Nordenson, Nordenson and Chapman, 2018) and Scape Studio's works in their book "Towards an Urban Ecology" (Orff, 2016) to name a few for cases in the USA. And for Denmark, Realdania's "Cities and the rising seawater" pilot projects (Realdania, 2019; Realdania and KU, 2020), and many other reviews of S-O-T-A coastal adaptation/protection projects (e.g. by Wiberg (2019)).

habitats and seabed by removing large amounts of boulders, rocks and stones[50] to use for construction on the land, as shown in Figure 11 (Mørk Jørgensen, 2020; Stubgaard, 2020; Svendsen, 2020; Hedrup, 2021). Although these reclaimed areas are relatively small in comparison to the vast coastline of Denmark, they contribute to marine dead zones in the ocean bed because it claims coastal areas that are ideal for the survival of many marine habitats dependent on specific depths below sea level with access to sufficient sunlight to thrive, as shown in Figure 11 (Dahl et al., 2003; Bishop et al., 2017; Palmgren, 2019). The removal of conditions for coastal ecosystems due to land reclamation also removes the opportunities for urbanites to physically and visually interact with marine life forms closer to land, making the nature-culture divide more prominent (as outlined in section 3.1). Thus, there is an opportunity and a gap in research to address the current lack of spaces designed for a meeting place between the residents and the sea/marine life on the harbourfront and waterfront – something that Kanten/The Edge design competition set out to address (i.e., a requirement of a nature-based solution utilising nature *under*water). Therefore, the research seeks to address this gap by investigating through Kanten/The Edge competition different ways in which seaweed, as part of a designed intervention at the waterfront, could contribute to the city's nature-based solution and an alternative relation with the nonhuman marine world in the future.



50 Furthermore, the intensive fishing industry (i.e. bottom trawling) also removed habitat-forming substrates like stones, rocks and boulders (Organo Quintana, 2020).

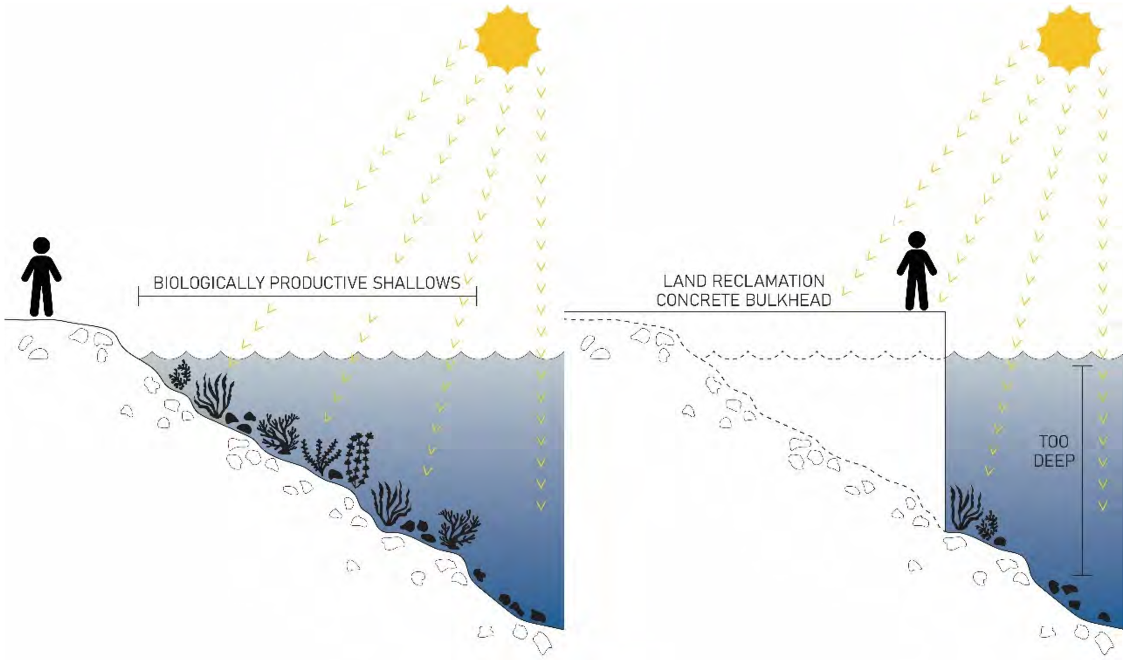


Figure 11. (Top Left image) Illustration of how coastal ecosystems such as seaweed depends on a certain depth below the sea (depending on water clarity) to access sunlight for photosynthesis and is sensitive to thermal stress (Dahl et al., 2003; Harley et al., 2012). Hence, many coastal ecosystems thrive at an ideal depth below sea level, which land reclamation projects have replaced (the shallow areas). Image credit: Dahl et al., (2003).
(Top Right image) Sugar Kelp ("sukkertang" in Danish) is brown macroalgae, which like many seaweed species, requires solid substrates like stones or rocks to attach itself to (Mouritsen, 2019). Therefore, they do usually not grow in sandy or muddy areas (unless they are seaweed species that float and thus are not dependent on rocks). Therefore, the removal of stones and rocks from the Danish coastline contributes to the lack of marine biodiversity. Image credit: The photo of the sugar kelp was taken from Aalbæk beach in January 2022.
(Bottom image) A section drawing shows before and after the impact of the land reclamation process that replaces biologically productive shallow areas. The leftover areas are too deep for sunlight to reach, preventing the photosynthesis of marine vegetation such as seaweed. Image credit: Soo Ryu and Agnes Jarmund.
(Extracted from Kumu Multiscalar map – Cyclic scale node).

The plight of seaweed

Unfortunately, seaweed as a life-supporting part of coastal ecosystems is globally declining due to anthropogenic climate change and human industrial activities (see Figure 12) (Harley et al., 2012; Filbee-Dexter and Wernberg, 2018a; 2018b). The changes in global sea temperatures have already resulted in a mass migration of seaweed to colder waters (i.e. kelp), putting pressure on them to adapt to their changing new environment (ibid.). For Denmark, the majority of coastal water bodies and their lifeforms are in poor ecological conditions due to environmental problems related to high levels of eutrophication from nutrient load from excessive use of fertilisers for agriculture[51]

51 According to many researchers, agricultural activity is mainly responsible for the emissions of nitrogen (N) and phosphorous (P) responsible for poor Danish coastal conditions (the coastal waters are not impacted by other countries, but purely leaching from Denmark) (Bredsdorff, 2018a; 2018b; Organo Quintana, 2020; Fjeldsø Christensen, 2021). The EU deadline for achieving "good ecological condition" of coastal waters (119 coastal water bodies in Denmark) by 2027 is deemed unrealistic by researchers due to the continuing large amount of leaching of N and P in recent times (Bredsdorff, 2018a). Furthermore, increased rainfall predicted in the latest IPCC assessment

(see Figure 13) (Bredsdorff, 2018a; Filbee-Dexter and Wernberg, 2018b; Miljøstyrelsen, 2022a; n.d.). Excessive levels of eutrophication[52] found in Danish coastal waters lead to ecosystem degradation and hinder the restoration efforts of coastal ecosystems (Riemann et al., 2016). Therefore, there is a need to implement different ways to spread awareness of the impact of climate change and human activity on profoundly altering the ocean[53]. The irony is that these coastal ecosystems, like seaweed, face an uncertain future that needs to be protected from the negative impact of human activities while at the same time requiring proactive human management to survive in challenging conditions (Orff, 2016).

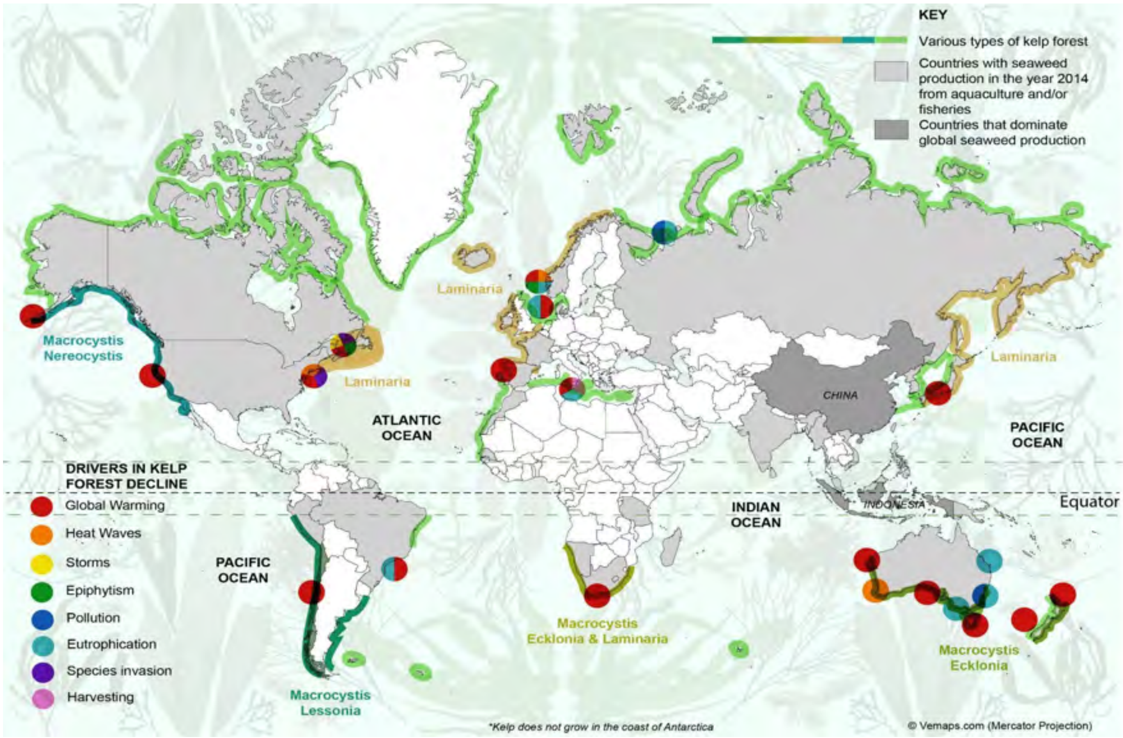


Figure 12. Various drivers in global kelp forest decline. The map was created by Soo Ryu, combining maps from various sources (Filbee-Dexter and Wernberg 2018; Froehlich et al. 2019; Gundersen et al. 2017; Steneck et al. 2002). Note: Unlike kelp, other seaweed types can grow on the equator.
(Extracted from Kumu Multiscalar map – Global scale node).

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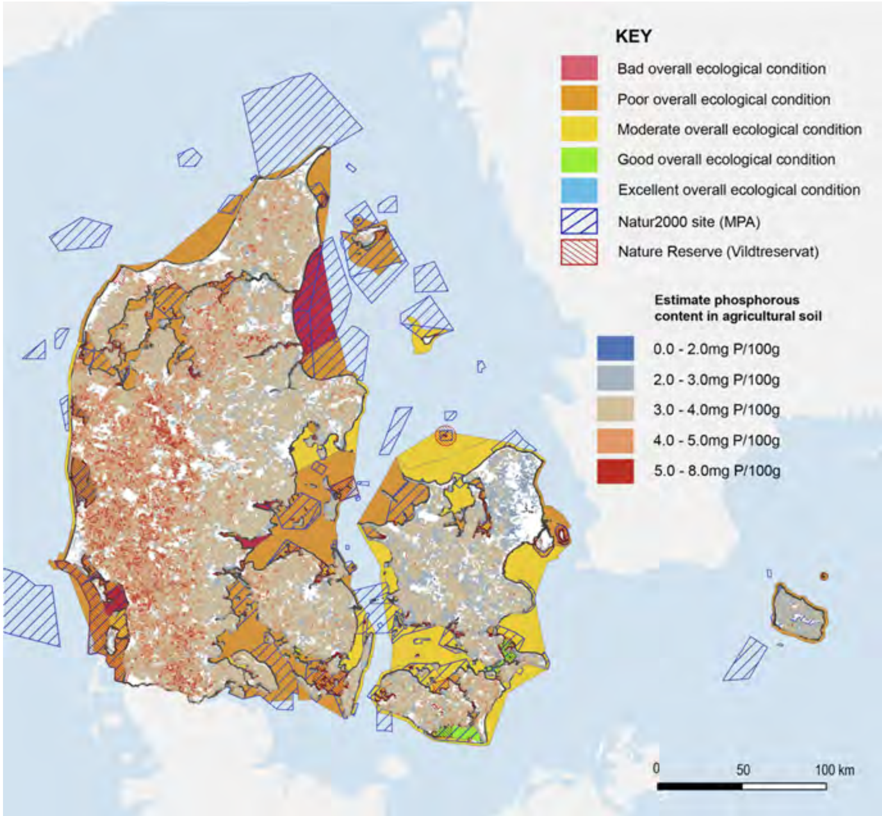
report (2021) will carry more excess nutrients from agricultural runoffs to the coastal waters, worsening water quality for marine life and decreasing coastal waters' salinity levels and more algal blooms.

52 According to Riemann et al. (2016), since 1985, a number of Danish mitigation measures (i.e. Environmental Water Plan/Vandmiljøplanerne in 1987) have been implemented to reduce nutrient losses from three sectors: (i) agriculture, (ii) urban wastewater treatment plants, and (iii) industries with separate discharge. Since the eighties, there have been efforts to reduce P and N discharges, but the reduction is mainly due to the improvement of industrial and wastewater treatment (Carstensen et al., 2006; Riemann et al., 2016; Bredsdorff, 2018a).

53 According to the latest report by the IPCC (2021), the ocean is warming rapidly with more frequent marine heatwaves, accelerating ocean acidification and deoxygenation levels. IPCC (2021) issues a warning that "these changes affect both ocean ecosystems and the people that rely on them, and they will continue throughout at least the rest of this century." Moreover, the negative impacts of global warming and water pollution are responsible for the global degradation of 66% of marine environments (IPBES, 2019).



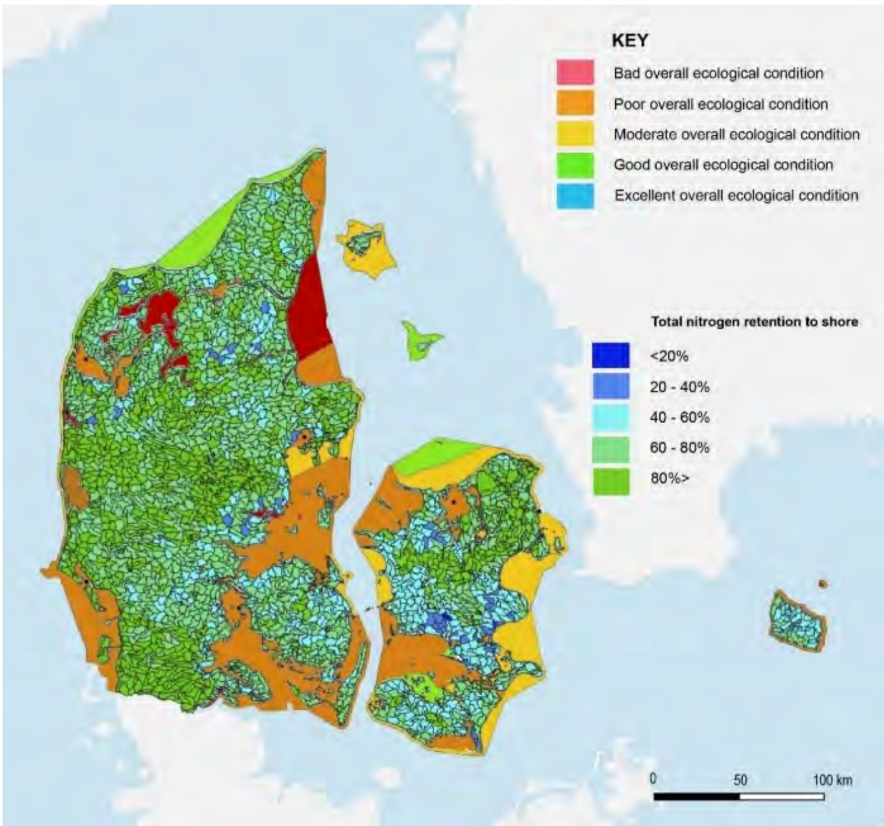


Figure 13. The overall ecological status of coastal waters in Denmark from June 2016 (top image) to July 2021 (bottom image) shows some signs of improvement (Miljøstyrelsen, 2016; 2021; 2022b). The maps show the overall ecological

condition of coastal waters based on several quality measures[54] with the nitrogen and phosphorous load on land. The poor condition is mainly due to excessive phosphorus and nitrogen load from agricultural farming. Recent efforts to clean up the coastal waters have shown some levels of improvement in water quality over the years. However, only a few coastal water bodies are in good ecological condition (as indicated in green). Jutland has a poorer water quality than Zealand due to a higher concentration of agricultural activity, as indicated by the maps. Maps created by Soo Ryu, GIS data from MiljøGIS (Miljøstyrelsen, 2016; 2021; 2022b).
(Extracted from Kumu Multiscalar map – National scale node).

Restoring the health of these water bodies is paramount as it directly impacts biodiversity, recreation, climate change mitigation and coastal protection (refer to section 1.5.2 below). Therefore, coastal adaptation strategies present an opportunity to integrate seaweeds into the urban shorelines so that humans might get more exposure to them, thereby making possible educational efforts that might raise awareness about the plight of the forests of the sea. Coastal zones are important figures of a meeting place that can provide opportunities for interaction and appreciation of the entanglement between land and water. Moreover, as global warming pushes the sea further into coastal cities, the question of how marine life forms could transform these inundated spaces remains an unexplored solution.

1.5.2 Seaweed's ecosystem services

To further support the case for seaweed as a good contender for nature-based solution (NbS), this section explores the diverse instrumental impact on humans and its role in the function of the ecosphere. The intention is to explore the various properties of seaweed that contribute to coastal resilience, adaptation[55] and urban/cultural transformation. Therefore, a well-known Ecosystem Services[56] (ES) framework is used as a general guideline to showcase the connections between ecological and socioeconomic systems (Everard and Waters, 2013; Tusznio et al., 2020). However, this research intends not to use the ES assessment[57] framework extensively and exhaustively but as a guiding framework to support seaweed.

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54 See footnote 46.

55 Bearing in mind that there are different objectives for growing seaweed in more challenging urban areas, be it for education, coastal protection, increased biodiversity, water filtration, or carbon sequestration. They are not always mutually agreeable (Mouritsen, 2019).

56 There are four different categories of ecosystem services. 1. Provisioning services that are those that benefit people which can be extracted from nature such as plants as food, wood for fuel, etc. 2. Regulating services are those that make life possible for people, such as plants that produce oxygen, bacteria that decompose waste etc. 3. Cultural services are non-material benefit that contributes towards the advancement of culture, such as through art, music etc. 4. Supporting services are those that provide living habitat for humans and non-humans as the basis of all ecosystems and their services (Gundersen et al., 2017).

57 I am aware that ES assessment is extensive, with limitations and challenges for its implementation and effectiveness. For instance, ES assessment have difficulty in integrating different subjective values and conflicting interest from the various stakeholders, it has limitations in comparing the various categories of ecosystem's "benefits" and challenges around operationalising through an objective threshold and some critics find the assessment too anthropocentric with the lack of intrinsic value propositions to name a few (Tusznio et al., 2020).

Some of the key ecosystem services of seaweed are elaborated below in its three main categories:

1. Regulating and supporting ecosystem services: Environmental benefits of seaweed
2. Provisioning ecosystem services: Economic benefits and potential of seaweed
3. Cultural ecosystem services: Aesthetic, epistemic and social significance of seaweed

Regulating and supporting ecosystem services of seaweed:

i) Wave attenuation and coastal erosion mitigation

As part of the coastal resilience strategy, kelp forests[58] can reduce the strength of waves from storms (Duarte et al., 2017; Gundersen et al., 2017; Morris et al., 2020). This potential is dependent on various factors, such as the morphology, strength of the wave, season, size, age and density of the forest, to name a few (Løvås and Tørum, 2001; Marine Scotland Directorate, 2016; Smale et al., 2013). Kelp is the only known macroalgae with wave-attenuating properties (ibid.). Although, based on an older study, Mork (1996) found that a natural kelp forest (i.e. Laminaria Hyperborea) on the coast of Norway extending 6-8km offshore has proven to significantly reduce the impact of waves from storm surges up to 60% in height and measured 70% to 85% wave energy reduction across a 258 m long kelp bed (during low tide). These kelp forests played an important role in protecting the coastal cities behind them (ibid.). Moreover, research by Zhu et al. (2021)[59] indicates that dense kelp aquaculture farms (grown on floating buoys of long horizontal lines, see Figure 14) have the potential to serve as a form of nature-based coastal protection (and are more effective than natural help forests growing on sea beds due to floating kelp being closer to the wave energy). This method can attenuate the strength of waves (i.e., storm surge) if they are installed perpendicular to the direction of wave propagation. These relatively low-maintenance and efficiently grown kelp aquaculture farms (Fehrenbacher, 2017; Parfitt, 2018) can serve as part of the blue infrastructure in coastal adaptation and protection strategy.

58 Seaweed forest is also called a kelp forest which is usually referring to a type of brown seaweed/macroalgae in the *Laminariaceae* family (macroalgal order *Laminariales*). Common names of the main kelp species available in Denmark are: Sukkertang (Sugar Kelp in English), Fingertang (Oarweed in English) and Palmetang (tangle or cuvie in English) (Fraser, 2012; Lundsteen and Nielsen, 2019a; MarLIN, 2022).

59 To assess the wave attenuating potential of floating kelp farms, Zhu et al. (2021) designed a set of 1:10 scale physical suspended kelp model experiments based on the mechanical and morphological properties of the cultivated sugar kelp (*Saccharina latissima*) from Saco Bay, Maine, USA. Zhu et al. (2021, p.1) "… showed that suspended kelp farms in the designed configuration with 20 long lines of 1m-long blades and 100 blades/m have the potential attenuating wave energy by up to 33.7% under the experimental wave conditions." The experimental results indicate that the technique to improve the wave attenuation capacity of suspended kelp farms for nature-based coastal defence is to install the kelp farms in shallower water, expand the farm size by adding more longlines, locate the kelp in a higher position of the water column, grow the kelp more densely, and choose the kelp species with more rigid, wider, and longer blades/biomass (Zhu et al., 2021).

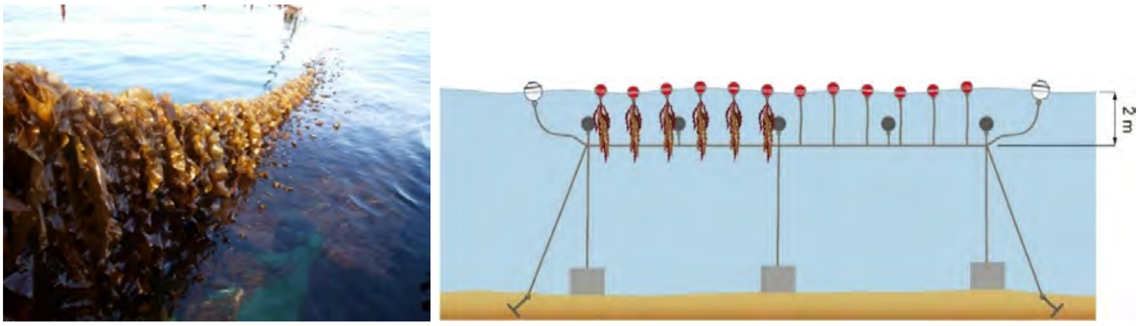

Figure 14. Sugar kelp or Sukkertang (Laminaria saccharina) is grown on lines and buoys in Danish waters. There is scope to grow kelp forests in appropriate conditions to dissipate the strength of storm surges (Zhu et al., 2021). Several kilometres of dense kelp forests are required to provide significant coastal protection.
Local testing is required to understand various factors that influence the performance of the kelp. Furthermore, sugar kelp requires colder temperatures to thrive (less than the surface water temperature of 20 degrees), which is challenging as overall temperatures increase due to global warming (Boderskov, 2021).
Image credit: Teis Boderskov (Boderskov, 2020; Boderskov et al., 2021).
(Extracted from Kumu Temporal map – Long-term node).

Additionally, growing seaweed on seawalls as a "living seawall" can also increase the life of hard defences (Depietri and McPhearson, 2017; Naylor et al., 2017). Seaweed forests (clusters of seaweed) in combination with rock reefs, in some instances, can also prevent coastal erosion as breakwater by changing the hydrology of the water that mitigates the erosion process, as shown in Figure 15 (Fjeldsø Christensen, 2021).

Figure 15. Rock reefs, in conjunction with marine life forms (e.g., seaweed and mussels), are used to protect the coast by breaking the waves and limiting the damage (i.e., erosion) to the land. While at the same time, it promotes marine life, such as providing a habitat for seaweed, mussels and fish. Image credit: Søren Winther Nørbæk (Aaberg, 2021).
(Extracted from Kumu Temporal map – Short-term node).

ii) Water purification and pollution control

Seaweed improves water quality by filtering pollutants[60], such as retaining fine sediment particles and uptake nutrients (i.e., fertiliser runoffs) from the mainland (see Figure 16) (Bruhn et al., 2020; Seghetta et al., 2016). Thus, kelp forests help combat eutrophication, reducing the threats of algal blooms and hypoxia, and improving ecosystem diversity and functionality (Duarte et al., 2017; Gundersen et al., 2017). The pollution-cleansing properties are useful for reducing nutrient loads from industrial activities from farms, factories and sewage plants (Fehrenbacher, 2017). However, seaweeds have a threshold at which excessive pollutants in the water will prevent them from growing due to murkier waters from floating particles that inhibits sunlight (Fehrenbacher, 2017; Organo Quintana, 2020; Fjeldsø Christensen, 2021) (see Figure 11).

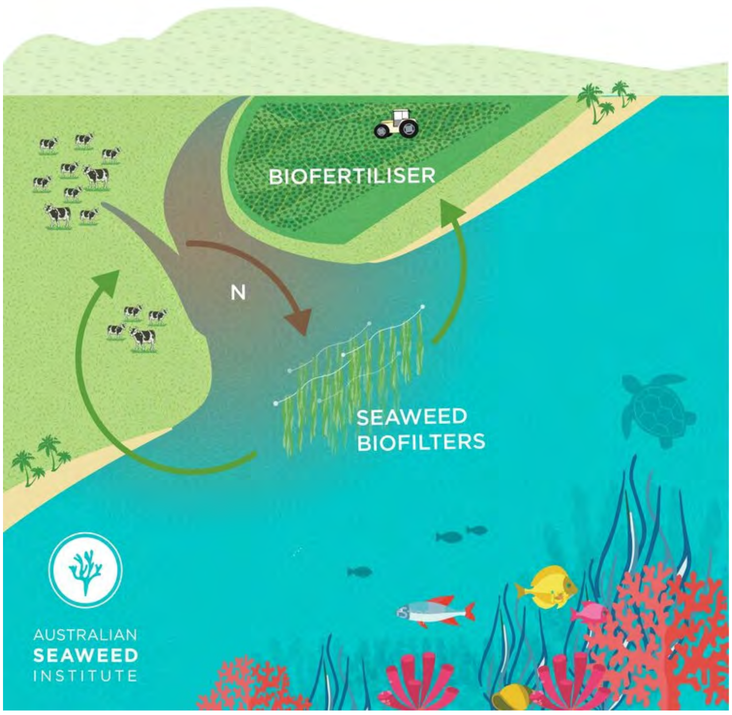

Figure 16. According to the Australia Seaweed Institute (2020), "Seaweed can remove vast amounts of excess nitrogen and carbon dioxide as it grows... seaweed can then be harvested for use in products such as bio-fertilisers, animal feed and bioplastics, delivering both an environmental solution and an economic boost." Image credit: Australian Seaweed Institute and CQ University Australia (2020).
(Extracted from Kumu Multiscalar map – Cyclic scale node).

60 Seaweed is not the only marine organism capable of cleaning the water. In fact, bivalves such as blue mussels and oysters are more efficient in the uptake of nutrients and thus filtering pollution (Boderskov, 2020). However, they all have varying strengths and weaknesses. For instance, according to Greenberg (2013), "seaweeds absorb persistent inorganic nutrients in the water column much more effectively than mussels. And unlike bivalves, which use oxygen as they filter and respire, photosynthetic seaweeds generate oxygen, making for a more oxygen-rich system - provided they are harvested before they die and decompose."

iii) Blue carbon (air quality and carbon sequestration)

Seaweed is regarded as one of the earth's most ecologically productive photosynthesising systems[61]. It has higher carbon sequestration properties than land-based plants and grows rapidly (Boyd, n.d.; Krause-Jensen and Duarte, 2016; Nellemann et al., 2009). Furthermore, seaweed forests do not burn like forest fires on land, and there is potential for sinking the kelp to the bottom of the ocean bed at the end of its life, guaranteeing carbon capture. Therefore, seaweed may even have an important role in climate mitigation by transferring carbon to the deep sea, where it can be stored (Nellemann et al., 2009; Krause-Jensen and Duarte, 2016; Krause-Jensen et al., 2018; Boyd, 2021) as shown in Figure 17. However, the potential of dead kelp material storing carbon for the future is under-researched, with no conclusive data yet due to challenges with documenting and quantifying carbon sequestration beyond their habitat (Gundersen et al., 2017).

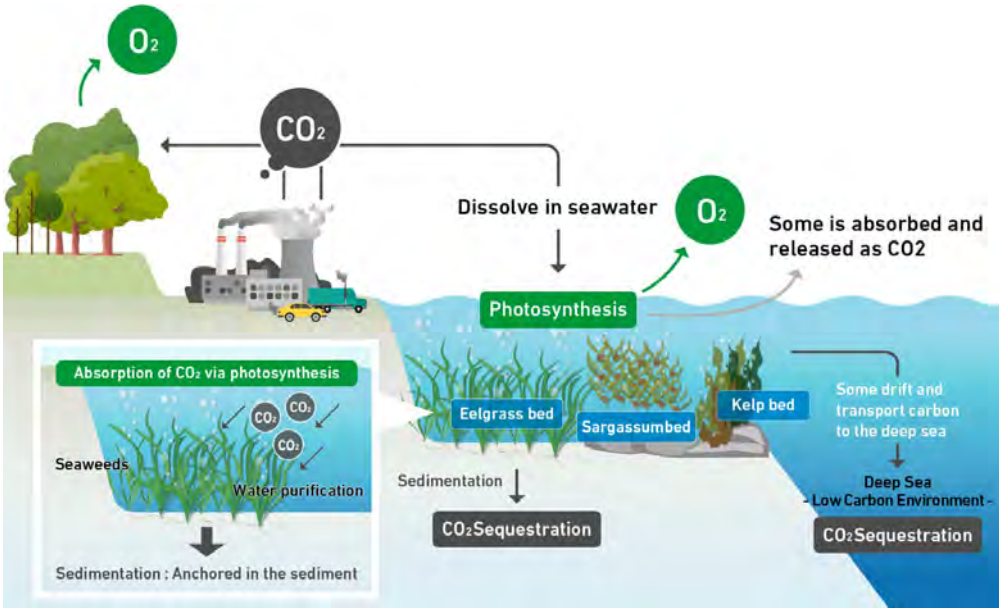

Figure 17. A cyclic diagram of the blue carbon potential of marine vegetation such as eelgrass and seaweeds via photosynthesis. Image credit: ENEOS Mirai Hub, (2020).
(Extracted from Kumu Multiscalar map – Cyclic scale node).

iv) Improve biodiversity and crucial habitat

The various forms of seaweeds are habitats, nursery grounds and food for fish, marine invertebrates, mobile pelagic and benthic organisms, improving biodiversity and opportunities for recreation (i.e., marine nature reserves) (Orth et al., 2020). Moreover, kelp forests are a habitat that hosts one of

61 For instance, these coastal ecosystems play an important role in coastal mitigation strategy by reducing the severity of climate change (thus, to a certain extent, the scale of sea-level rise) in the future as they play a key role in climate change mitigation by taking up CO_2 from the atmosphere (Duarte et al., 2017; Filbee-Dexter and Wernberg, 2018a). The oceans (i.e. micro and macro algae) act as a "giant reservoir of carbon," reducing and moderating the impacts of human fossil fuel use (Galland et al., 2012, p.12), and the ocean is a primary producer of oxygen through the plants that live in it (for instance, plankton and algae). For instance, algae (micro and macro) is responsible for around 50% of all oxygen production) (Chapman, 2013).

the world's most diverse and crucial ecosystems, supporting biodiversity and food webs (Krause-Jensen and Duarte, 2016; Dijkstra et al., 2017; Gundersen et al., 2017; Filbee-Dexter and Wernberg, 2018a).

Provisioning ecosystem services of seaweed:

i) Sustainable food production

Seaweed can be eaten by humans, contributing to local, sustainable food production. In East Asian cultures, seaweed is revered as a healthy superfood[62] and medicine with a strong holdfast on the culture. To this day, in South Korea, seaweed soup is eaten as a form of celebration, i.e. on birthdays and when mothers give birth (Snodgrass, 2012; Jeong, 2013; Korean Food Promotion Institute, 2018). The common names of various types of seaweed are well-known and well-used among the public. For instance, in Japan and South Korea, macroalgae's common name is not labelled as "weed" in seaweed[63], which semantically denounces its value and worth, designating its purpose as a nuisance and a useless entity.

Seafaring cultures like Denmark[64] had a stronger relationship with seaweed in the past, unlike today. For instance, during the early Viking period, the accessibility of in-land driven seaweed to coastal populations after a storm made seaweed available for applications[65] such as feed for animals to supplement human diets and as a fertiliser for soil (Danmark and Ministeriet for Fødevarer, Landbrug og Fiskeri, 2010; Indergaard, 2010). However, with the onset of the agricultural revolution, it is probable that seaweed was slowly forgotten from the Nordic diet (Mouritsen, 2013). However, in recent times, seaweed is making a resurgence in New Nordic Cuisine as a healthy superfood and a form of sustainable food that does not require any land, freshwater, fertiliser or pesticide to grow and can mitigate food shortages in the future due to global warming (Efstathiou and Myskja, 2018; Krause-Jensen and Duarte, 2016; Krause-Jensen et al., 2018; Mouritsen, 2013). Seaweed is a plant-based, sustainable source of protein that can alleviate the agriculture industry's high ecological footprint (see Figure 18) (Fehrenbacher, 2017).

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62 Seaweed has great nutritional value with high contents of protein, vitamins, minerals, fibre and antioxidants with many other health benefits (Fehrenbacher, 2017).

63 Seaweed in English conveys a meaning that is neither useful nor beautiful. However, the Danish term for seaweed is "tang", according to research by Efstathiou and Myskja (2018, p.420). The English word for tangle is derived from the old Norse term tang, meaning "to entwine or entangle." One of the Norwegian words for seaweed, "tare" is related to the English word "tender". The seaweed in "Nordic languages conveys their tangled, delicate and twisting natures" (ibid.).

64 Denmark has more than 8,000 km of coastline, and no point on land is more than 50 km from the sea (denmark.dk, 2022).

65 Seaweed had impacted the food culture in the Nordic region as early as the 10th century, when seaweed was in the diet of the Nordic people (and Greenland), with stories of Viking voyagers bringing dried seaweed as provisions for long expeditions. Moreover, seaweed was incorporated into oats and barley to make bread and boiled with milk. "It is said that during the famine, almost half of the bread dough consisted of seaweed" (Mouritsen, 2013, p.64). Seaweed was a common substitute during harsh winters and was also given to farm animals as supplements (fodders) (Mouritsen, 2013, p.221).

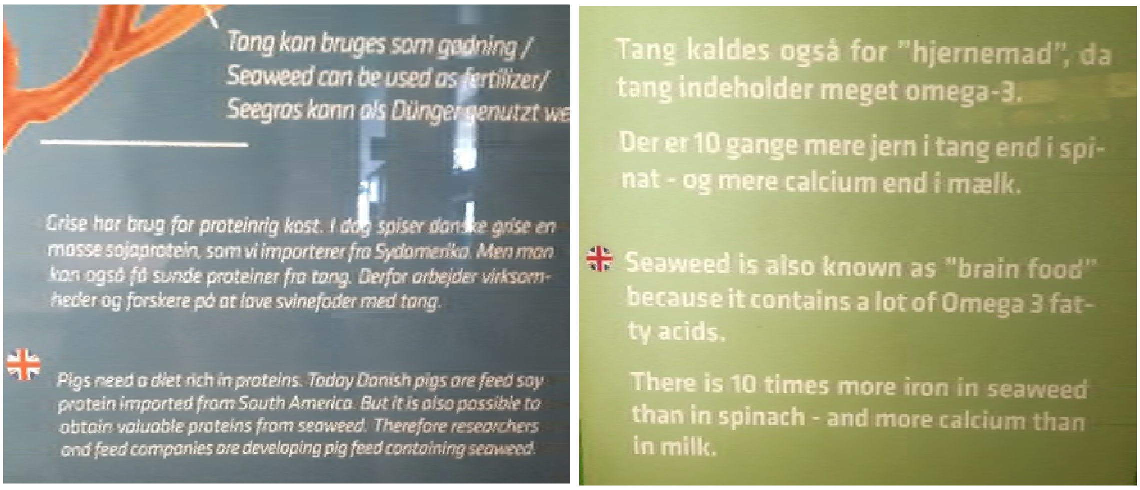

Figure 18. Photos of the information displayed from the Kattegat Centre in Grenå, Denmark, on seaweeds. The image was taken by the author on 01/07/20.

ii) Other broader uses of seaweed

Seaweed is used for a broad range of products[66], such as organic fertilizers, alginate (agar), animal feed, pharmaceuticals, cosmetics, bio-plastic, bio-paint/dye, paper and chemical compounds such as emulsifiers and bonding agents (AlgaeCenter Denmark, 2013; Schiller, 2015; Filbee-Dexter et al., 2018; Hasselström et al., 2018). They can provide a source of biofuel to replace fossil fuels (Fehrenbacher, 2017). Seaweed also provides an alternative source of revenue for commercial fishers, who can grow with other species, such as oysters, mussels and scallops, to replace dwindling fish numbers due to overfishing (Schiller, 2015).

Cultural ecosystem services of seaweed:

Cultural heritage and aesthetic value

Aside from seaweed impacting local food culture, it also had another cultural impact during the natural history boom of the Victorian period, popularized, amongst others, by Charles Darwin. British women who were excluded from scientific fieldwork engaged in more socially acceptable fieldwork to collect seaweed and dry press seaweed showcasing its beauty (Mouritsen, 2013; Meier, 2014; Giaimo, 2016; Trethewey, 2020) (see Figure 19). As a source of beauty, seaweed is an under-explored avenue (unlike terrestrial plants) that could be better exemplified at the meeting place between the terrestrial and the marine world. For instance, research by Norwegian scientists Efstathiou & Myskja (2018) explores the inherent value of seaweeds as a source of beauty (see Figure 19), and many emerging artists utilise seaweed as a medium for contemporary bio-art (Pentecost, 2008; Iselin, 2014; Lohmann, 2018). Efstathiou & Myskja (2018) argues for a paradigm shift to

66 Denmark has a history of the production of hydrocolloids extracted from seaweed (Danmark and Ministeriet for Fødevarer, Landbrug og Fiskeri, 2010; Holdt, n.d.).

increase ecological awareness and appreciation of seaweed as a source of cultural heritage and its scientific knowledge – of epistemic value.

Figure 19. (Top left image) Showcasing the unknown aesthetic qualities of seaweed by artist/photographer Josie Iselin (Iselin, 2019).
(Top right image) The artist Julia Lohmann in Finland works with seaweed as part of her artworks. Image credit: Julia Lohmann (Lohmann, 2013; Todd Hart Design, 2014).
(Middle row image) Victorian women dry pressing seaweed during the Victorian era. Image credit: The Natural History Museum, London (Oatman-Stanford, 2013).
(Bottom image) Various dry pressed seaweeds (called macroalgae) from the coast of East Jutland (near Grenå), Denmark, by the author on July 2020 (from the workshop in Kattegat Centre, see Appendix 10: Notes and photos from workshops, meetings, events, field trips and festivals). Some of the seaweed species shown are (captured within A4 page): Red macroalgae – Blomkålstang (Irish moss), Søl (Dulse), Blodrøde ribbeblad (Sea beech), Rødkløft (Discoid fork weed). Brown macroalgae – Blæretang (Bladderwrack), Butblæret Sagassotang (Japanese wireweed). Green macroalgae – Søsalat and Rørhinde (Sea lettuce). There are over 350-400 different types of seaweed (three main categorisations of seaweed: red, green and brown) in Denmark (Lundsteen and Nielsen, 2019a, 2019b).

Educational and epistemic value

Sea gardens and other educational initiatives involving seaweed can play an important role in raising awareness and appreciation of the underwater world as a way to bring the ocean close to land (Mouritsen, 2019; Hedrup, 2021; Dagens Byggeri, 2022). Initiatives like "Havhøst[67]", translated

67 Havhøst started in 2011 and now boasts more than 1000 sea farmers, more than 20 established maritime utility gardens around Denmark and an educational course for schools where more than 10,000 students have had maritime education (Havhøst, 2021).

as “Sea Harvest”, is a Danish association of sea gardens, NGOs, schools, businesses and ordinary people who share a passion for food from the sea and sustainable development. The idea behind the association is to promote regenerative cultivation [68] in the sea as part of the blue-green transition. The sea gardens grow and harvest sustainable marine crops such as seaweed, mussels and oysters to open up a world of different edible culinary experiences unknown to many Danes (Havhøst, 2019; Hjerl, 2019) (see Figure 21). According to Mouritsen (2019), seaweed could bring people together by creating a culture through food.

Moreover, dedicated marine education centres such as the Marine Education Center in Malmö teach children and adults about the importance of the sea through tactile and hands-on immersive experiences via snorkelling, and fishing for seaweed and mussels, to name a few (Palmgren, 2019) (see Figure 20). For instance, they have created snorkel paths and walking paths along the shoreline and offer experiences and knowledge that are absent in the traditional classroom setting by directly engaging with the so-called invisible marine world (ibid.). The Marine Education Center's vision is to facilitate ocean literacy through knowledge creation, research, awareness and marine stewardship among citizens, businesses and decision-makers (SMKC, 2022). These organisations address the importance of educating the complex assemblage of marine lifeforms of the sea with the residents of the city.

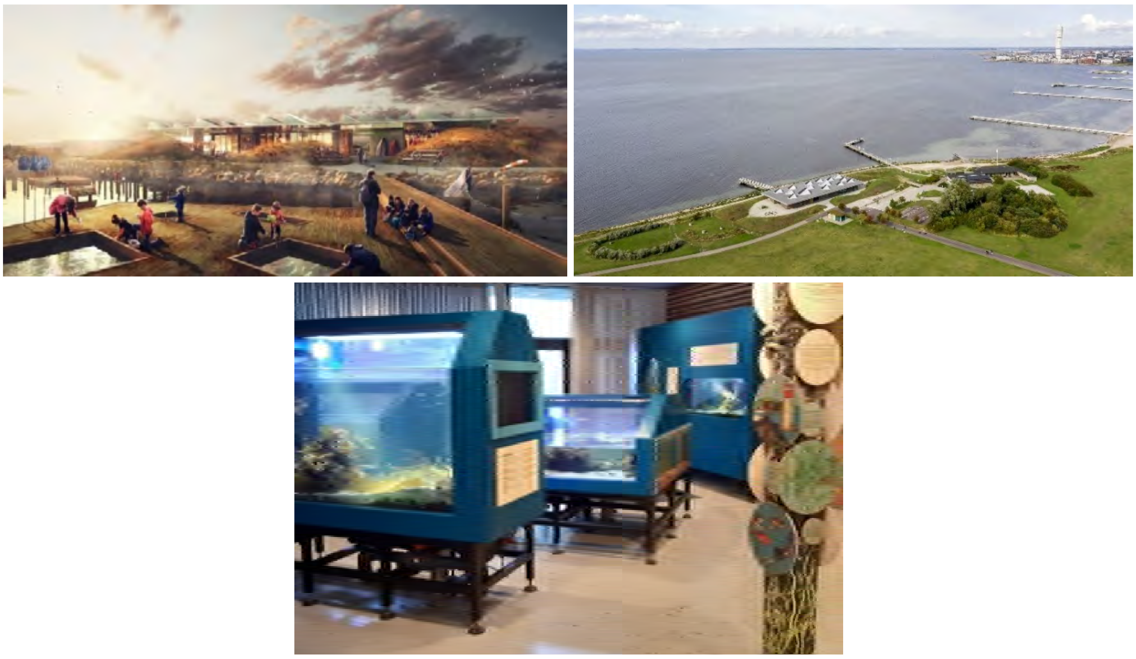

Figure 20. (Top row of images) Marine Education Center in Malmö (Marint Kunskapcenter in Swedish). It was finished in 2017 to teach people about ocean literacy. Image credit: Nord Architects (Mairs, 2014; Nord Architects, 2022) (Bottom row of images - Left) A photo of the water tanks inside the Marine Education Centre taken by the author on a site visit on 23/11/19.

(Extracted from Kumu S-O-T-A map – Marine Education Centre in Malmo, Sweden node).

68 Regenerative cultivation involves leaving the sea in a better condition after cultivation. For instance, mussels, oysters and seaweed capture a lot of nutrients which clean the water during their lifetime (Hjerl, 2019).

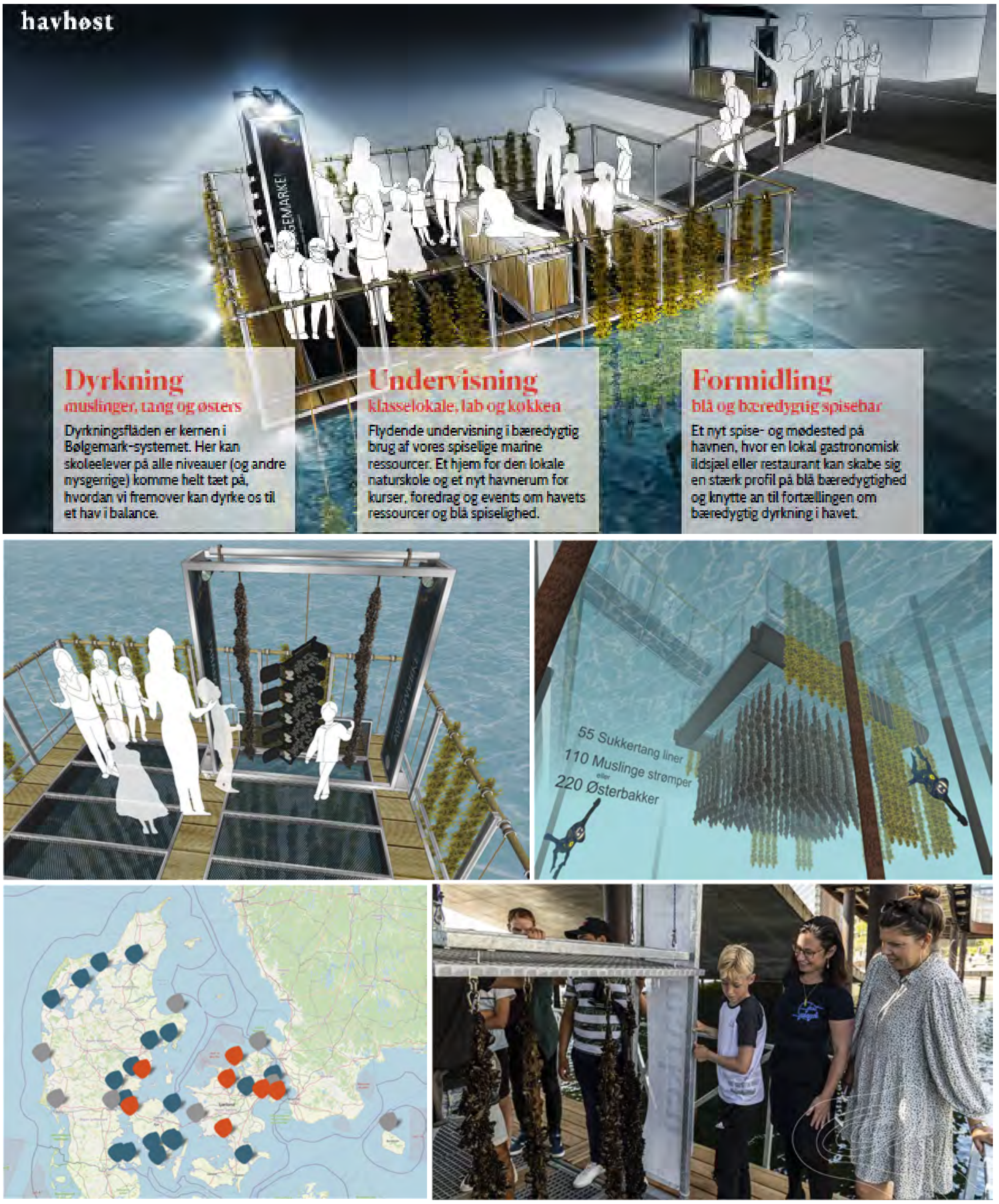

Figure 21. (First and second row of images) Visualisations of the "Bølgemarken" (translated as "the wave field") proposal by Havhøst in Copenhagen harbour (built). The floating platform is designed to bring up the mussels and seaweed growing under the water to be seen, touched and eaten by the citizens above. Although this is not a large-scale intervention, this project is a structural (architectural) response to making the invisible marine realm visible, educational and engaging to the public. Image credit: Joachim Hjerl (Havhøst, n.d.; n.d.; Hjerl, n.d.). (Bottom-row left image) Havhøst/Sea gardens/Marine utility garden associations are gaining traction across Denmark (map), with sea gardens popping up in different coastal regions, as indicated by the map. Image credit: Joachim Hjerl, Havhøst in June 2020.

(Extracted from Kumu S-O-T-A map – Havhøst node in Copenhagen, Denmark node).

The various ecosystem services of seaweed highlight its ability as a life-giving and life-supporting ecosystem. Seaweed is a good contender for representing the vegetated marine realm that can fill the current under-explored research gap in integrating seaweed into coastal adaptation strategies. The ability of seaweed to provide other ecosystem services such as provisional (i.e., food) and cultural services (i.e., art, literature) sets it apart from other vegetated coastal ecosystems like salt marshes or eelgrass. These pre-existing and potentially new practices of seaweed make it a good candidate to forge closer connections between humans and nonhumans of the sea.

1.5.3 Current barriers to integrating and utilising seaweed

Despite the growing awareness and a newfound appreciation of seaweed as the next revolutionary actor in the green transition (Degnarain, 2020; Cai et al., 2021), there are several physical, regulatory and psychological barriers to implementing and thinking about seaweed, especially among the general public's consciousness in Denmark. According to the municipal nature guide Steen Hedrup (2021) and marine biologist Dorte Krause-Jensen (2022), the Danish public's awareness of life under the water is very low, with little interest in and knowledge of seaweed. In the following sections, I explain in more depth why seaweed has become a forgotten actor in nature-based solutions as part of coastal adaptation strategies, compared to the rising interest in reviving salt marshes and wetlands.

Invisible seaweed

Seaweed is a marine lifeform that grows mainly submerged under the water (called the intertidal and subtidal zone in the littoral zone – see Figure 23). Consequently, some of the seaweed species are invisible to the human eye, and many can only be observed by paying close attention (i.e. crouching to get closer to the water, as shown in Figure 22). Furthermore, the ability to see seaweed from the naked human eye depends on the clarity of the water and weather, which has been impeded by the excess nutrient loading from mainly agricultural activity (Hedrup, 2021) and in other cities, the unsettled sediments can come from sewage run-offs and motorboats activity like in Venice (see Figure 22). Salt marshes and reed forests that are half-submerged (i.e. emerged plants) are visible on land as they peep out from the water (Krause-Jensen, 2022). The "invisibility" of seaweed is an aspect that makes it difficult to be noticed and thus recognised as a beautiful[69] and noteworthy marine life (see Figure 19). Unfortunately, when seaweed is more visible to the human eye, it is often associated with rotting seaweed on the beach with a stench, and it is often experienced as a nuisance – the slimy thing you want to avoid when swimming in the sea (Hedrup, 2021; Krause-Jensen, 2022).

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69 I have spoken to several marine biologists from various institutions in Denmark specialising in seaweed, and many have declared their motivation and inspiration to study seaweed is due to their aesthetic beauty (Krause-Jensen, 2022).

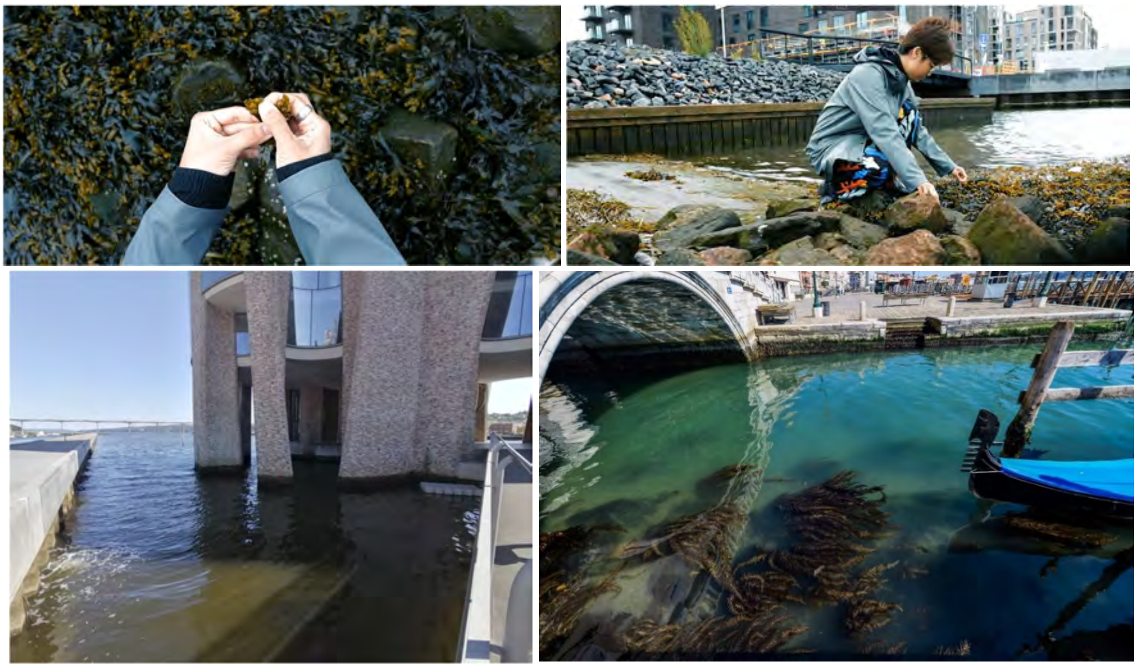
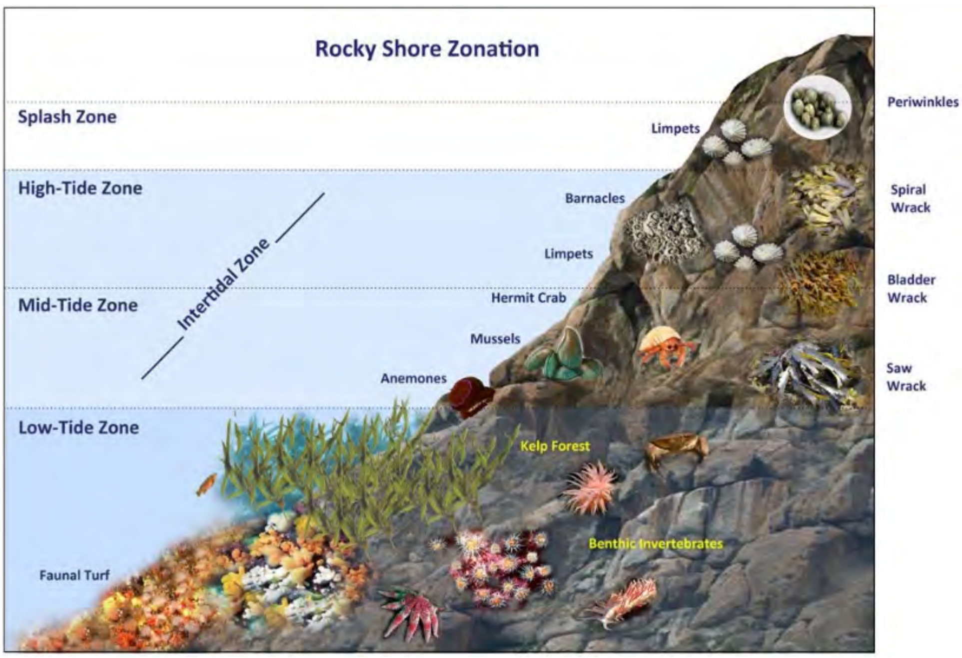
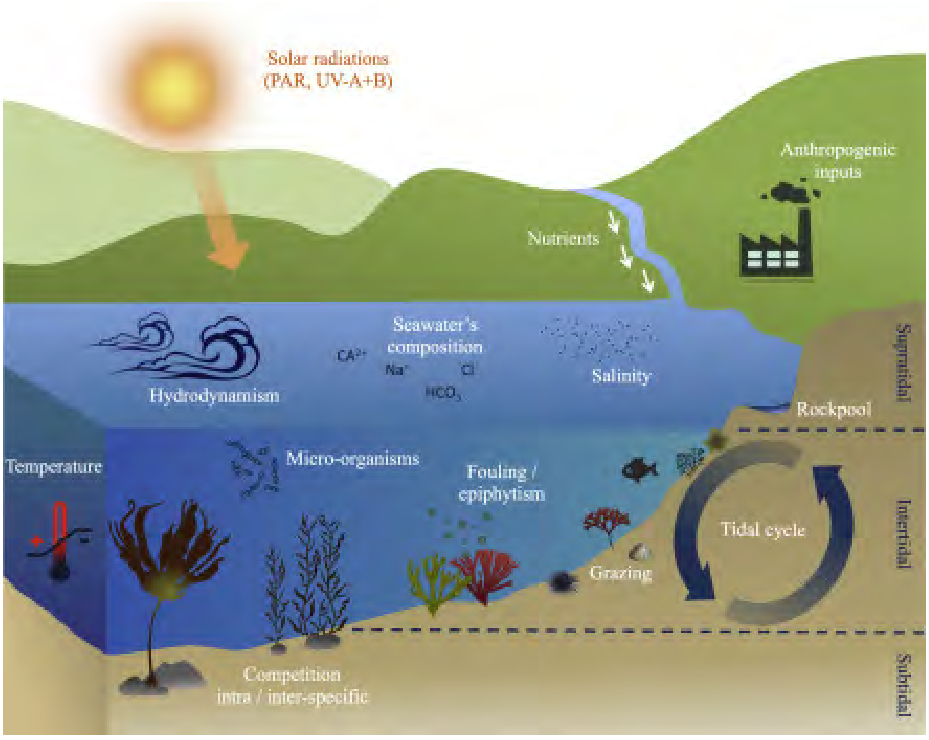


Figure 22. (Top row images) Photos from a site visit to Vejle Fjord. Blæretang (bladderwrack) is one of Denmark's most common forms of seaweed. They are easier to spot visibly due to the air pockets stored in their blades, allowing them to float on water. The photo was taken on 07/06/22 by Niels Rysz Olsen (Arkitektskolen Aarhus, 2022).
(Bottom left image) A photo of inner Fjord's murky waters around Fjordenhus, an urbanised area of Vejle's waterfront. Seeing anything below the water is difficult, especially after the rain. Image credit: Cintia Organo Quintana (Quintana, Kristensen and Petersen, 2021).
(Bottom right image) In Venice, during COVID-19 lockdowns, which halted all motorboat activity, the sediments were able to settle, allowing the Venetians to see clearly the living organisms in the water/lagoon (i.e. seaweed, fish, sea horses etc.) for the first time in a long time (McLaughlin, 2020). Image credit: Andrea Pattaro/AFP/Getty.





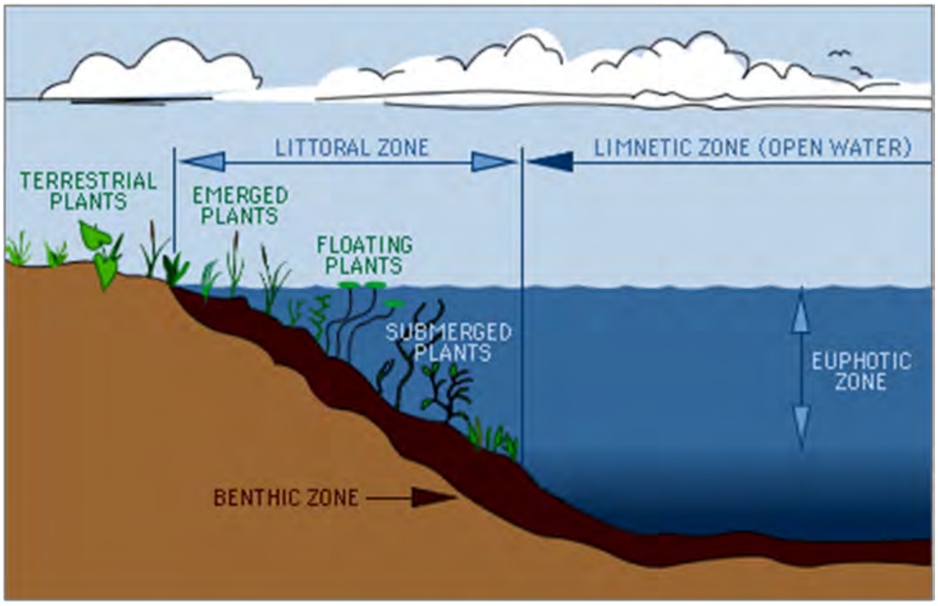


Figure 23. Various types of seaweed live in different intertidal and subtidal zones requiring different depths below the water due to salinity and temperature levels. The seaweed species that can survive closer to shores, such as Bladderwrack (Blæretang in Danish) and Sea lettuce (Søsalat in Danish), can be seen by the human eye. In contrast, kelp species are in deeper waters (subtidal) that are invisible to the human eye. Emerged plants (i.e. found in salt marshes and wetlands) are more likely to be visible to the human eye than seaweed species that are mainly floating and submerged.
Image credit: Top image (Lalegerie et al., 2020). Middle image (Carey, 2010). Bottom image (Water on the web, 2022).
(Extracted from Kumu Multiscalar map – Seaweed scale node).

Algae as a bad and ugly neighbour

For those who are not experts, it is easy to confuse the difference between micro and macroalgae, harmful and favourable algal blooms and thus, natural and cultural causes of eutrophication. Eutrophication is a naturally occurring phenomenon; however, the excessive nutrient load is caused mainly by anthropogenic activities, creating negative effects of eutrophication (otherwise known as algal blooms – see definitions). It disturbs the ecological balance by accelerating algae growth (both micro and macro), causing oxygen depletion and killing marine life (Ærtebjerg, Andersen and Hansen, 2003; European Environmental Agency, 2021), as shown in Figure 24. This phenomenon of degrading the water quality can contribute to a negative perception of algae rather than understanding the actual causes of the pollution. Moreover, beach wrack that includes algae is perceived negatively by the public (Hofmann, Banovec and Janin, 2021) despite playing an important function in the local ecosystem and even mitigating coastal erosion (Innocenti, Feagin and Huff, 2018; Hofmann, Banovec and Janin, 2021).

Figure 24. (Left image) An image of algal bloom (mass of phytoplankton rapidly grown in the water body as a result of eutrophication) killing fish. Image credit: (US EPA, 2013).
(Right images) Excessive nutrient load in the spring of 2022 have resulted in an explosion of fast-growing algae (brown, long-haired) growing on the meadows, eelgrass, rocks and on the fishing lines with clams and blue mussels in Vejle Fjord documented by the Sund Vejle Fjord project. They have been casually and colloquially referred to as "skidtalger" (translated to "scum algae") or "lortalger" (shit algae) by the volunteers working with the restoration project, indicating a negative reputation (Bredsdorff, 2018b; Sund Vejle Fjord, 2022). Image Credit: Sund Vejle Fjord Facebook Page posted on the 23/05/22 (Sund Vejle Fjord, 2022).
(Extracted from Kumu S-O-T-A map – Sund Vejle Fjord node in Vejle, Denmark).

There is also a negative perception of floating buoys on the water used to grow mussels and seaweed. It is considered visually "ugly" by some of the residents because it disturbs the untouched view of the water, as shown in Figure 25 (Organo Quintana, 2020; Fjeldsø Christensen, 2021) (refer to section 3.1.5 The paradox of the Seaview).

Figure 25. Vejle Fjordhave (Vejle Fjord garden association). With seaweed and blue mussels growing on vertical lines floating on buoys on the water). Despite all the benefits of these sea gardens, these buoys are considered an "eyesore" for the locals who advocate a more pristine and untouched view of the fjord, making it difficult for a larger-scale application (Boderskov, 2021).
Image credit: (Top left) Sund Vejle Fjord Facebook page (Sund Vejle Fjord, 2022). (Rest of the images) Vejle Fjordhave (Vejle Fjordhave, 2022).
(Extracted from Kumu S-O-T-A map – Vejle Havhøst node).

Unknown and unwanted weeds of the sea

Seaweed is not part of "normal botany" education in Denmark, further adding to the lack of awareness (Krause-Jensen, 2022). Thus, the common names of seaweed/macroalgae[70] are not well known to the public, unlike terrestrial plants. Common names of plants and animals often have cultural relevance and play a critical role in society, making it easier for people to remember and refer to them (Fraser, 2012). However, many species of seaweed have no common names; hence, scientific names are used (the Latin classification), or foreign common names are used when there is a lack of local common terms. For instance, in Venice[71], a particular brown macroalga found in

70 In Denmark, there are common names for a few seaweed species, such as Søsalat' (literally translates to: sea salad), 'blæretang' (bloated seaweed), sukkertang (sugar seaweed), palmetang (palm seaweed) etc. There is some general public awareness of blæretang (bladderwrack) which is one of the most common seaweed in Denmark, associated with childhood memories of popping the air bubbles out of the blades, as shown in Figure 22 (Krause-Jensen, 2022).

71 The following findings are based on the workshop in Venice called "The algae, the lagoon and the city" (Algae Platform and Atelier Luma, 2021) in collaboration with a local marine biologist. See Appendix 10 for more details.

the lagoon is referred to as *Undaria Pinnafida* (Latin classification), or the Japanese common name, "wakame", is used as it lacks any local common name in Italian. This is because wakame is not a native species to Venice thus, borrowing the term from its origin in Asia as an invasive species. Thus, wakame in Venice[72] has a negative reputation and is considered a nuisance by winding up motorboat propellers (Hooper, 2006).

Eelgrass as the most recognised marine vegetation in Denmark

In countries like Denmark, most coastal sea bed conditions are largely sandy and not rocky, which is the ideal environment for eelgrass but not necessarily for seaweed that requires hard substrate (some seaweed are floating ones that do not need stones to hold fast). A hundred years ago, a belt of eelgrass in coastal areas reached approximately 1km, making it the most common form of coastal vegetation that Danes were used to seeing. Therefore, eelgrass is more identified and recognised as coastal vegetation than seaweed (Krause-Jensen, 2022). However, due to diseases and environmental pressures from eutrophication, eelgrass has been in great decline; thus, much of the restoration effort has gone into reviving and protecting eelgrass, putting more emphasis on eelgrass than seaweed in Denmark (ibid.).

Lack of legislation and market demand to support seaweed

Current state legislations are barriers to cultivating seaweed. According to the founder of Havhøst/Sea gardens, Hjerl (2019) argues that these state legislations are outdated with an old understanding of what we could do with the sea in terms of cultivation (Bagge, 2022). There is limited availability of suitable areas with specific conditions for different types of seaweed, which can compete with other human activities (Duarte et al., 2017). Moreover, gaining permission to use the sea for cultivation (or other purposes) requires permits that are currently difficult to attain (Boderskov, 2021; Hedrup, 2021). There are also technological challenges with larger-scale cultivation to withstand storms. In the future, these structures will need to be stronger and more flexible to adapt to changing climatic conditions (Duarte et al., 2017; Boderskov, 2021). Furthermore, seaweed has yet to infiltrate the Danish market as food, feed and fuel as the demand for seaweed is still niche (Hornbek Nielsen, 2020; Boderskov, 2021).

Thus, understanding the plight of seaweed from various angles is a way to understand the continuation of overlooking issues below sea level and the numerous opportunities and potentials that seaweed offers.

72 Furthermore, the classification of seaweed in Venice is considered a "waste", preventing it from being utilised as products for upcycled eco-friendly paper made of seaweed (Favini, 2022).

1.6 An initial hypothesis of Urban Seascaping with seaweed

Landscape architecture is above and below water... It will take time for nature to re-establish itself. The most important thing we can do now is to start by recreating better living conditions for life on the shoreline.

Elin T. Sørensen, *Kanten: Åben idékonkurrence programmet* (translated from Danish) (Vejle Municipality, 2020a, p.27).

This research project proposes a neologism called "Urban Seascaping" (USS) as a response to the main research question (RQ), "How can coastal cities of Denmark integrate the sea and its lifeforms to contribute towards re-envisioning urban development in light of a rise in sea level and frequent storm surges?" At its initial phase, USS is a conceptual hypothesis to the RQ to grasp and guide the desired changes we want to see in the unforeseeable future for coastal cities. Thus, the departing point for USS presents an unexplored opportunity for the everyday encounter and acceptance of the marine realm as an amalgamated part of living in a coastal city. Unlike urban landscapes, the conception of the seascape is not well understood by the LUDP disciplines (other than the definition from natural sciences – see definition). Therefore, seascapes could be considered a subset of the landscape perspective that reflects the relationship between people and place, particularly the marine and coastal environments.

Furthermore, the importance of new concepts like USS is its ability to start discussions about the different values we want to address and, through their frequent use of the terms and what it represents, make these new conceptions more familiar and normative (Fink, 2012). While the intention is not to create any grand or universal theory, the aim of USS is to present and show how this spatial design approach to intervening coastal developments could connect to broader conversations about "thinking with" and including marine lifeforms such as seaweed. Therefore, the main intention of the USS is to develop a conceptual guide for various stakeholders to integrate the sea and marine life as a normative practice in waterfront/ harbourfront developments and coastal adaptation strategies (see Figure 26 as a potential example of a USS project).

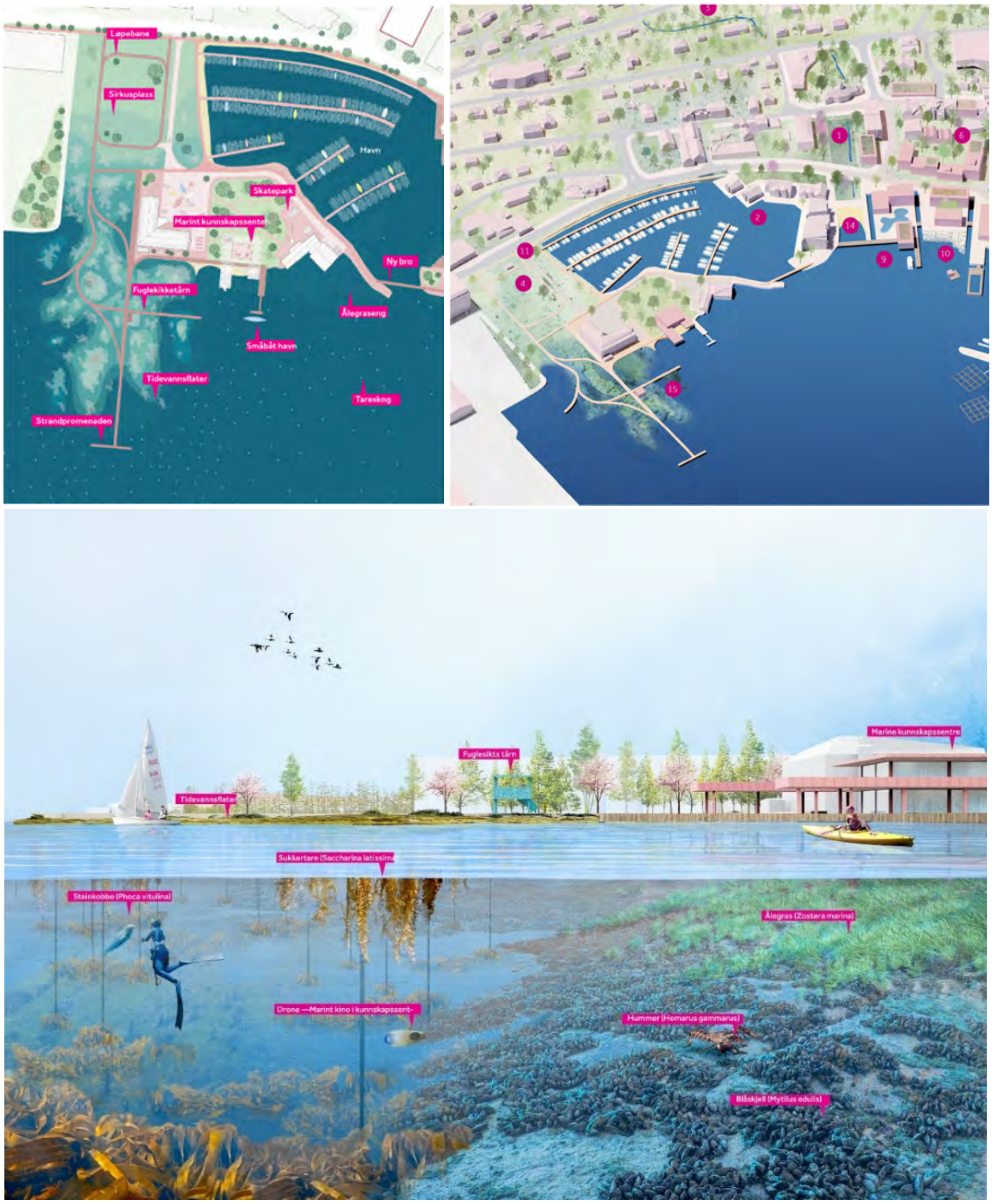


Figure 26. A potential example of Urban Seascaping. A project called: "Ulsteinvik – Multigenerational City" to transform the city of Ulsteinvik's waterfront and park area by Edit landscape architects from Oslo, Norway. The project proposes to design coastal landscapes that are integrated into the city for better human and ecosystem health. Area of intervention 2.7km². It was in collaboration with various consultants, including Elin T Sørensen, a marine landscape architect. Norwegian coastal bodies have more favourable conditions for kelp, as shown in the visualisations (with more tidal flow, salinity, temperature and cleaner waters).
Image credit: Edit Landscape Architects (Edit, 2022).
(Extracted from Kumu S-O-T-A map – Multigenerational City node in Ulsteinvik, Norway).

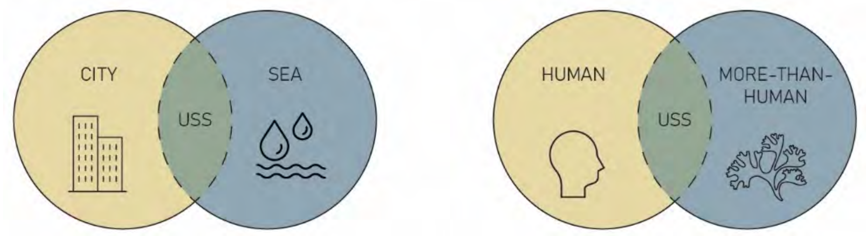
In sum, the proposed hypothesis of "Urban Seascaping with seaweed" builds upon existing epistemologies, theories, viewpoints, schools of thought and state-of-the-art practices in the field of LUDP (addressed in Part III). It aims to utilise the power of design and qualitative methods of inquiry to help re-envision coastal cities for a new reality with the sea in the context of climate change. Therefore, USS is offered not as definitive but as a suggestive contribution to growing conversations bridging methods, theory, and questions of various urban inequalities and risks in the Anthropocene. Moreover, it responds to a more unified spatial reality of nature and culture[73] by reimaging the traditional dualistic notions of a city as culture and the sea as nature to a more hybrid and dynamic zone (see Figure 27). This is represented in the term "scaping" as a unifying element between urban culture and the sea.

Therefore, USS also serves as a way to critique the current B-A-U practices in coastal cities that are resisting the changing boundary and relationship between city and sea (see section 3.1.1 The wicked problem of living on the edge, for more information) and serves as a way to explore alternatives that enhances marine-based eco-aesthetics.

It also aims to contribute to a sub-field within urban landscapes (see Figure 27) that draws on transdisciplinary knowledge to add various perspectives to strengthen affiliations between marine life, blue-green infrastructure and spatial design practice. The USS proposition intends to help guide design decisions and form new narratives on coastal adaptation at urban shorelines and a way to include nonhuman forces in landscape/seascape architectural practices. Furthermore, Urban Seascaping is a working hypothesis in development that is intended to critically analyse and reinterpret the case study findings from Kanten/The Edge competition entries and a way to select specific state-of-the-art projects for analysis. The final Urban Seascaping propositions can be read in section 3.3 and their use as propositional frameworks to analyse and reinterpret Kanten/The Edge competition entries in Part IV.

73 The discussion on the conceptions and relationship of nature and culture is an age-old, ongoing debate. Nature in traditional western notions is considered separate and independent from humans. In response to this pre-existing view, ecologists, environmental philosophers, and, more recently, new materialist scholars have argued that nature and culture need to be perceived and conceptualised as fundamentally interrelated. A common critique within this strand of scholarship is the dualistic conceptions of nature and culture, which scholars have claimed are responsible for the current ecological crisis (Bennett, 2010; Guattari, 2000; Haraway, 2016; Morton, 2012; Rosa, 2019). According to the scholars Scherer and Klingan (2013), "Nature, as we know it, is a concept that belongs to the past. No longer a force separates from and ambivalent to human activity, nature is not an obstacle nor a harmonious other. Humanity forms nature. Humanity and nature are one, embedded from within the recent geological record" (Prominski, 2014, p.7). Nevertheless, interconnected conceptions of nature and culture is nothing new, as it has been for many indigenous worldviews around the world. Refer to section 3.1.7 Nature vs Culture binary at the coast.

URBAN (CULTURE) + SEA (NATURE) + SCAPING (INTEGRATION OF NATURE-CULTURE)



Seascape ~~Landscape~~ architect (marine landscape architect) noun

Definition: *A person who develops ~~land for human use and enjoyment~~ land-to-sea continuum for human and nonhuman benefit, ~~placement of structures, vehicular and pedestrian ways and plantings.~~ through a design and landscape approach that integrates the marine realm while strengthening coastal adaptation and mitigation in light of climate change.*

Figure 27. Urban Seascaping as a neologism is a proposition and a concept to investigate the inter-relationship between humans and nonhumans, land and water in coastal cities. The use of "scaping" signifies the need to unify the current dualist reality by emphasising inter-relationality and interdependency. USS contributes to an emerging sub-field within landscape architecture and urban design/planning with references to blue and coastal urbanism. The potential role of a "seascape architect" (or a marine landscape architect) is redefined (in red) from the definition of a landscape architect in Merriam-Webster Dictionary (Merriam-Webster, n.d.).

Finally, seaweed's various functions and roles are acknowledged in the USS hypothesis as a potential catalyst that fosters equity for both human and marine life in the urban shorelines. For instance, as the sea seeps further into our coastal cities, USS investigates the unexplored potentials of seaweed as a connector between the urban (risk areas in the waterfront/harbourfront areas) and the marine realm in the form of new urban commons[74]. As mentioned in the previous sections, seaweed has the affordance to act as a connector to support and impact the livelihood between humans and nonhumans. However, aside from its productive capacity for supporting life, there is a need to acknowledge its right to thrive in a shared world as a welcomed resident of the coastal commons.

74 The term urban commons represents shared material and immaterial resources (i.e. land) that belong to or impact the whole community in an urban environment (Hardt and Negri, 2009). It is founded on the guiding principle of equity that fundamentally reconceptualises how we view spaces and entities as something that affects all.

1.7 Research scope and limitations

While the current research project is situated in a transdisciplinary context, the scope of the research is still within the disciplines of the creative fields such as landscape architecture and urban design (LUDP). Furthermore, it is important to outline the limits to transdisciplinary work, especially in disciplines where I have limited expertise, such as marine biology, coastal engineering and policymaking and to bring this knowledge back to the realms of LUDP in a palpable manner (see section 2.1.3 for more details).

It is worth mentioning that while seaweed was chosen as the marine life form on the basis that it is the least explored in coastal adaptation strategies, the research questions are not answered exclusively through seaweed, as the reality of the marine world is inextricably interconnected, making it difficult to isolate and focus solely on seaweed[75].

Moreover, this research is limited in its opportunity to test the design explorations at a 1:1 scale in-situ study or via computer-simulated experiments to generate more positivistic data outcomes. Furthermore, conducting research during COVID-19 influenced the overall direction of the research, as participatory aspects of the design process were difficult to explore (see section 5.4 Future research avenues for more details - where I discuss further research avenues that were not part of the scope of this PhD).

1.8 Ethics, biases and validity

Addressing the ethical dimensions of the current research project, one of the primary obligations of researchers in the LUDP discipline is to contribute to potential solutions to the increasing impacts of climate change. As my project seeks to explore the potential integration of marine life, such as seaweed, in alleviating wicked problems, one of the ethical positions is to ensure the intrinsic values[76] of coastal ecosystems are recognised (along with their instrumental benefits to humans), i.e. the right to exist and thrive in the intertidal zones as a critical part of the waterfront (i.e., multispecies coexistence). This effort to consider nonhuman species as intrinsically valuable draws on alternative ways of conceiving nonhuman ecosystems, which have especially been the case with studies of indigenous world views that think differently about the environmental crisis (Mentink, 2018; Rodgers, 2017) (see section 3.2.5 A relational approach to water for more information). In sum, alternative world views can help create and support spatial and environmental conditions that aid marine habitats to form in changing climatic conditions, not only as an instrument for human concerns but as an entity with a right to exist in and of itself.

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75 For example, while seaweed is edible to humans and thus has a better potential to infiltrate the local sustainable food culture, eelgrass has more visibility and recognition in Denmark. Moreover, making conditions only favourable for seaweed (i.e. hard surfaces) is not appropriate for eelgrass, but hard surfaces invite other organisms, such as blue mussels to thrive.

76 Intrinsic values of ecosystems have increasing importance in today's exploitative economic models, as natural seaweed forests are vulnerable to exploitation in the future, such as their potential for feed and biofuel. For instance, before WW2, there was a fairly large natural population of red macroalgae (Furcellaria – Danish agar) on the coast of Djursland in shallow waters, which was almost made extinct due to over-harvesting by industry (Mouritsen, 2019).

Furthermore, while subjective preconceived biases, preconceptions and interpretations of the researcher are inevitable, I have strived to make the research processes as transparent as possible, thereby bringing any situated biases and preconceptions to the foreground. Additionally, I have tried to ensure that both contrasting sides of the arguments around developing our coastal cities are presented (for instance, presenting the case for both hard and soft approaches to coastal protection and adaptation in Part III). To do so, multiple sources of evidence are presented, and the most recent literature is referenced whenever possible. In my effort to further validate the reliability of the research and to tackle the transdisciplinary nature of this research carefully (particularly the integration of marine biology), I have also engaged in close collaboration and consultation with many marine biologists and other experts through semi-structured interviews to test and review my ideas and proposals (refer to preface section: The expert peer review process and access to data and Appendix 2: The profile of all interviewees). There were also other opportunities to get more detailed peer reviews/expert feedback for the journal articles I wrote throughout my PhD.

To conclude

The initial PhD call questioned if there were alternative ways to utilise the phenomenon of sea-level rise in urban development. However, one cannot isolate and single out a phenomenon like sea-level rise as it is entangled with other interconnected issues. Therefore, preventative measures such as reducing emissions through nature-based solutions have a role that needs to be explored in parallel to other conventional strategies. Thus, as a hypothesis, USS seeks to explore the potential and currently understudied role of coastal landscapes/seascapes, such as seaweed, as a spatial design driver in re-envisioning the boundary between land and sea in the Anthropocene. But more importantly, Urban Seascaping is an ode to the often-forgotten world underneath, using seaweed as a catalyst to challenge new ways of living with the sea in an increasingly wet world. The layered and entangled complexity this research seeks to explore highlights the increasing complexity that needs to be addressed, which calls for new representational and analytical tools for thinking and doing.

PART II: METHODOLOGY

Introduction to Part II

Part II provides an overview of the overarching methodologies used to answer the research questions in a transdisciplinary context. This chapter is intended to make the research process transparent, outlining the objectives, approach and decisions I made as a researcher working within the embedded local context of Vejle.

The first part of the chapter outlines the main methods, such as expert interviews, state-of-the-art (S-O-T-A) analysis, literature review and site observations. The second part of the chapter outlines a real-world problem-based case study research using the "research-through-design" (RtD) methodology through the medium of mapping. Specifically, I utilised an online interactive network mapping program called "Kumu", which was used to develop three different types of hybrid maps to help explore the research questions. The first Kumu map (Map 1) is mainly intended as a multi-scalar in-depth context analysis for Vejle's Kanten/The Edge competition entries. The second Kumu map (Map 2) is intended for state-of-the-art (S-O-T-A) analysis of various projects and ontologies that may inform future design strategies for Vejle's Fjordbyen. The third Kumu map (Map 3) is a timeline-based map that is used to illustrate how the mapping tool can help speculate a design response to future scenarios of SLR/SS in Vejle based on learnings from Kumu Maps 1 and 2. The three Kumu maps are guided by the four main Urban Seascaping propositions (see section 3.3), which have been developed throughout the study and are then used to guide the direction and content of the mappings. Urban Seascaping as an initial hypothesis (i.e. Part I) evolves throughout different phases (or "moments") of research as a guardrail to help answer the research questions.

Figure 28 and Figure 29 outline the main methods and methodologies as context-driven case study research where various methods and theories have led to the research outcomes.

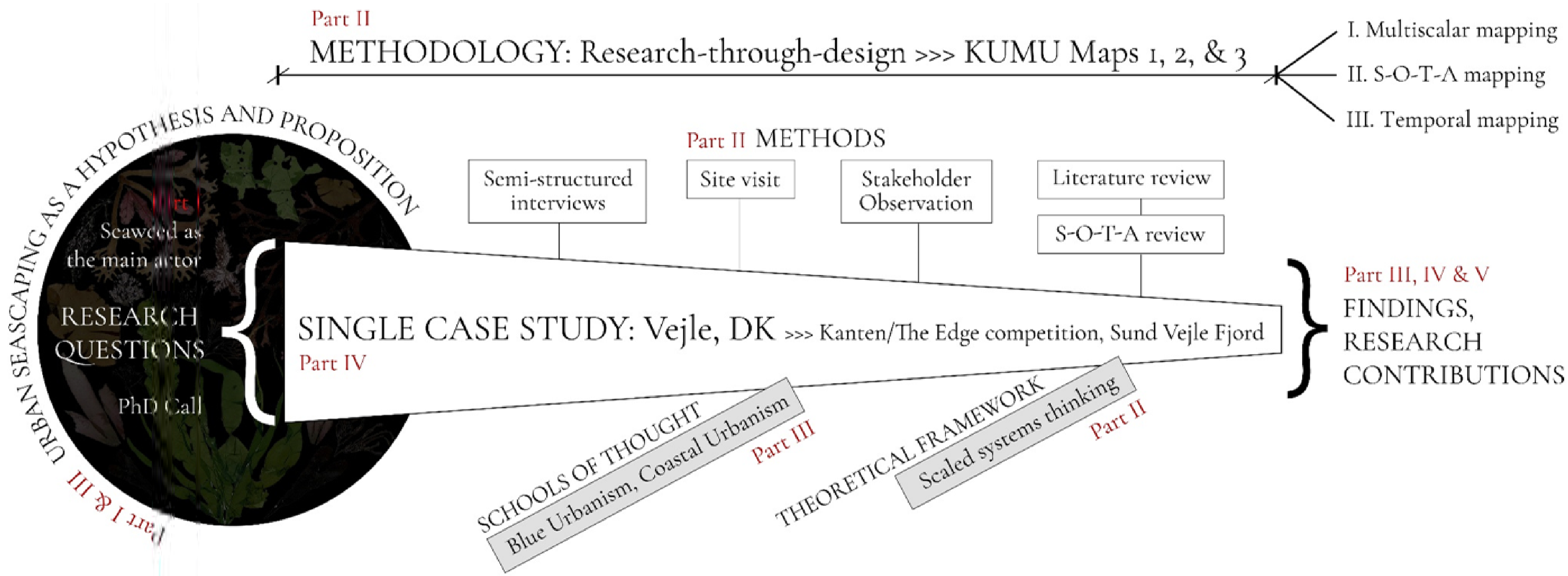

Figure 28. A diagram to illustrate a context-driven case study research. The context is in Vejle Denmark (East Jutland), looking specifically into Kanten/The Edge design competition and the Sund Vejle Fjord project that runs in parallel. The main methodological approach is Research-through-design via Kumu mappings (Maps 1, 2, and 3) informed by various methods such as interviews, site visits (fieldwork), literature reviews (also of state-of-the-art precedents), and stakeholder observations/engagements. The main theory driving the mapping for this research is "scaled system thinking" (systems-based approach), which is elaborated on in section 2.2.5.

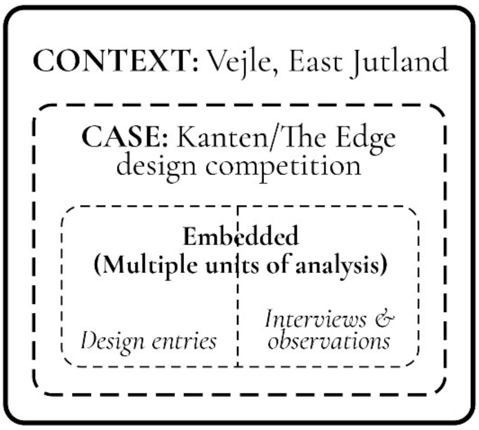

Figure 29. (Left image) The single case study context of Vejle has multiple embedded units of analysis (Yin, 2017). Mainly the design entries and interviews of winning participants form one set of data for analysis and involvement in the brief feedback and the judging process during Kanten/The Edge competition process. Image credit: Adapted from Yin (2017).

2.1 Main methods in qualitative research

A qualitative case study is a research methodology that helps in exploration of a phenomenon within some particular context through various data sources, and it undertakes the exploration through variety of lenses in order to reveal multiple facets of the phenomenon (Baxter and Jack, 2008).

Rashid et al., *Case Study Method: A Step-by-Step Guide for Business Researchers* (Rashid et al., 2019, p.2).

The Case Study Method in Qualitative research

This research deploys the case study method in qualitative research to understand a complex real-world phenomenon of addressing sea level rise (and storm surge) on urban development. The findings are derived from qualitative empirical data, such as interviews, workshops, site visits, Kanten/The Edge competition winning entries, and stakeholder meetings[77] (see section 4.1.1). The research is predominantly about problem identification, data collection and generating insights about seaweed's "new" and "unknown" potentials in the East Jutland context. This type of qualitative knowledge production proposes new paradigms –concepts, meanings or cultural critique, as well as material constructs, such as spatial forms of landscapes-seascapes and urban environments (Lenzholzer, Duchhart and Koh, 2013). While the knowledge generated from this research is embedded in a constantly changing physical and social context, such insights may be difficult to generalise. However, certain parts of the knowledge can be transferable as a conceptual approach (i.e. such as the Urban Seascaping propositions), and the processes of research design can also be applied in different contexts (research contributions are explored in Part V).

For case study research, my role as a researcher (and participant in some cases) is used as a "tool" for data collection and analysis through my tacit knowledge, observational skills, gaining the trust of the participants/interviewees, the ability to extract and assess the appropriate information. Furthermore, my integrative, reflective and analytical abilities and experiences in the context of Vejle are important to draw meaningful and critical extrapolations of the phenomenon of interest and data (Yin, 2017). This was especially the case when participating in the deliberation meetings with the judges for Kanten/The Edge competition, where observations on the comments made by the different actors were interpreted through one's individual and collective value propositions. For instance, some politicians expressed more concerns about the city's economic growth, whereas the biologist was more concerned with the ecological health of natural systems.

The same relativism applies to semi-structured interviews with experts, such as marine biologists[78], presenting different value propositions.

77 Although the observations conducted in this research are not as methodologically extensive as the ethnographic research methods, it is not the main purpose of the research to use ethnography as a method.

78 For instance, even among biologist they differ in the value proposition of whether to work with/integrate non-native or hybrid species for the future due to climate change. They also differ on their approach to nature conservation, be it to revive the former "nature" of the past, or whether to work with new species that may also be

In sum, the research uses three main methods (qualitative research) of investigation to answer the research questions (RQ):

1. **A single case study site of Vejle**[79] - as one of the representatives of coastal conditions in East Jutland, with an investigation into the Kanten/The Edge design competition brief and entries as empirical design data (refer to Figure 29) to answer the main RQ and SRQ1.
2. **Fieldwork - Site visits, participation in workshops and meetings** contributed to data collection. For instance, several site visits to Vejle resulted in accompanying photographs, videos, sketches and field notes (refer to section 2.1.2). Notes taken from various workshops and meetings with Vejle Municipality contribute to research findings (refer to Appendix 11, 12 and 13).
3. **A literature review** of academic papers (both white and grey) and other found data (i.e. municipal strategic documents and GIS data) informed the main theoretical proposition of Urban Seascaping (see section 3.3). Moreover, the initial focus on seaweed played an important role in helping keep the enormously complex task of reviewing transdisciplinary knowledge in a targeted manner.
    i) **Review of the state-of-the-art (S-O-T-A)** (i.e. mini-case studies) projects, worldviews and coastal adaptation strategies (both realised and speculative). The analysis of S-O-T-A showcases alternatives to the current B-A-U of coastal urban developments.
4. **Semi-structured interviews of different stakeholders and experts** as a method of attaining and testing insights, knowledge and data unable to be acquired via literature review (refer to section 2.1.1).

2.1.1 Semi-structured interviews and workshops with experts

Semi-structured interviews and workshops with experts were one of the major qualitative approaches and methods of inquiry. These interviews were important because they allowed for gathering data unavailable in the literature due to the specificity of site-related conditions. This was particularly the case with the involvement of marine biology/ecology experts. Generally, the interview questions were formulated concerning the progression of the research and the professional and academic background of the interviewee to aid in answering the research questions. Additionally, the questions were open-ended rather than closed to ensure that the interviews remained focused but not guided. The interviews and workshops took place between

suitable for the area of interest. This is a complex discussion and debate among biologists/ecologists influenced by different views on nature based on various schools of thought.

79 A case study method emphasises the importance of contextual factors that should be considered in seeking explanations of a phenomenon of interest, even though being context-dependent may limit the generalisability of research implications. Furthermore, as a context driven research majority of the literature reviews of the state-of-the-art projects, relevant theories and GIS data were filtered by their relevance to the context of Vejle.

15.10.2019 to 02.02.2022, both physically and online. Where possible, the interviews were recorded[80] and transcribed (refer to Appendix 2-9), and notes were taken for the interviews that were not recorded (not all interview notes are included in the Appendix as it contains sensitive material). The interviews were conducted in English, and those that could not be conducted in English were translated from Danish. Detailed information on the interviewees and their professions is shown in Table 6 to Table 9 in Appendix 2.

Qualitative interviews with experts and stakeholders[81] were initially sought as part of a strategy to aid background understanding of the potential of seaweed as a valid actor in coastal adaptation projects. Expert interviews were used to test the validity of Kanten/The Edge competition's design ideas and my design research in Part IV. The initial research strategy was to conduct the first round of semi-structured interviews with various seaweed experts in Denmark to scope out the state-of-the-art research and practice around seaweed, as shown in Table 6 and Table 9 in Appendix 2[82]. Some of the interviews also involved an on-site tour of various facilities (e.g. the Marine Education Centre in Malmö, Sweden and Leigh, New Zealand, a workshop with Havhøst in Kattegatcentret, a public aquarium and Pure Algae's seaweed lab in Grenå etc. – see Appendix 2 and 10 for more details).

Then, the interviewees were chosen concerning their connection with Kanten/The Edge design competition (i.e. the winners – see Table 7 in Appendix 2) to understand from the practitioner's point of view the way the design field can contribute to emerging marine landscape architecture as a key part of coastal adaptation strategies. The interviews were conducted to understand how the different perspectives of the experts and participants in the design competition might illuminate the Urban Seascaping propositions. Consequently, the semi-structured interviews are based on a constructivist approach to capture the underlying ontological understandings of the different respondents and to focus on how their varying values, interpretations and meanings illuminate my study at hand (Yin, 2017). Furthermore, the interviews seek to understand any potential setbacks the participants faced while doing the competition design. Furthermore, interviews were conducted with the marine biologist present at the Kanten/The Edge design competition (as an advisor to the judges). The interviewees were told their responses would be anonymised (where appropriate) to garner more earnest discussion.

I have worked closely with the marine biologist (Associate Professor Cintia Organo Quitano from the Southern University of Denmark) during the Kanten/The Edge design competition, which allowed the relationship to develop organically into an informal advisory role for my research (see Table 7 in Appendix 2). Cintia and I met fairly regularly (both in-person and online) as an informal

80 My supervisor Katrina Wiberg have found in her PhD research that recording the interviews and meetings with stakeholders (not necessarily researchers) have impacted the candidness of the interviewee thus, resulting in less rich conversation. Therefore, I have also been reluctant to record interviews to ensure the most earnest answers/discussions.

81 Some of other relevant potential interviewees (stakeholders) declined or were too busy to conduct an interview such as the city architect from Vejle Municipality. However, the inspiration video by the city architect is translated in Appendix 11A.

82 See Appendix 3, 4, 7, 8 and 9 to see interview notes on seaweed as food, seaweed as an educational tool, seaweed cultivation and marine restoration with the experts.

meeting to get feedback on aspects of my research to ensure it worked from a marine biological perspective.

Moreover, during my research stay at Lincoln University, New Zealand, I interviewed researchers in urban planning and law working with integrating the intrinsic value of ecosystems into the legal frameworks. The main reason for going to New Zealand was to investigate a world-renowned case of granting a river legal personhood in 2017 according to the Maori (indigenous people of New Zealand) worldview (see section 3.2.5 for more information). It was an example of a real-world state-of-the-art application of an intrinsic value proposition to a water body. Furthermore, interviews were conducted with the host associate professor, an environmental planner focusing on water-based commons and integrating intrinsic values into the local planning regulations. This interview was then supplemented with a lawyer with extensive knowledge of working with indigenous communities to grant legal protection to natural entities. These interviews sought (see Table 8 in Appendix 2) to understand whether these intrinsic value propositions might be integrated into a LUDP and planning context. Therefore, the interview questions were formulated to see if there was potential for this intrinsic value proposition to influence the ethical stance of Urban Seascaping – i.e. an alternative to the current dominant utilitarian approach to the integration and protection of ecosystems.

Towards the latter part of the research, other marine biologists (see Table 9 in Appendix 2) specialising in cultivating seaweed in or near Vejle Fjord were interviewed to get further context-specific feedback on the possibilities of growing kelp to integrate it as part of coastal adaptation strategy. As former nature guides, the interviewees also had insights into public perceptions and knowledge of the marine life in Vejle Fjord. They understood the perceptual, economic and regulatory barriers to implementing seaweed on a larger scale. Moreover, I was able to interview the project manager and a marine biologist, Mads Fjeldsø Christensen (see Table 9 in Appendix 2), for the project "Sund Vejle Fjord" (refer to section 1.4.1), who is currently working to restore the marine ecosystem. Discussions with these marine biologists gave valuable insights into the complexity behind watersheds (catchment areas) carrying pollutants (i.e. fertiliser runoffs) impacting the water quality (Fjeldsø Christensen, 2021). The ecological health of the fjord is an important factor to consider as they greatly influence the success of any design interventions involving marine nature-based solutions.

Furthermore, I was involved in several relevant workshops, local events, field trips, conferences and festivals in Denmark and abroad (see Appendix 10 and 12 for notes on the learnings from the workshop and events). Although the knowledge gained from these casual interactions was not as targeted in attaining a specific answer as the interviews, the learnings were nevertheless valuable to the research. During these workshops, trips and events, I could engage in conversations with various actors, which provided an informal way to test my ideas and access information I did not have access to about the marine realm. Overall, the learnings from the interviews, workshops and events highlight the importance of more direct engagement with experts and exploring the research from various perspectives, but also the importance of engaging with those who have experiences with fieldwork/on-site investigations of marine life in Denmark. Much of these learnings take the form of "soft" data, often inaccessible in academic literature. Therefore, I believe the semi-structured interviews and workshops covered a sufficient range of experts working with coastal adaptation from a design perspective, to seaweed experts working with food, education, habitat, blue carbon and wave attenuators, to experts working with marine nature restoration facing challenges associated with water pollution from anthropogenic activities.

2.1.2 Site visits – Field observations

Several site visits[83] to Vejle as the main case study site and other relevant places (the waterfront and harbourfront area in Fjordbyen) were undertaken throughout the research. Site photos, videos, drone shots and notes were taken as part of field observations (via walking) on 27/01/20, 29/07/20, 05/10/20, 11/09/21 and 06/06/22. Site visits also entailed a guided tour with coastal protection experts from Vejle Municipality on 14-15th December 2021 (for detailed notes, see Table 16 in Appendix 12). These materials and notes from the site visit supported the detailed site analysis conducted in Part IV.

Furthermore, the project drew insights from the work of master students from AAU, who produced further investigations [84] of Vejle Fjordbyen and the Lystbadehavn area (the waterfront area of Vejle), where were used as a supplement to the site analysis (some examples of the work are shown in Figure 30 below and Figure 144 in section 4.1.2). The site analysis by these students (Falk Pedersen et al., 2017; Sørensen et al., 2017) includes mapping work that refers to data from GIS (see Appendix 1, Table 5 on GIS sources) and the mapping of the main impressions, functions and atmospheres of Fjordbyen area. Some of these findings were incorporated into the site analysis of Vejle in Part IV.

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83 The site visits were not limited to Vejle but also other relevant coastal cities in Denmark (i.e. Middelfart, Juelsminde and Randers) due to the activities associated with the Realdania research network group.

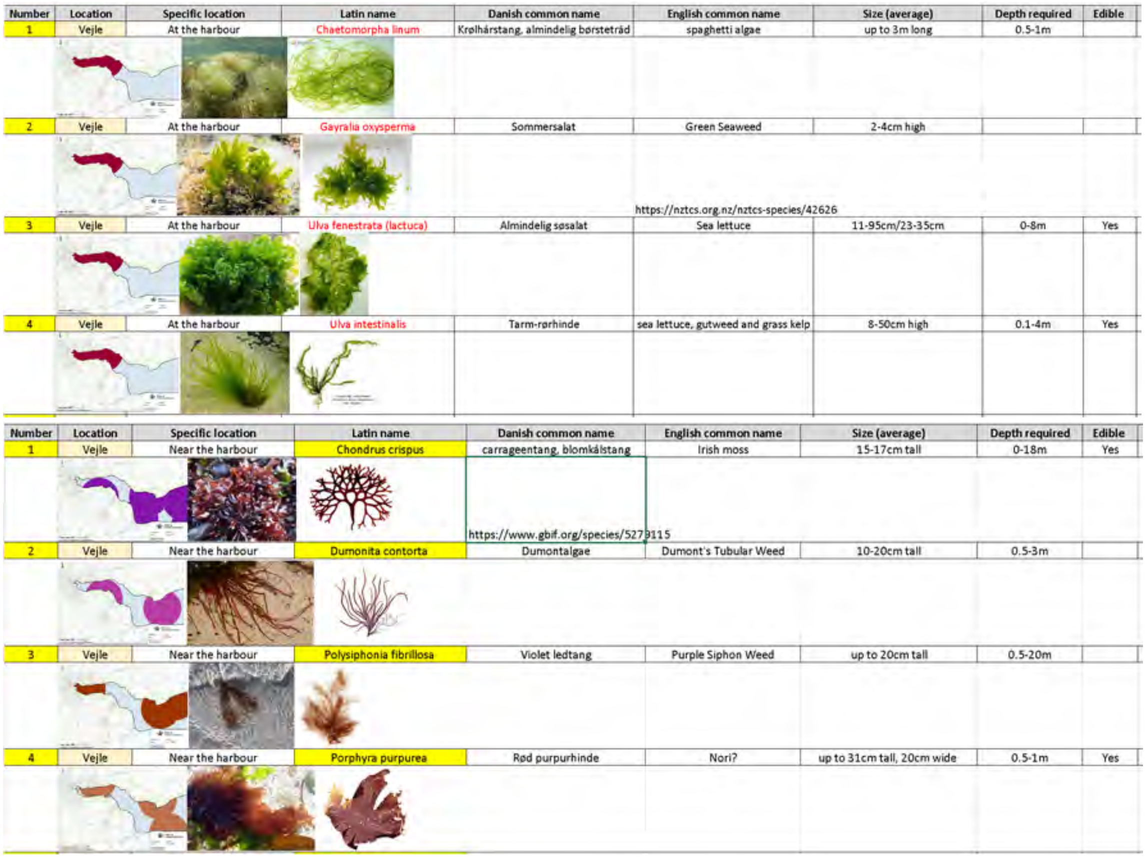
84 Permission has been attained from the former students of the report to use their works for this research.

Figure 30. Excerpts from the field studies of Master students from Aalborg University of Vejle's waterfront (called Lystbadehavn) and Fjordbyen area. These learnings have contributed to the site analysis for Vejle. (Left image) Master student's mapping of all the key areas, businesses and buildings in Fjordbyen. Image credit: Sørensen et al. (2017). (Right image) Master student's mapping of all the key functions and atmosphere of Fjordbyen area. Image credit: Sørensen et al. (2017).
(Extracted from Kumu Multiscalar map – Fjordbyen scale node).

Furthermore, particular attention was paid to look out for the visible presence of seaweeds throughout the hard edge conditions of the publicly accessible waterfront area in Vejle (see Figure 31 below). The field observation of seaweed found in the nearby waters of Fjordbyen area corresponded with the research by Lundsteen and Nielsen (2019a, 2019b) and Naturbasen.dk on the different types of seaweed found in Vejle Fjord. The information gathered on the possible seaweeds available in Vejle (both inner and outer) was important in figuring out the design parameters of spatial interventions to include marine life for the design brief of Kanten/The Edge competition - i.e. the water depth required to attract a certain type of seaweed that can grow in a particular area and whether it would be visible to the human eye.

Figure 31. (First row of image) Location of areas in the accessible part of Vejle's waterfront where I took photos of the most visible form of seaweed – blæretang/bladderwrack growing on the hard surfaces throughout various times of the year during site visits (regardless, it is difficult to capture the seaweed underwater via photographs). Background image credit: Vejle Municipality (n.d.) and Pine Cone Project (n.d.).
(Middle row of images) Excerpts from the two books called "Danmarks Havalger" by researchers Lundsteen and Nielsen (2019a, 2019b), where there are maps of all the different macroalgae types that grow in Vejle Fjord along with details for their main characteristics and conditions for growth. The information from this book is translated into the excel table in Appendix 13.
(Bottom row image) Similar databases (not as extensive as Lundsteen and Nielsen) on different seaweed locations and basic facts in Denmark. Image credit: Screenshot of the Naturbasen website (Naturbasen, 2022).

The comprehensive book on macroalgae in Denmark by Lundsteen and Nielsen (2019a, 2019b) outlines the different types of seaweed found in the Vejle Fjord (Figure 31). The findings of different characteristics of seaweed found in Vejle Fjord are compiled into an excel table with reworkings of the location map with photos (see Figure 32 and Appendix 13). This excel table is further converted into a map to be embedded into the research-through-design mapping in Figure 148 in section 4.1.3. The intention was to understand which type of seaweed could qualify as marine nature-based solutions that could be integrated into Vejle's waterfront/harbourfront (and beyond).



Number	Location	Specific location	Latin name	Danish common name	English common name	Size (average)	Depth required	Edible
1	Vejle	At the harbour	Chaetomorpha linum	Krølhárstang, almindelig børstetråd	spaghetti algae	up to 3m long	0.5-1m	
2	Vejle	At the harbour	Gayralia oxysperma	Sommersalat	Green Seaweed	2-4cm high		
					https://nztcs.org.nz/nztcs-species/42626			
3	Vejle	At the harbour	Ulva fenestrata (lactuca)	Almindelig søsalat	Sea lettuce	11-95cm/23-35cm	0-8m	Yes
4	Vejle	At the harbour	Ulva intestinalis	Tarm-rørhinde	sea lettuce, gutweed and grass kelp	8-50cm high	0.1-4m	Yes

Number	Location	Specific location	Latin name	Danish common name	English common name	Size (average)	Depth required	Edible
1	Vejle	Near the harbour	Chondrus crispus	carrageentang, blomkålstang	Irish moss	15-17cm tall	0-18m	Yes
				https://www.gbif.org/species/5279115				
2	Vejle	Near the harbour	Dumonita contorta	Dumontalgae	Dumont's Tubular Weed	10-20cm tall	0.5-3m	
3	Vejle	Near the harbour	Polysiphonia fibrillosa	Violet ledtang	Purple Siphon Weed	up to 20cm tall	0.5-20m	
4	Vejle	Near the harbour	Porphyra purpurea	Rød purpurhinde	Nori?	up to 31cm tall, 20cm wide	0.5-1m	Yes

Figure 32. A sample of the extensive excel sheet was created for all the living red, brown and green macroalgae in the inner (and outer) Vejle Fjord. The table indicates the scientific name, the common name (both English and Danish), average size, typical water depth, colour, invasive or local specie, etc. (See Appendix 13) based on learnings from Lundsteen and Nielsen (2019a, 2019b), Naturbasen (n.d.) and MarLIN (n.d.). This information is re-appropriated into a map that is embedded back into the master Kumu map 1 – multiscalar analysis (see section 4.1.3, Figure 148).

2.1.3 Transdisciplinary research context

[I]ssues of sea level rise, integration of marine life, etc. cannot be investigated from the perspective of a single discipline, single time frame or a single scale. It requires a long-term historical and large-scale understanding of the space I'm investigating, which requires different tools and new narratives to synthesise the various complexities and entanglements my research involves.

Kate Orff, Scape Studio *Toward an Urban Ecology*
(Orff, 2016, p.15).

There is a growing recognition that new inter and transdisciplinary approaches are needed to bring holistic and innovative thinking by connecting different specialisations of knowledge and practice (Toomey et al., 2015; Orff, 2016). This is particularly relevant when dealing with the challenges of sustainable development, which requires inter and transdisciplinary collaboration between various specialists in the natural and social sciences (Sillitoe 2004; Farrell 2011). Furthermore, issues concerning ocean management and design thinking currently play almost no role (Gang et al., 2016), creating a gap in research for the potential of design research. Working with marine ecosystems such as seaweed inevitably directs the research to a trans-disciplinary[85] path that requires the integration of ecology/biology with the LUDP disciplines. Thus, this research attempts to synthesise various analytical and theoretical frameworks and professional practices beyond their disciplinary perspectives to a transdisciplinary context. For instance, ecosystem service (see section 1.5.2) is an established framework used frequently by biologists. This was used in this project to broadly address the various benefits of seaweed to build a case for their integration into the urban shorelines. Furthermore, to build a narrative for the critical and ethical proposition of Urban Seascaping[86] to "think with" and to "co-exist with" nonhuman life forms (see section 3.3), the project drew inspiration from the emerging field of blue humanities[87].

Additionally, dealing with sea-level rise and storm surge issues requires integrating knowledge from coastal hydrology (engineering) and dealing with water quality influenced by the watersheds (catchment area) and the influence of topobathy, which requires an understanding of geography. Finally, an understanding of economics, politics, building systems, planning laws and urban forms

85 However, what may be missing in this research in a transdisciplinary context are the disciplines of anthropology and psychology in understanding how these physical interventions such as Kanten/The Edge competition winning design will be received by humans (and nonhumans – i.e. will the fish like what we built for them?). This however goes beyond the scope of my project and is a research gap for further exploration (see section 1.7 Research scope and limitations and section 5.4 Future research avenues).

86 However, it is important to note that this research is bound by the limitation as a solo PhD project within an associated disciplinary boundary of LUDP.

87 The Blue Humanities is an emerging field characterised by disciplinary fluidity between humanities with environmental studies, oceanography, marine biology/ecology, maritime history, science studies, and more (Gillis, 2013).

is required to work in the municipal context of Vejle, which is responsible for making informed decisions about the development of the coastal areas. Therefore, inter-and trans-disciplinary[88] approaches are important for understanding "a process wherein people develop a critical awareness through collective inquiry, reflection, and action on the economic, political, and social contradictions they are embedded in" (Torre, 2014, p.3). This *collective* inquiry, reflection and action were particularly relevant to my research, especially given Kanten/The Edge design competition, which already constituted a transdisciplinary collaboration. (refer to Appendix 11). Ultimately, the project proposes that methodologically speaking, in order for coastal cities to reach a more sustainable transition to coastal development in the Anthropocene, integrating and synthesising different disciplinary knowledge needs to be realised in novel sub-fields such as "marine landscape architecture" (proposed by Sørensen (2020)) and "blue urbanism" by Timothy Beatley (2014) (see section 3.2.1).

Nevertheless, there are challenges associated with inter-and trans-disciplinary research. First, it requires more time and effort for the researcher to establish a base knowledge of other disciplines. Moreover, trans-disciplinary research becomes a more trust-based collaboration. That is, I have to place "trust" in the information from other experts as I have a limited understanding of the other subject field. In my case, it has been with the information I received from marine biologists.

The aim of inter- and transdisciplinary research for this PhD is to contribute knowledge that can have broad implications. As such, according to Toomey et al. (2015), the main aim of inter (trans) disciplinary research is to contribute to either/or both practical and theoretical knowledge. Practical knowledge starts "with a real-world question and uses different disciplinary ideas and methods not just as guideposts, but rather as tools to provide a solution for society" (Toomey et al., 2015, p.1). Theoretical knowledge links principles from different disciplines to form a more comprehensive theory. Therefore, the intention of Urban Seascaping as a research contribution is to serve as a theoretical approach to guide a practical strategy for coastal cities to integrate marine life forms as part of urban development.

2.2 Main methodology – Research-through-design[89]

[E]verything has become a matter of concern, and the entanglements between humans and non-humans are one of composition, an issue of design... an urgent call to include design in research processes, because if everything is a result of design, this mode of action should be embraced actively in producing knowledge.

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88 Today there is no consensus on the definition of and the difference between interdisciplinary and transdisciplinary contributions (Lawrence, 2010). However, according to Lawrence (2010), the main difference between the two is that while interdisciplinary research integrates knowledge and methods from different disciplines, using a synthesis of approaches, transdisciplinary research creates a unity of frameworks beyond the disciplinary perspectives.

89 Research-through-design can also be known as research-through-designing, research-by-design or research-as-design with design as the main method of knowledge creation. However, there is a tendency for research-through-design(ing) to be the preferred term for landscape architects (Lenzholzer et al., 2013).

Martin Prominski, *Design Research for Urban Landscapes – Chapter 2: Design research as a non-linear interplay of five moments* (Prominski, 2019, pp.43–44).

One of the main ways the project's analysis has been conducted is the "research-through-design" (RtD) methodology. This method refers to integrating the act of designing into the core part of the research and its efforts to answer the research questions (Lenzholzer, Duchhart and Koh, 2013; Prominski, 2019). It is a form of qualitative research methodology currently gaining traction in the spatial design disciplines of architecture, landscape architecture, and urban design. It is a method and a "theory of spatial production, investigating the social role of space in the historical context within which we live" (Lucas, 2016, p.7). Prominski (2019) argues that RtD's use of the transformative capacity of design and its forward-looking means of investigation or knowledge production is critical in responding to the climate crisis in this current time of urgency. No other methods offer this unique potential for exploring possible futures and designing non-existing systems through urban landscapes (ibid.). According to Prominski (2019, p. 44), "the Anthropocene demands projective[90] research tools which are able to deal with complex processes," and thus, "research-through-design has the potential to act as the epistemological paradigm for transdisciplinary studies and transformation design" (according to Wolfgang Jonas (2015, p. 35) in Prominski (2019, p.46)).

Therefore, RtD presents itself as the most appropriate methodology for investigating the future potential of Urban Seascaping with seaweed from a spatial design approach. Moreover, Vejle as a case study method is complementary to RtD, as it provides the "real world" problem in an actual context in which possible design solutions can be investigated. Furthermore, RtD is apt in its capacity to enable the researcher to translate different scientific knowledge (i.e. hydrology, climatology, marine biology, environmental psychology) to substantiate design into general applicable design principles and parameters through a common visual language of drawings, models and maps. Moreover, the new design proposals or knowledge developed by the spatial design disciplines can be tested and/or validated in collaboration with other specialists, such as engineers and marine biologists (Lenzholzer, Duchhart and Koh, 2013).

However, in the past, sceptics have voiced concerns about whether design can constitute a legitimate research method (i.e. is it just a design project or is it design *research*?). Therefore, Prominski (2019) argues that RtD must be coupled with other reflective research processes to validate design research. For instance, he outlines the five main design research processes or "moments." They are Original, Reflective, Projective, Transfer and Empty moments. These moments represent parts of the research process that lead to new or refined findings, which can start a new loop of all five research moments. First, the Original moment of design research represents a careful formulation of a coherent research hypothesis/question that has not been answered satisfactorily (i.e. research gap) and which may contribute to a transferrable knowledge rather than a specific design solution. Second, Reflective moments represent a process of reviewing

90 Prominski (2019) refers to an epistemological stance of design-based researchers who consider the world as a project of design. Therefore, projective research from the perspective of the creative disciplines would involve the role of design in helping to speculate on a future scenario based on findings from various explorations and studies.

and evaluating one's work in the broader scientific context. Thus, the Reflective moment is an extensive investigation into existing theories, projects, cases and methods that could contribute to answering the research questions (Original moments) and help reframe them through a retrospective process. Third, Projective moments represent designing as a mode of exploratory knowledge production that concretises unknown futures based on learnings and by setting premises. However, it is important to note that Projective moments through RtD are insufficient on their own. They need to be closely linked to Reflective moments (i.e. research *about* design), Original moments and Transfer moments (i.e. research *for* design) to ensure the knowledge from design work is converted into a reusable result from the interplay of these different research moments. Therefore, a Transfer moment represents the process of translating findings (i.e. specific design works from a case study site) to generalisable knowledge that can have a broader impact. Lastly, Empty moments of design research represent what appears to be the "unfocused" and "unproductive" part of the research, where the researcher can feel adrift from the research. Here, Prominski (2019) argues that these "voids" are an important part of the research process that could lead to a breakthrough in productive and unexpected findings. Therefore, Empty moments acknowledge the active and passive disengagement during the design research process (Prominski, 2019).

The process of encountering these different research moments is unpredictable and is closely linked to each other in more small interplays of entangled mini loops occurring throughout the research. "Performed this way, research through design, with its unique, projective potential, can play a crucial role in knowledge production. The interaction of the five moments can fulfil all criteria for common research mentioned: the original moments ensure originality, the reflective moments address the scientific significance, transfer moments guarantee broader impact, and the interplay of all five moments determines the relevance of the design research" (Prominski, 2019, p.41).

Urban Seascaping evolved throughout the research process into four main states/stages mirroring Prominski's five moments, as shown in Figure 33. First, USS is an initial hypothesis[91] that addressed the PhD Call/initial research question (i.e. Original moments – see Part I, section 1.6). Second, USS develops into propositions that act as guard rails for the research based on literature review (i.e. Original and Reflective moments – see Part III, section 3.3). Third, USS evolves into a guide for a hybrid mapping tool that acts as a conceptual framework/tool driven by RtD (i.e. Reflective and Projective moments – see Part IV). Finally, USS is used to test whether the research findings are valid (also its shortfalls) in the form of a reflective conclusion (i.e. Transfer and Empty moments – see Part V).

91 Initial hypothesis: Can "seascaping" with seaweed provide an answer to addressing sea level rise/storm surges in coastal cities as part of the urban development and coastal adaptation in the Anthropocene?

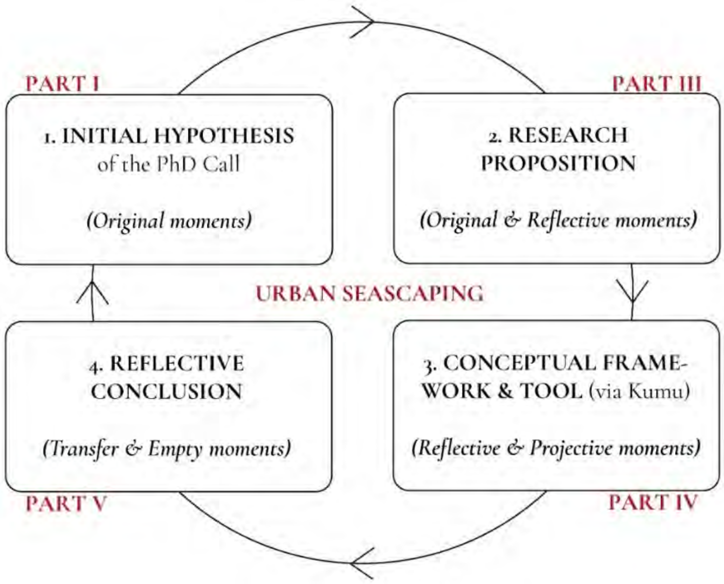

Figure 33. A flow chart describing the various moments of design research from Prominski (2019). Urban Seascaping evolves throughout the different moments in this research. In reality, this process is much messier, with mini-loops of these processes starting over again, with various empty moments interweaving in between.

2.2.1 Mapping as Research-through-design

Mapping as a cultural project, creating and building the world as much as measuring and describing it... mapping is particularly instrumental in the construing and constructing of lived space. In this active sense, the function of mapping is less to mirror reality than to engender the re-shaping of the worlds in which people live... uncovering realities previously unseen or unimagined, even across seemingly exhausted grounds.

James Corner, *The Agency of Mapping: Speculation, Critique and Invention* (Corner, 2011, p.213).

The complexity of working with the challenging site of the urban landscape-seascape continuum requires designers to read and understand the existing context and then interpret and evaluate the situation in question, taking into account its entangled and changing conditions (Langner, 2019). According to Seggern (2008, p.72), "grappling with what exists intensively and creatively can promote the process of understanding." For the design disciplines, this deep understanding is a crucial step in design work, aided by mapping to arrive at "new perspectives and projections of the urban landscape that serve as a basis for discovering new opportunities for its development and actualisation" (Langner, 2019, p.59). Mapping is not only a representation of a spatial perception of a place but also an iterative and performative way of understanding the complex relational nexus of spatial relationships (ibid.). Thus, mapping helps foster new ideas and knowledge in the design process, especially for challenging large-scale context-specific situations that lead to speculations about the future impact and course of actions they can reveal (ibid.).

Furthermore, maps are an established communicative visual medium in the LUDP disciplines and a legible and well-distributed medium for other stakeholders (Corner 2011). As such, "[a]rchitects and urban designers, with their abilities to draw information out of diverse stakeholders and delineate spaces, are distinctly suited to lead this kind of (mapping) spatial inquiry." (Gang, Cahan and Kramer, 2016, p.87). Thus, maps are a recognised way of addressing the dynamic, complex and large-scale landscape-seascape continuum that can help envision new frameworks, territories and realities (Corner 2011). The potential for design mapping as a research method is not just to (re)interpret and (re)present an urban landscape-seascape condition but also to analyse, transform and (re)configure it. Thus, mapping is also a self-reflexive activity for the researcher in telling stories from various angles, such as, for this research, the conflicting interest between humans and nonhumans in the urban realm (Heise, 2019).

Corner (2011) and Gang et al. (2016) argue that experimenting with alternative and new forms of mapping is needed. However, the method remains largely understudied if not repressed. Thus, the role of mapping in this project is to explore further the current lack of representation of the fluid and invisible world below sea level and engage with the complex spatial nexus of the landscape-seascape continuum in the Anthropocene. Moreover, the changing role of mapping as the main medium of engagement by the spatial design disciplines addresses the need for new ways to represent, curate, connect, analyse, experiment, project and synthesise the increasing need for complexity and transdisciplinary knowledge. Departing from this notion of mapping as a projective medium, the research adopts mapping as the basis for research-through-design. Therefore, the next sections outline the potentials and limitations of different types of mapping as an investigative and explorative spatial-visual medium/method. The methodology chapter divulges into the myriad reasons why a new form of hybrid mapping was developed for this research (i.e. the Kumu mappings).

2.2.2 Limits of maps

> *[S]patio-temporal information, maps, and geovisualization techniques themselves might best be understood as powerful yet limited pieces of subjective – that is, both partial and affectively ambiguous – data that are best pursued in holistic conjunction with additional methodological and theoretical frameworks which more thoroughly situate them and engender deeper critical engagements with broader processes – socio-spatial as well as discursive – that no map or visualization alone can ever fully represent.*
>
> J.K Jung and C. Anderson, *Extending the conversation on socially engaged geographic visualization: representing spatial inequality in Buffalo, New York* (Jung and Anderson, 2017, p.904).

Maps are never neutral products without biases, subjective interpretations and agendas of the mapmaker (i.e. the power to hide and highlight). It is embedded in the values, opportunities and limitations of the culture that the maps produced (Corner, 2011; Jung and Anderson, 2017). Thus, maps are not a representation of "true" territory but particular *ideas* about the territory (Duarte, 2017; Heise, 2019). It is a perception of reality that tries to make sense of the invisible and the myriad layers of factors that constitute a territory. Therefore, without the self-reflective and criticality of the mapmaker (researcher), maps can unintentionally adapt and reproduce the normative narratives and power relations they sought to depart.

For this research, I have tried to represent certain ideas about the territory of concern, namely Vejle, in the Eastern coastal context of Jutland, guided by the propositions of Urban Seascaping (section 3.3) and Kanten/The Edge competition design brief (section 1.4.1), as seen, for instance, with the importance of showcasing the invisible marine realm to the urban realm through mapping and analysis. Conventional maps used in LUDP (see Figure 34 below) typically provide more literal and static visualisations of absolute spaces at a given point in time, often limited in their representation of temporal, interpretive, or interactive elements. For instance, when depicting water bodies as a floor plan on a 2D map, conventional maps delimit marine areas with arbitrary orthogonal outlines as boundaries that treat the ocean as though it were largely a dark, flat, featureless surface alone with very limited information or character (Gang, Cahan and Kramer, 2016). I argue that these maps are incomplete in helping us visualise and make sense of the scale of the sea, the complexities of the hydrological cycles, the numerous ecological habitats and ecosystems, or the interrelationship of the coastal areas to its surroundings (ibid.). Most importantly, such mapping conventions are limited in stimulating the human imagination towards the nonhuman bodies of water and the interconnection between them and us. That being said, conventional static maps can hardly be blamed as there are inherent difficulties in conventional mapping methods to represent something constantly in flux as the sea. Furthermore, there is limited information on the sea (i.e. detailed bathymetric data in Denmark) to work with in creating more insightful volumetric maps of the sea.

Figure 34. Examples of conventional territorial mapping styles used by municipalities and practitioners. The top image is a proposal by Aarhus Havn/Port of Aarhus to propose a "Blue Line", a landscape-seascape project at the edge of its newly land-reclaimed harbour extension project. It makes the mistake of only indicating the green landscaping on land, while anything below the sea is represented in a grey singular plane with no indication of marine vegetation due to the new rock reefs. Moreover, the maps convey the bathymetry as flat contour lines, and the delineation of the extent of the map's borders is orthogonal and does not include its connection to the wider context (sea-side). Image credit: Aarhus Municipality and Aarhus Havn (Bak Lyck, 2022; Aarhus Havn, n.d.).
(Extracted from Kumu S-O-T-A map – Aarhus Bugt node in Aarhus, Denmark).

Nevertheless, the objective of using mapping as a RtD method in this research is not to dwell too much on the limitations of maps but to extend them through critical analysis. Furthermore, although this research recognises the limitations of conventional static mapping, it also recognises that these conventional mapping methods still play an important role in the continuation of analytical and communicative work in LUDP disciplines. These conventional mappings are also in the process of evolution as "blue" issues become more influential. Therefore, the next section presents attempts to challenge the conventional mappings of the sea to include examples from various disciplines using different mediums. These examples inform the mapping methods used in this research to help answer the research question SRQ2 on the role of spatial design disciplines and their representational tools.

2.2.3 Mapping the invisible

Regarding mapping the world under the surface of the water[92], progress has been much delayed (Gang, Cahan and Kramer, 2016). Moreover, as shown in mapping examples in Figure 34, depictions of the marine realm are presented as lifeless and mysterious blue planes viewed from above (i.e. bird's-eye-view), not from the perspective of the marine realm (i.e. fish's-eye-view as shown in Figure 35). There is a need to better represent the liquid realm underneath, especially in

92 Oceans cover over 70% of the surface of the earth (and will cover more in the future due to SLR) (Smith et al., 2008). But, humans know more about the surface of the moon than the deep waters of the ocean. While there are advanced sonar technology, less than 10% of the ocean has been mapped in high resolution compared to 100% mapping of the surfaces of Mars and the Moon in high resolution (National Oceanic and Atmospheric Administration, 2021).

the LUDP disciplines[93], if we want to design better the interchange between land and sea, human and nonhumans. There are inherent difficulties in representing and speculating potentials for the marine realm with a different set of rules, boundaries and orientations than the linear and fixed structures we are used to on land.

Fortunately, some attempts to map this perceived invisible realm do exist. For instance, Google has recognised the importance of mapping the ocean and is leading in trying to map the ocean beds similar to its Google street view function (see Figure 35). This map offers an interactive way of navigating through the oceanic world, allowing the user the control to explore this liquid space. While Google Earth data for underwater is not available for the case study context of the Vejle fjord, this form of navigable photographic depiction of the marine realm is important to highlight the sea bed conditions that form the basis of a site for Urban Seascaping. For instance, the Sund Vejle Fjord project has recorded an underwater video of the sea bed in Vejle Fjord, as shown in Figure 35. The video presented a powerful medium to communicate the dire conditions of the majority of the Vejle fjord (i.e. dark and dead), indicating the extent of the challenge in the task of reviving marine life in these conditions. Depiction of the 3D spatial conditions of the sea bed in the form of moving images gives another sense of understanding from the typical 2D visualisations and section drawings. Therefore, the screenshots from the Vejle Fjord sea bed videos are incorporated into the mapping analysis as part of the research (refer to Part IV).

93 I have often encountered practitioners who want to work with the sea who say, “we just do not know enough about what is under the water.”

Figure 35. (Top row of image) Google Earth street view of the ocean bed of Lizard Island – Parts of the Great Barrier Reef in Australia have been mapped by Google with divers and hand-held cameras, showing numerous marine life. Currently, only a few ocean beds have been mapped by Google Earth. Image credit: Google Earth (screenshot captured on 03/05/22) (Google, 2022).
(Bottom row of images) Two screenshots from the 70hrs of videos captured by the Sund Vejle Fjord Project show the dead sea bed due to water pollution in Vejle fjord. Image credit: Sund Vejle Fjord (n.d.).

The second example I wish to highlight is a historical map that changed how people depicted the underwater realm. This map was created by Marie Tharp, a geologist and oceanographer. She created topographical maps of the ocean bed[94] incorporating bathymetric information that changed how people imagine two-thirds of the world. In 1957, Tharp and her research partner, Bruce Heezen, began publishing maps that showed the main features of the bottom of the ocean consisting of mountains, valleys and trenches, contrary to the popular scientific assumption that the seabed was featureless (see Figure 36 of her maps below) (Gang, Cahan and Kramer, 2016; Atlas Obscura, 2020). Her iconic hand-drawn maps of the ocean floor showed that land and sea are not as easily demarcated and separated as people initially assumed. The maps indicated that land and sea are a changing continuum, not a border. The importance of these maps was their success in sparking a new way of envisioning the ocean, not as lifeless and unknown but as a familiar territory to one on land. This form of mapping led to the modern mapping of topobathy, which combines land-based topography and bathymetry (water depths) into one surface (see Figure 37).

For Vejle, the topobathy data I gathered was re-appropriated in the mappings used in the research for analysis, as shown in Figure 37. However, only 5m intervals of contour lines are publicly available in Denmark for bathymetric data, limiting the accuracy of the main case study site of Vejle.

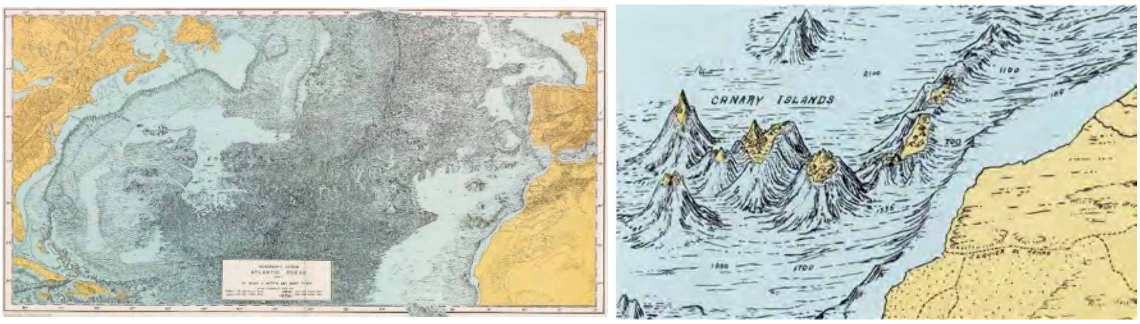

Figure 36. Marie Tharp and Bruce C. Hezeen's hand-drawn (physiographic diagram) map of the North Atlantic Ocean floor helped support the tectonic plate theory and ultimately challenged the way we see the seafloor as a continuum. As shown in the left-hand image, the centre of the Atlantic Ocean shows the rift valley due to the tectonic plates. The right-hand image indicates that the Canary Islands (in yellow) is essentially a tip of a mountain that is above the waterline, indicating visually that the land and sea are interconnected. Image credit: Marie Tharp (1957) (reproduced).

94 Tharp's maps were foundational to the development of plate tectonic theory (i.e. continental drift). She accurately identified that mountains and valleys in the Atlantic ocean where the two continents of Africa and South America could have been separated (Gang, Cahan and Kramer, 2016; Atlas Obscura, 2020). She had limited data and had for certain parts of the sea, she had to use her artistic license to fill in the gaps (Kovats, 2014).

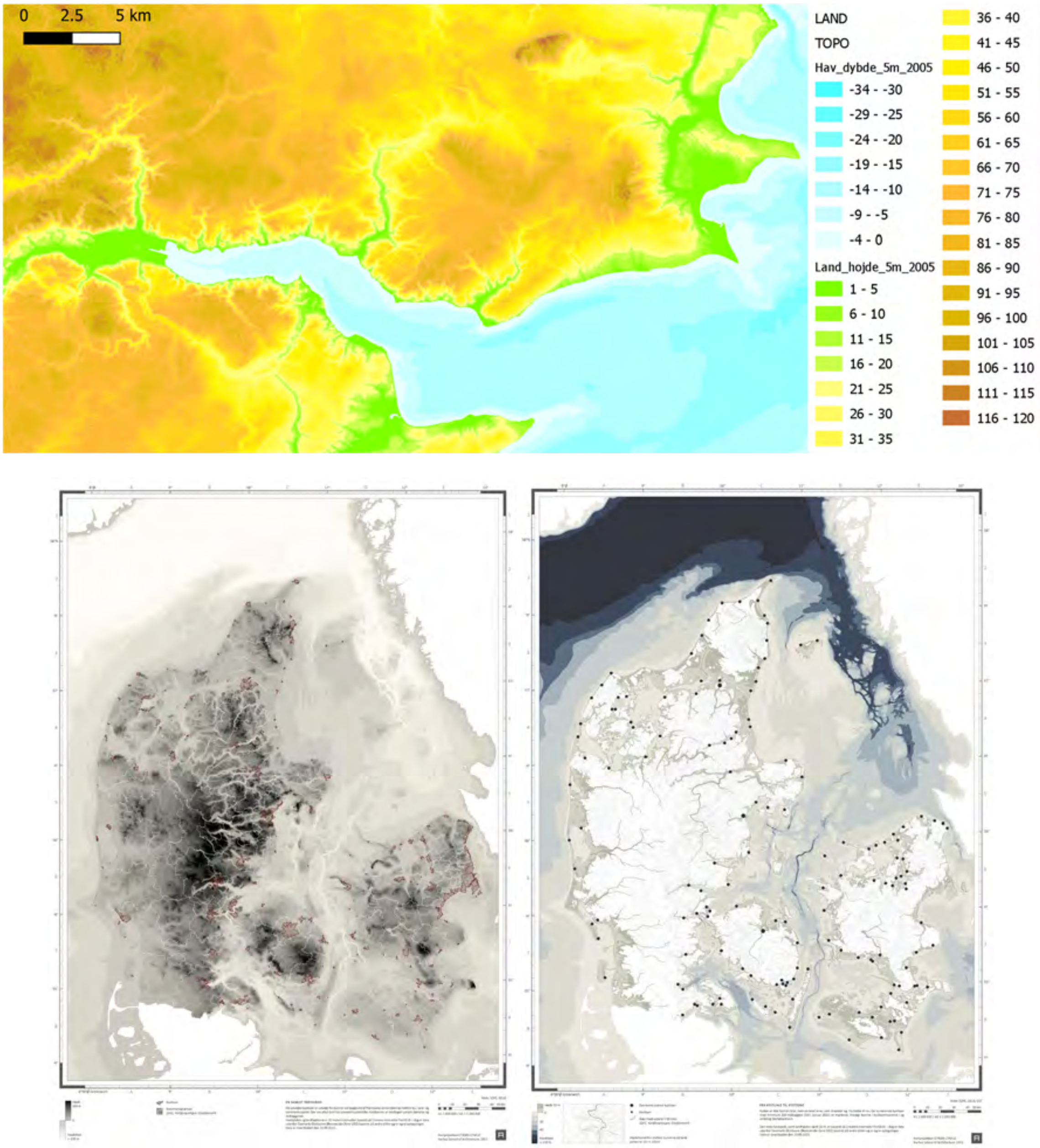

Figure 37. (Top image) Topographic and bathymetric data of Vejle fjord. The different colour gradation represents different heights above and below the current average sea level. This type of topobathy map is useful when engaging with a site that concerns the boundary between land and sea.
GIS data from: GEUS Dataverse (Tougaard, 2006).
(Bottom Left image) Map of Denmark showing the continuation of height-to-depth relationship from land to the sea via topobathy. The highest latitude is shown in black on land to the deepest sea beds in light beige. The red areas highlight the coastal cities and towns.
(Bottom Right image) Map of Denmark showing the elevation up to 10m on land (in dark beige), which shows the most low-lying areas of the Danish coast. The depth of the sea is a degradation from the colour beige to dark blue.
Both maps show the relationship between the low-lying areas near the coast (i.e. coastal cities/towns), marking their vulnerability to rising sea levels and storm surges. The map is a good example of visually portraying the coast as not a line but a transitioning zone.
Image credit for both maps: "Det Lille Blå Atlas" by Wiberg et al. (2022).
(Extracted from Kumu Multiscalar map – National scale node).

One of the principal aims of the maps developed in this project is to highlight our reliance on territorial thinking as well as the insights that might be gained by adopting the perspective of the water. In turn, this means that we can also start to depict our “dry” lands as wet territory crossing arbitrary man-made municipal borders. For instance, all of America’s (48 contiguous states) waterways were mapped and created by computer programmer Nelson Mina (see Figure 38) (Gordon, 2013; Mina, n.d.). He managed to show how blue America is, much like the veins in the land, contrary to the usual satellite imagery showing green forests and brown deserts. Mina’s visual representational technique has been adopted for this research using GIS data, as shown in Figure 38, showing how “wet” Denmark truly is.

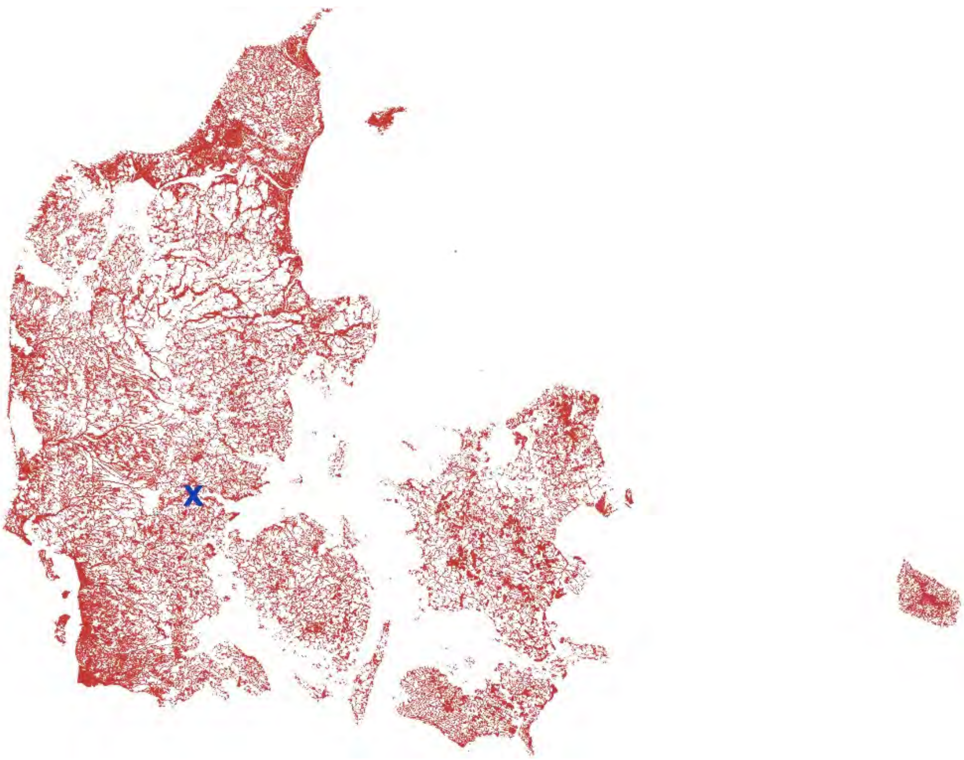

Figure 38. (Top image) "The veins of a nation: All of America's rivers mapped" by Nelson Mina. Image credit: Nelson Mina (Gordon, 2013; Mina, n.d.).
(Bottom image) My attempt at mapping all of Denmark's "on-land" water bodies (streams, rivers, lakes, ponds, etc.). Water bodies are shown in red like blood vessels of a human body. GIS source: Miljøstyrelsen (n.d.).
(Extracted from Kumu Multiscalar map – National scale node).

Valuable lessons can be learnt from the examples of mapping techniques of the water bodies, which invoke the viewer's imagination to think differently about the water. These techniques are also employed for the various mapping analysis presented throughout this research as part of the multiscalar contextual analysis (refer to Part IV of this research).

2.2.4 New emerging hybrid maps

In addition to these novel innovations within ocean mapping, there are emerging transdisciplinary hybrid forms of mapping[95] that combine other mediums in order to stimulate different affective and perceptual responses[96], such as films[97], art, photography[98], poetry, or music., These new maps address the importance of visual curation of different mediums to tell an alternative story and as a tool for analysis and projection. An example of such a hybrid map is the Feral Atlas[99] (as shown in Figure 39), which is an online/interactive platform for transdisciplinary research. The map provides "dissemination about how to recognise feral ecologies, that is, ecologies that have been encouraged by human-built infrastructures but which have developed and spread beyond human control" (Tsing et al., 2021). Thus, Feral Atlas is a mapping platform that invites the viewer "to explore the ecological worlds created when nonhuman entities become tangled up with human infrastructure projects" (such as industrial ruins). It contains more than a hundred essays, field reports, videos, poetry, articles, analyses, and artworks by leading natural scientists, humanists and artists creating a playful, political map that hosts nonhuman histories (Tsing et al., 2021). It builds on the interactive potential of the digital medium (such as the website) to offer new ways of analysing, representing and understanding the complexity of the Anthropocene (Tsing et al., 2021; Luong, 2022).

95 There are many established and emerging qualitative mapping methods, especially in the field of (urban) geography such as, Qualitative GIS (Cope and Elwood, 2009), Geo-visualisation (Jung and Anderson, 2017), Deep mapping (Bodenhamer, Corrigan and Harris, 2015), to name a few.

96 See definition page on Affect.

97 In retrospect, there is whole new potential in using films (moving images) as a medium and a method of investigation, analysis, curation and production. Films have the ability to involves the viewer from a narrative approach, mirroring human emotional and sensory experience, (such as light, sound, movement etc.) (Troiani and Kahn, 2016). It can also create intimacy between place and observer by overlaying, voices from interviews, maps, and drawings, using films as a medium could have provided another way to explore this research.

98 For instance, Rasmus Hjortshøj's PhD research explores photography as a medium of mapping the landscape-seascape condition (Hjortshøj, 2021).

99 Feral Atlas is part of Aarhus University Research on the Anthropocene's (AURA) outreach and collaborative ambitions and is edited and curated by Anna Tsing, Jennifer Deger, Alder Keleman Saxena and Feifei Shou, published by the Digital Repository at Stanford University Press. There are over hundred contributors to this atlas (Tsing et al., 2021).

The way Feral Atlas works as an online interactive map hosting and connecting visual mediums through the use of nodes became an inspiration for this research (nodes are highlighted in Figure 39 as red circles). These nodes are able to embed various territorial mappings within the main master map, as shown in the artistic depiction of different contextual themes.

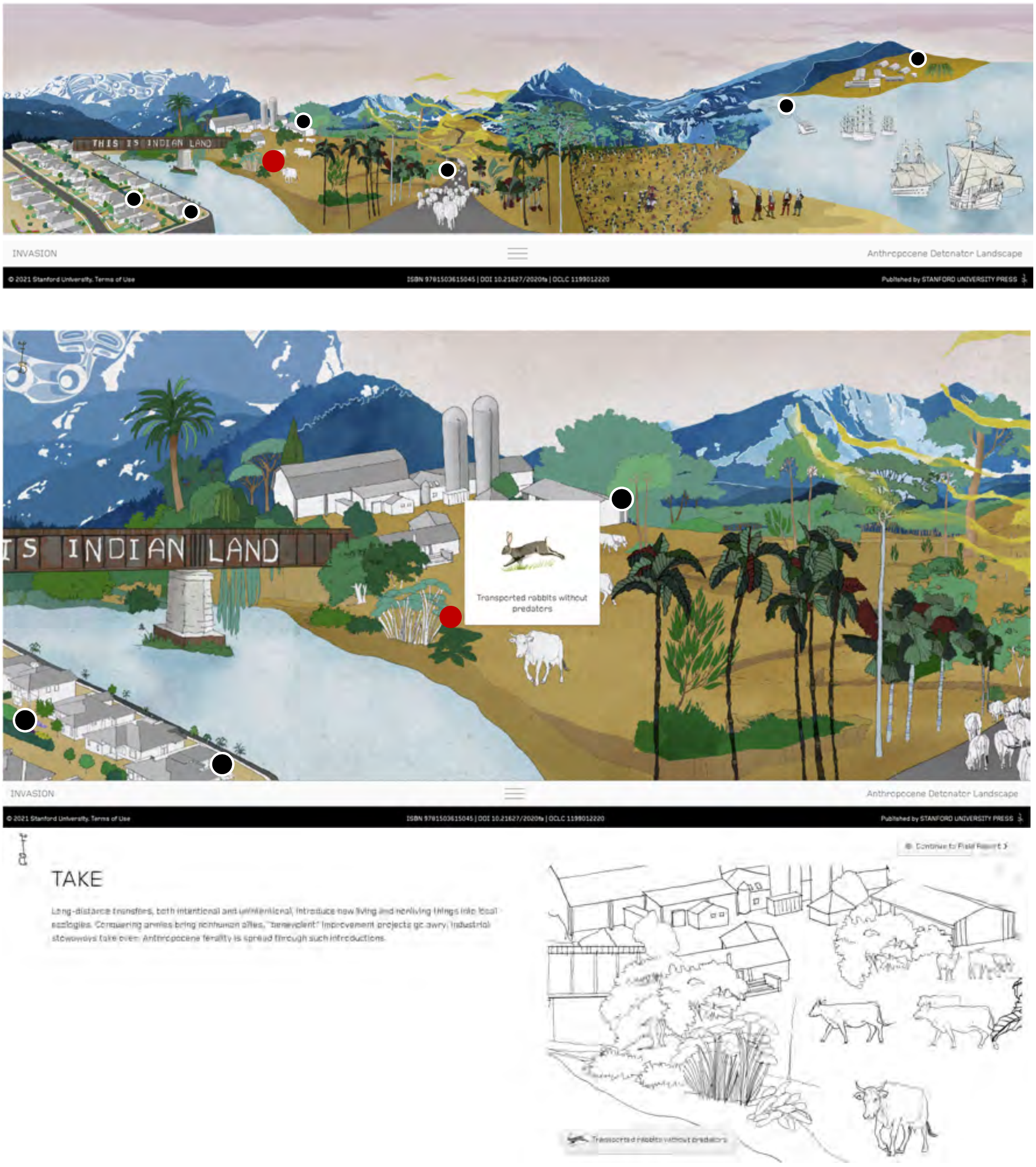

Figure 39. One of the maps in the "Feral Atlas" project was led by Anna Tsing from the spatial humanities at Aarhus University and Stanford University in collaboration with artists and ecologists (Tsing et al., 2021). The nodes are embedded into various artistic backgrounds (highlighted in red and black dots) that host relevant content to each theme. Each node can contain tables, poetry, videos, maps, drawings etc. Image credit: Carr et al. (2021).

The different types of mapping as a method of investigation, analysis, representation and curation are explored to answer sub-research question 2, "What *representational, analytical tools* and worldviews can help stakeholders (i.e. municipal, practitioners, educators) address RQ1 and SRQ1?" Section 2.3 delves more into detail on how mapping for Urban Seascaping developed for this research.

2.2.5 Scaled System Thinking Approach

> *Current local-scale changes in the landscape interweave with larger forces of globalization, time-space compression and media proliferation altering the face of landscape, both rural and urban, around the world. These larger forces span all sectors of human activity and inform a new cultural economy of space, creating new landscape spatialities that require a reformulation of landscape definitions, as well as new conceptual models and methodological approaches for landscape design.*
>
> Theano S.Terkenli, *New landscape spatialities: the changing scales of function and symbolism* (Terkenli, 2005, p.165).

As briefly addressed in the discussion of the Feral Atlas above, the issues surrounding climate change (the Anthropocene) further complicate the interrelated reality of urban and natural systems. This challenges practitioners in the LUDP field to better understand complexities across spatial and temporal boundaries (Chen and Lee, 2015). For instance, a deeper understanding of the site and its context is needed before developing any landscape-seascape design proposals. In turn, this involves paying attention to diverse forms of expertise, multiple scales, spatial heterogeneity, non-linear time frames and feedback loops (Chen and Lee, 2015; Jensen, 2021). As such, understanding the complex interactions between the landscape-seascape continuum with the broader context, such as the inherent relationships between ecological habitats and human-dominated land-water uses, is a prerequisite for LUDP practitioners and municipalities to generate good design solutions that can also address sustainability and liveability (Steinitz, 2012; Chen and Lee, 2015). Chen and Lee (2015) propose a "Scaled System Thinking Approach" (SSTA) that aims to integrate different relationships and pressures across several spatial scales from global, national, and municipal levels down to local and site-specific levels into the process of design(Chen and Lee, 2015). They argue that it is critical to understand and think in "systems", "a group of interacting, interrelated, or interdependent elements forming a complex whole" (Chen and Lee, 2015, p.346).

Nevertheless, Chen and Lee (2015) state that the SSTA is used in conventional practice and teaching in the LUDP discipline, which tends to engage with system thinking at a particular spatial scale that seeks to understand the interrelating socioeconomic, geophysical, and ecological forces that shape landscapes. However, they argue that current practice and teaching "generally fail to recognise how these very forces are simultaneously functioning at other scales, let alone relate these cross-scale functions to gain a holistic understanding of broader interrelated landscape processes and their potential influences on the design solution" (Chen and Lee, 2015, p.347). While focusing on isolated problems may be desirable and easier, it may be limited and ineffective in attaining impactful, sustainable design and planning decisions (ibid).

Moreover, the book "Site Matters" by Andrea Kahn also addresses the need for multiscalar thinking and practice in urban contexts challenging the conventional notion of a site. She writes,

> the issue of scale is key to the definition of urban sites, influencing how designers understand the context of their work and how they define the geographic extent of their areas of concern. Because urban sites participate in many differently scaled networks at once, talking about an urban scale, as a singular measure or the attribute of some entity, obscures the multiscalar condition of urban sites. Urban locales register on multiple scalar networks, in some cases at different times, in other cases simultaneously. Site reach measures the extent, range, and level of interactions between a localized place and its urban surroundings. It gauges vicinities of exchange and intersection between places, reciprocal and nonreciprocal relations, inscribed within and contributing to co-present urban spatial networks (Kahn and Burns, 2021, p.197).

Therefore, for this research, SSTA is deployed as a theoretical foundation for the multiscalar mapping developed as part of this project (refer to section 2.3 for more detail). Finally, SSTA preludes to an operational multi-scalar approach to investigation, namely in mapping, as addressed in the following section.

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2.2.6 Hybrid network mapping

Design mapping supports the examination of the complex relational structures of urban landscapes. As a spatio-topological and spatio-temporal description method, maps open up special opportunities for accessing a multidimensional dynamic Raumgeschehen (spatial interaction) . . . Design mapping aims not only at describing and representing complex relational structures, but also at revealing these, at (re)interpreting, at (re)configuring and negotiating . . . Mapping can thus become a key navigational practice for (re)positioning within the ever-changing, complex conditions of urban landscapes.

Sigrun Langner, *Mapping as a navigational strategy*
(Langner, 2019, pp.66–67).

By considering the opportunities and limitations of different forms of mapping mentioned throughout section 2.2, further development and refinement of mapping methods are needed in order to "remain capable of taking action in the face of the increasing complexity of design tasks and to be able to develop and negotiate ideas for shaping urban landscapes sustainably" (Seggern and Werner, 2008, p.46). Moreover, new forms of mapping are needed to engage with the immense complex spatial systems that are large-scale, unpredictable and non-linear from long-term horizons with multiple stakeholders with differing interests. It also needs to fill the current lack of established design traditions, approaches or valid design methods towards designing complex, large-scale urban landscape-seascape interventions in the Anthropocene (Seggern and Werner, 2008). Therefore, this research takes inspiration from network mapping to address the increasingly interrelated entanglements in addressing a wicked problem through mapping as a process of discovering all the entities connected to a network, outlined in Figure 40. One of the most notable form of a network map is a sketch from Charles Darwin called the “Tree of life” in the 19th century. His sketch underpins the importance of visualising the understanding of connection across multiple organisms and then portraying the strength of the interaction between species. Figure 40 also shows other influential examples of network maps used throughout human history that also visualise the world as an interconnected network.

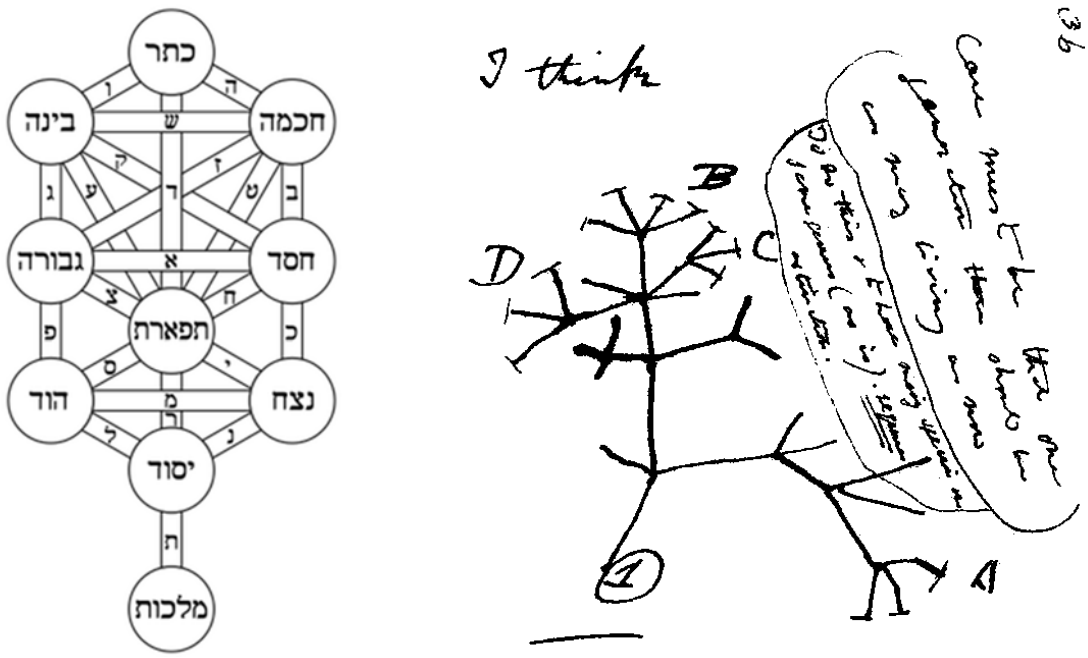


Figure 40. Examples of iconic network diagrams/maps that reflect systems thinking visually – interrelations of parts and whole.
(Left image) The Hebrew “Tree of life” (Kabbalah) diagram dates back to the 9th century BC. It consists of nodes (spheres) symbolising different archetypes and lines (paths) connecting the nodes. The diagram is believed to represent life – i.e. relationships between God and the human psyche (very broadly speaking). Image credit: AnonMoos (2014) from Wikimedia Commons.
(Right image) Charles Darwin’s “Tree of life” (1837) sketch could be argued as one of the most renowned forms of network mapping, understanding and representing interrelations in a visual format. The sketch of an evolutionary tree is from his notebook “Transmutation of Species”. Image credit: Darwin (1837) from Wikimedia Commons.

For my research, this type of network mapping was used in the initial research phase (i.e. Reflective moments – refer to Figure 33) to process the vast amounts of data that were collected within the transdisciplinary context (including issues regarding water, urban development, marine ecology, design decisions, etc.). Due to its size and complexity, this comprehensive body of data inevitably posed a challenge for the researcher to decipher, organise, analyse and curate in a cohesive way. Therefore, these entangled data sets[100] were initially arranged into broad categories in an online collaborative tool called Miro[101], as shown in Figure 41. This process was based on a methodological approach called "Giga Mapping[102]" by Birger Sevaldson (2011), an extensive mapping technique across many layers, sections and scales that seek to investigate relations between seemingly separate things, categories, and silos. According to Sevaldson (2011), Giga maps are process-oriented tools for visual thinking and understanding complex systems thinking in design. He uses Giga mapping in his teaching as an initial "data dump" by finding and mapping the data into key relations and categories, particularly at the beginning of a project. Using the method of Giga mapping with Miro, I did an extensive and gradual initial data dump of all the resources and findings related to integrating seaweed as part of the landscape-seascape approach to waterfront development in Vejle (as indicated in Figure 41).

100 Such as, findings from the GIS data, interviews and Kanten/The Edge design competition entries, state-of-the-art projects around the world, literature reviews of articles, reports, photos, videos, drawings, websites, diagrams, maps, etc.

101 Miro is a cloud-based collaboration tool for small to midsize organisations. The tool features a digital whiteboard that can be used for research, ideation, building customer journeys and user story maps, wireframing and a range of other collaborative activities. See www.miro.com for more details.

102 However, Giga-maps are not designed for communication with outside of the designer/creator as it is used as process tools to map complex data (Sevaldson, 2011).

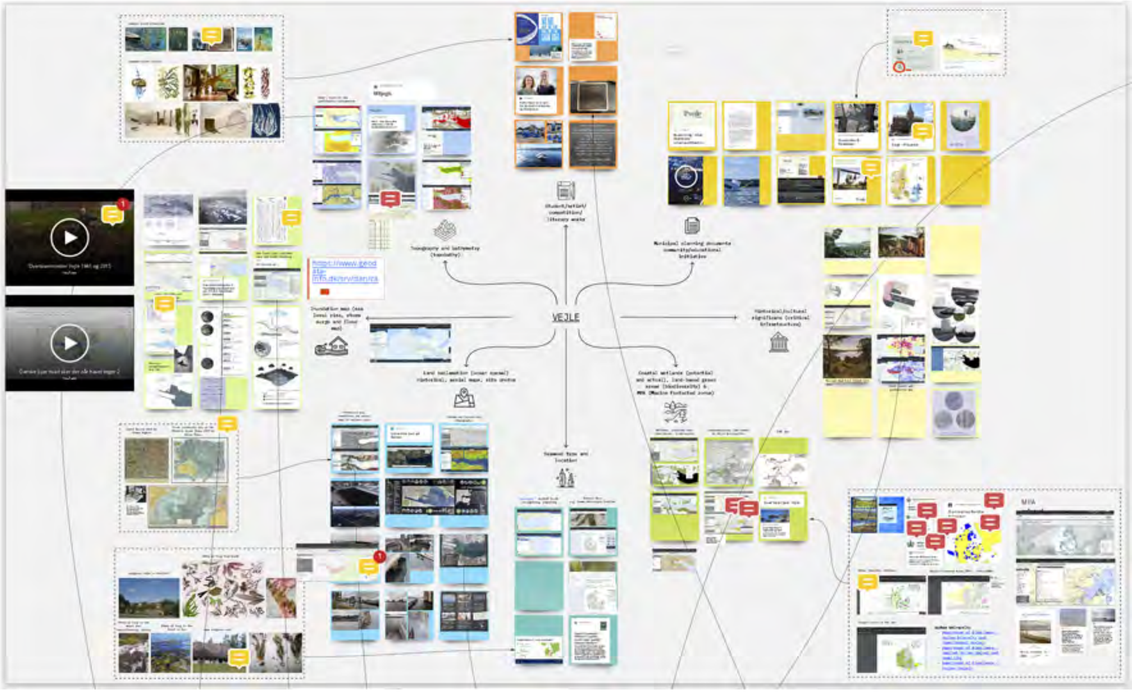


Figure 41. Screenshot of the initial data dump of everything relevant about Vejle, seaweed, coastal protection/adaptation, nature-based solutions[103] *etc., that are relevant in answering the research questions. The data include screenshots, hyperlinks to URLs and documents, and comments and arrows indicating their interconnections to others (organised in Miro, an online software).*

The initial Miro mapping evolved into a more sophisticated, organised, spatial format that could be operable to work with territorial mappings (and other visual mediums), different timeframes and multiple scales. Therefore, another online mapping tool, "Kumu[104]", was used to reflect the desired scaled systems thinking approach. The intention of using this tool was to go beyond the limitations of static 2D mapping addressed in section 2.2.2.

Interactive Network Mapping – Kumu

The research employs a network mapping tool Kumu as a methodological tool for curating, hosting, and making sense of various complex webs of information that the Vejle case study introduces. The Kumu tool was chosen as a data and geo visualisation (see definitions) tool because it allowed me

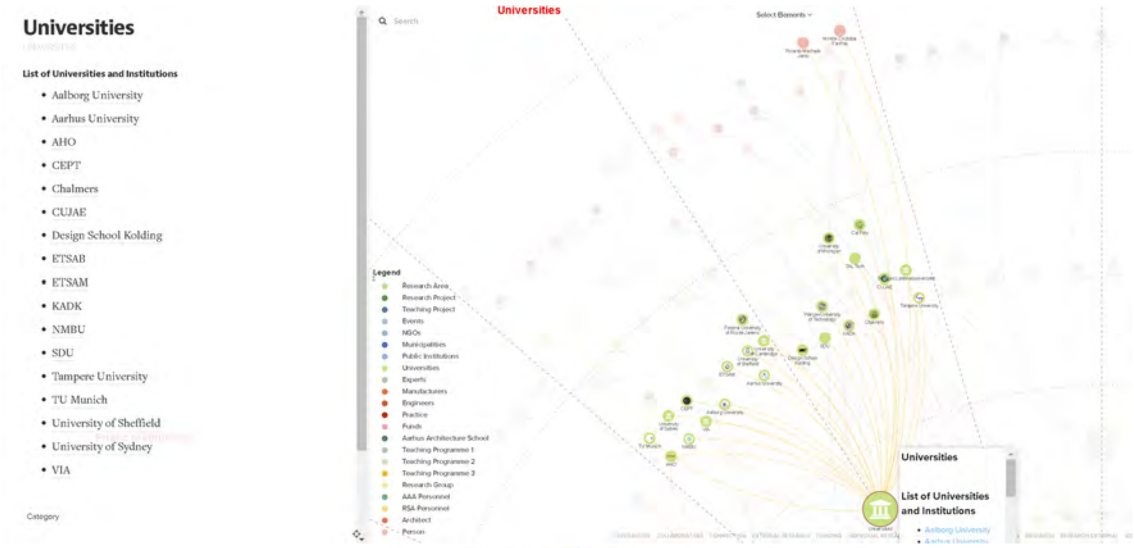
103 Initial categories of sorting the various relevant information: 1. geography related (i.e. topographical and bathymetrical data for Vejle), 2. municipal documents (i.e. storm surge strategy for Vejle Municipality), 3. historical and cultural infrastructure, 4. other research dissertations that could be useful (i.e. master student works), 5. Urban development models – land reclamation, 6. Sea level rise, storm surge (climate change related), 7. marine life forms (such as seaweed, eelgrass, wetlands, salt marsh).

104 Kumu is a network mapping tool primarily used for social network mapping between people, systems or concepts with data analytical tools that help navigate a web of interests, influence and alignment of key players around important issues (Kumu INC, 2011). Go to https://kumu.io/ for more information.

to compose an interactive map capable of converting complex data sets into maps delineating the relationships between these. In other contexts, Kumu[105] has been used to map the complex structure of personal networks and reveal connections between key players (see Figure 42 for an example of stakeholder mapping). It can also be used to brainstorm complex ideas and relate individual concepts to the bigger picture (Kumu INC, 2011; Sage Ocean, 2022). These mapping tools allow the user to investigate and navigate the complexity using parameters such as categorisations and links. Depending on which parameters one wishes to emphasise, Kumu can reveal and hide connections and nodes[106] by calculating which nodes are the most popular or least popular, thereby reorganising the nodes into different groups. It is also an online tool that can be shared anywhere, anytime, with the capacity to embed various visual mediums such as images, texts, videos, websites, hyperlinks and other information. Finally, a Kumu map can also link to other Kumu maps.

105 The main use cases for Kumu are: 1. Stakeholder mapping - Explore the complex web of loyalties, interests, influence, and alignment of key players around important issues. 2. Systems mapping - Understand and engage complex systems more effectively using systems maps and causal loop diagrams. 3. Social network mapping – Visualise and capture the structure of personal networks and reveal key players within an organization. 4. Community asset mapping - Keep track of the evolving relationships among community members and resources. 5. Concept mapping - Brainstorm complex ideas and relate individual concepts to the bigger picture (Kumu INC, 2011; Sage Ocean, 2022).

106 A node is a point in a network or diagram at which lines or pathways intersect or branch. For Figure 42, the nodes are different coloured circles which are embedded with various information by clicking on them.


Universities
List of Universities and Institutions
• Aalborg University
• Aarhus University
• AHO
• CEPT
• Chalmers
• CUJAE
• Design School Kolding
• ETSAB
• ETSAM
• KADK
• NMBU
• SDU
• Tampere University
• TU Munich
• University of Sheffield
• University of Sydney
• VIA
Category
Universities
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Universities
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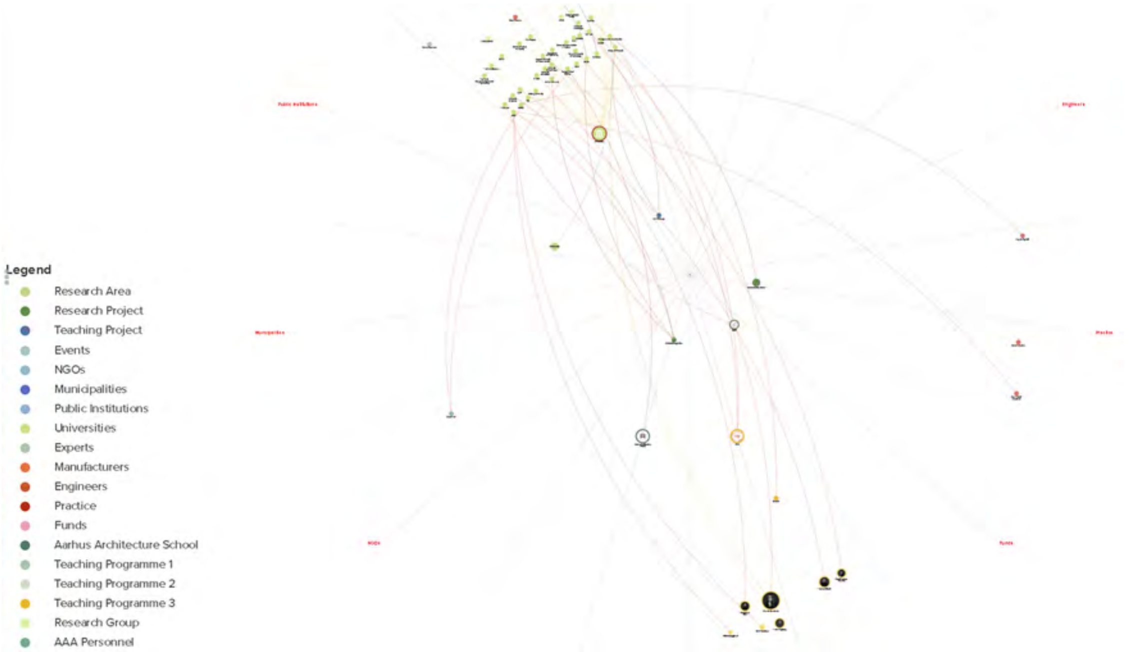
Legend
Research Area
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NGOs
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Public Institutions
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Funds
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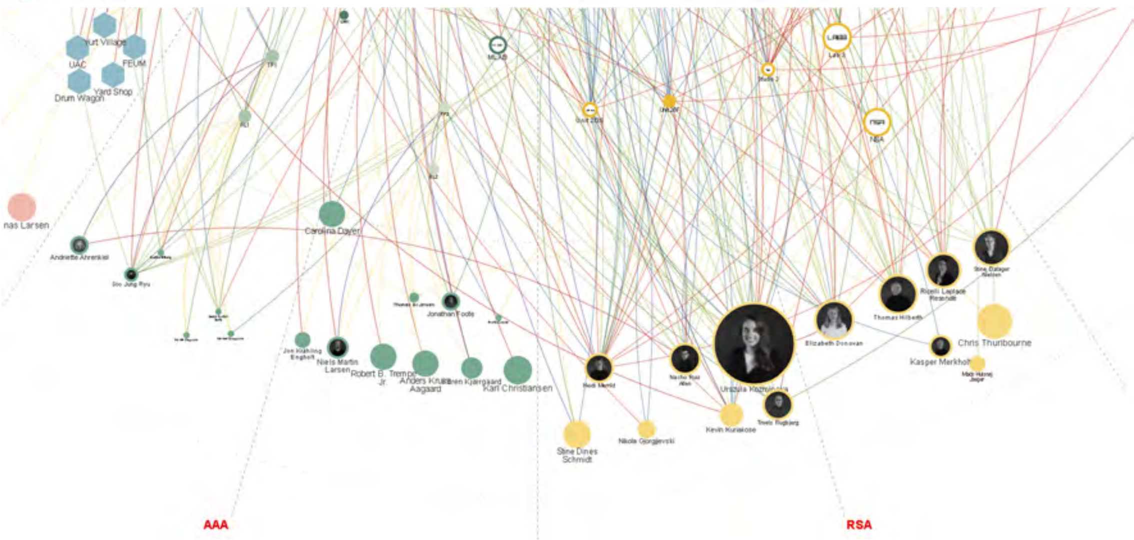
Teaching Programme 2
Teaching Programme 3
Research Group
AAA Personnel


Yurt Village
UAC
FEUM
Yard Shop
Drum Wagon
Carolina Dayer
Chris Thurlbourne
Kasper Markholt
Niels Martin Larsen
Robert B. Trempe Jr.
Anders Kruse Aagaard
Karl Christiansen
Stine Dines Schmidt
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RSA

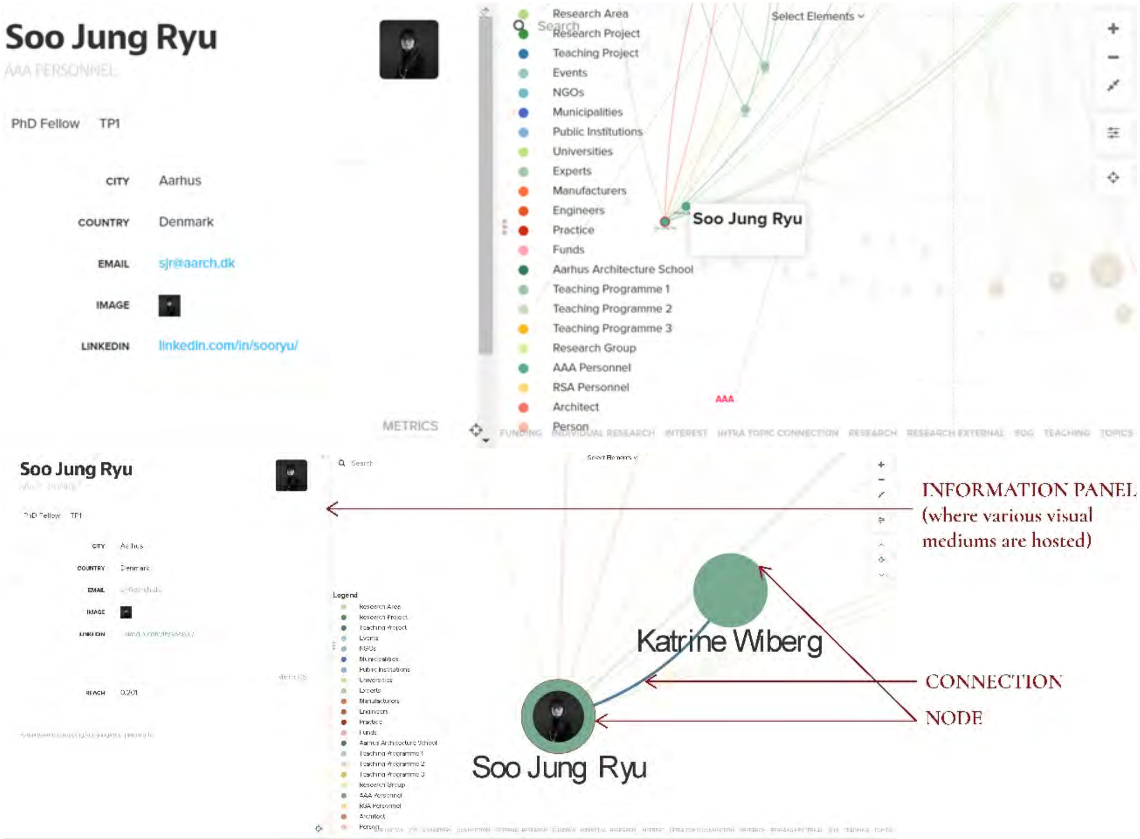


Figure 42. An example of a complex Kumu map of all the stakeholders involved with the Aarhus School of Architecture. It is divided into several categories (i.e. Aarhus School of Architecture's different research labs, teaching programs, personnel/staff, and collaborators such as universities, municipalities, practitioners, experts and NGOs). The map changes according to the variable you set, such as isolating only the University personnel and representing varying degrees of connections, as shown in the second and the third image above. It can also run analyses to find the nodes with the most connections and many other functions (which can be represented via node size, as shown in the last image). It can also be categorised and tagged into various groups to work through overwhelming and complex data sets. Image credit: Kevin Kuriakose. See this Kumu map: https://kumu.io/BASP-2020/basp#aaa-research-mapping (instructions on how to use the map: https://aarch.dk/en/interactive-map/).

2.3 Mappings for Urban Seascaping with seaweed in Vejle

Designers could help to address what are essentially spatial and organizational conflicts by translating these highly complex, interconnected issues into visual resources. New kinds of communicative drawings could emerge, analogous to those that organize terrestrial environments, but with an inherent temporal dimension. Though some may argue that mapping is not central to design, especially when it is focused on the ocean, this kind of deep, cross-disciplinary mapping is essential for understanding the climate changes ahead and our ocean's potential role in addressing them.

Jeanne Gang, Claire Cahan and Sarah Kramer, *Deep Mapping* (Gang, Cahan and Kramer, 2016, pp.87–88).

According to Langer (2014), navigational tools (i.e. mapping) and strategies help to successfully position and navigate design research within a dynamic relational spatial nexus of urban landscapes (Langner, 2019, p.50). In this research, this nexus refers to the boundary between land and sea in Vejle. Thus, the Kumu maps presented in this project have been specifically developed to provide a hybrid master map that curates and hosts various information within this context. Thus, the intention is to utilise these maps to conduct contextual deep site analyses that can develop a comprehensive reading of the complex characteristics of Danish seascapes qualities, all with the overarching aim of restoring marine ecologies as part of East Jutland's future urban development.

Three main Kumu maps were created (see Figure 43 and Table 2 for an overview), which became a method of analysis, review and exploration to answer the research questions and as a curatorial storytelling tool for research dissemination. The beauty of Kumu maps is that they are never meant to be completed but an ongoing process that can evolve in size and complexity with more inputs. The first Kumu map is used as a multiscalar master map to host, connect and arrange various scales that can relate to the immediate site in question (i.e. Vejle) and which can be applied to analyse Kanten/The Edge competition design entries. Here, the Kumu maps are used as a detailed and elaborate site analysis showing the complex spatial relationships between the scales ranging from global to local. Each node hosts various mapping explorations and connections to other nodes (see section 2.3.1 for more details). The second Kumu map is a "state-of-the-art" (S-O-T-A) map that presents the different precedents nationally and worldwide (see section 2.3.2 for more details). The third Kumu map is the accumulation of the contents from the two maps into a timeline format with future scenarios to project design strategies for Vejle (see section 2.3.3 for more details). Table 2 below summarises the main purpose of each Kumu map developed for this research and the corresponding main categorisation of the nodes. The materials embedded into these nodes from the three maps have been extracted and represented throughout this monograph[107].

107 However, not all the materials contained in the three maps are covered in this monograph; therefore, readers are encouraged to explore the Kumu map online.

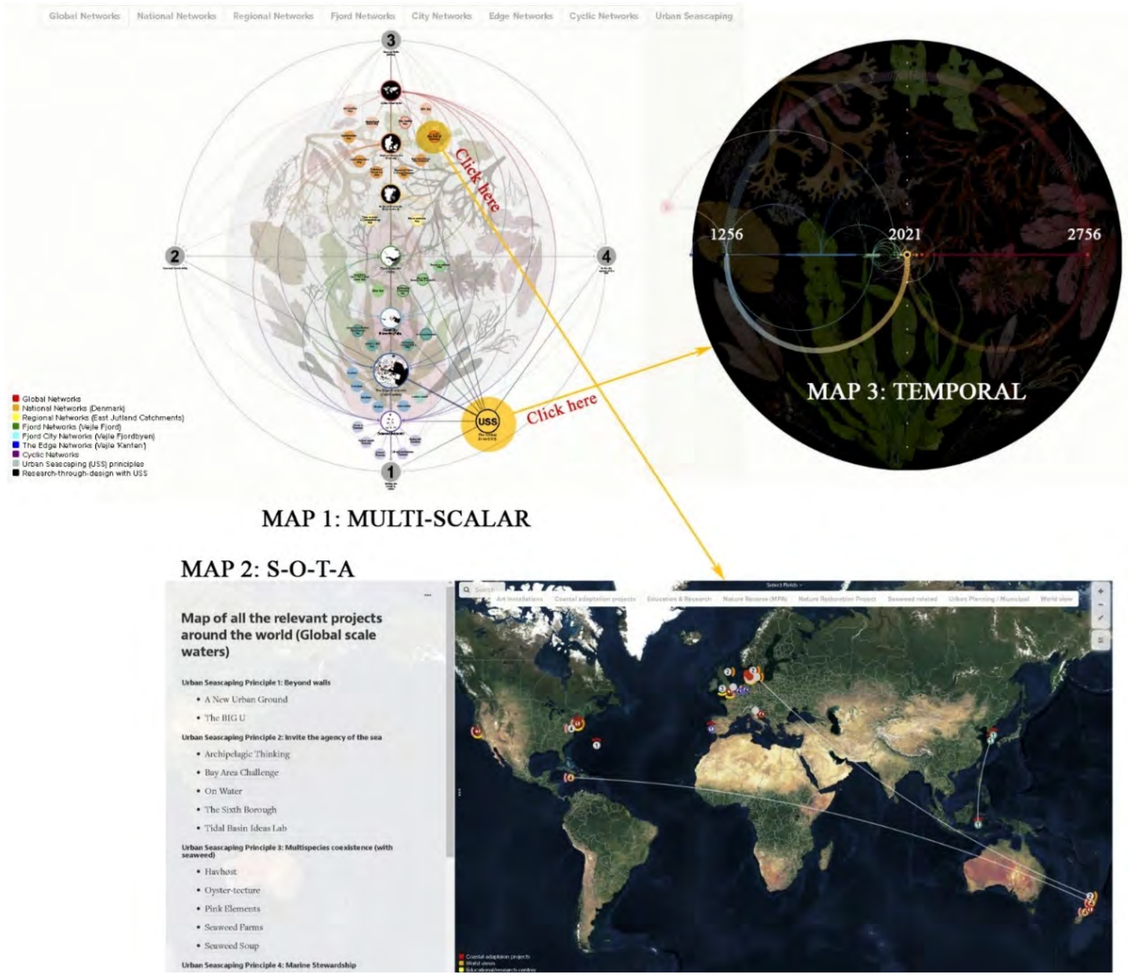
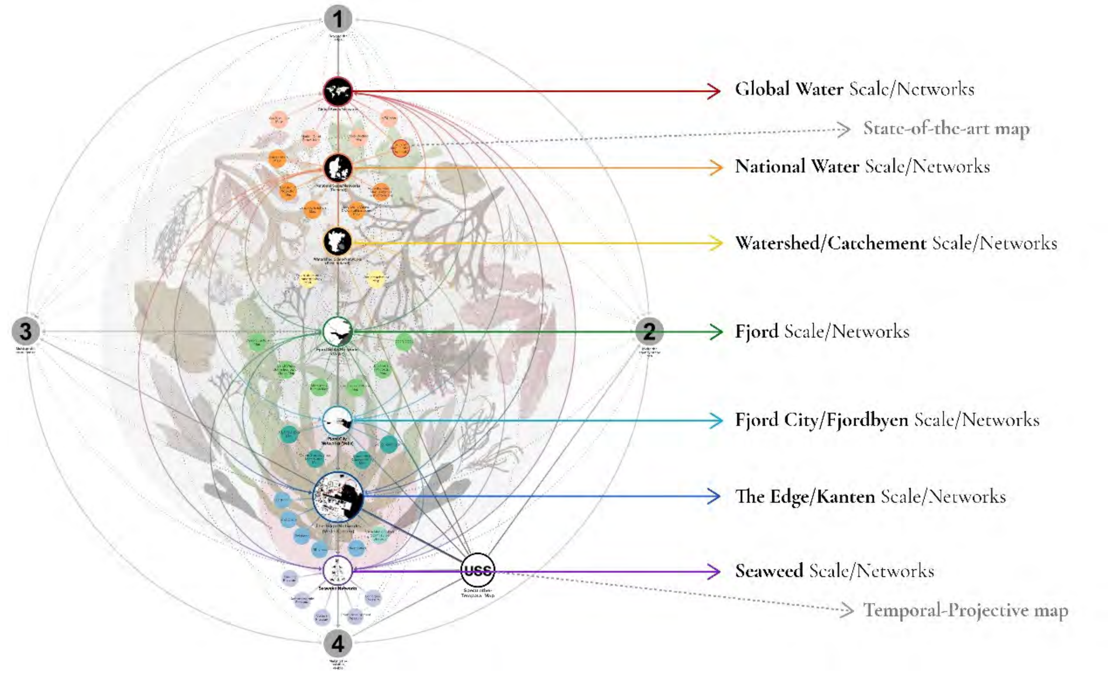


Figure 43. There are three main Kumu maps. The main map is the multi-scalar map (i.e. contextual analysis centred around Vejle), the second map is the S-O-T-A map (i.e. mini-case studies), and the last map is a temporal map (i.e. projective and scenario-based strategies for Vejle).
To access the online Kumu maps, visit www.urbanseascaping.com (password: tang), as shown in Figure 3.
Understanding the workings of these Kumu maps will make more sense in Part IV of this research.

Kumu map types	*Purpose*	*The main categorisation of nodes*
MAP 1 – Multiscalar *(Refer to section 2.3.1)*	To analyse Kanten/The Edge design competition winning entries as detailed multi-scalar site analysis with its associated connections. The multi-scalar approach is from	Seven major scales were determined for this map. They are: 1. Global water scale/network[108] 2. National (Denmark) water scale/network

108 I have decided to use the term both scale and "networks" as categorisation markers as it is not only about different territorial scales that are of concern, but also the network (inter-relationship) between the different scales. While the organisation of the different scales is linear in a vertical plane, the approach is to also make the map more intuitively navigable by users (i.e. municipal members and practitioners), who may be more used to conventional linear and hierarchical progression of scale (i.e. macro to micro and vice versa).

	the perspective of water bodies with seaweed as the focal lens in the main context of Vejle. The various nodes are informed by the USS propositions/concept.	3. Watershed/Catchment scale/network (Region of East Jutland) scale/network 4. Vejle Fjord scale/network (inner to outer fjord including the river valleys) 5. Fjordbyen/Fjord city (inner fjord) scale/network 6. The Edge/Kanten scale/network 7. Seaweed (cyclic) scale/network



MAP 2 – S-O-T-A *(Refer to section 2.3.2)*	To review the relevant state-of-the-art precedents, policies and ontologies/world views from around the world to aid the development of the USS proposition/concept and as a mini-case study analysis. The focus is on projects that integrate water and marine life (i.e. seaweed) in various ways that could help answer the research questions.	1. Art installations 2. Coastal adaptation projects 3. Education & Research (i.e. marine stewardship) 4. Marine nature reserves (i.e. MPA) 5. Marine nature restoration projects 6. Seaweed related initiatives 7. Urban Planning/Municipal strategies and policies (i.e. blue urbanism related) 8. World views (i.e. alternative ways of viewing the water and marine life) 9. A business-as-usual (B-A-U) approach to urban development in coastal cities[109]

109 This sub-category is an anomaly to the other S-O-T-A cases, where it is looking at the various projects that contribute to the current wicked problem of urban development. The mini cases from this category are mentioned

MAP 3 – Temporal-Projective *(Refer to section 2.3.3)*	To understand the consequences of previous urban development decisions in contributing to today's wicked problems in Vejle (i.e. issues with sea level rise, frequent storm surge and the ecological degradation of the fjord). Moreover, Map 3 is used to aid short to long-term scenario-based strategies for Vejle Fjordbyen's future developments guided by the USS propositions and learnings from Maps 1 and 2.	1. **PAST:** Nodes representing the various significant periods for Vejle, ranging from the conception of the city of Vejle in 1256 to the waterfront (Fjordbyen) development boom during 2009-2018. 2. **PRESENT:** The node in the centre of the map represents the duration of this PhD: 2019-2022. The central node is used as a reference to understand the decisions of the past that led to the urban conditions of the present and how the present conditions could impact the future. 3. **FUTURE:** Significant future climate deadlines, especially ones mentioned by the IPCC: 2030, 2050, 2100 and Vejle's Storm surge Strategy deadlines: 2025, 2030 and 2070. Projective design and development strategies based on this research are embedded into three main categories of nodes - short, medium and long-term strategy.

throughout this monograph (for e.g. the hard concrete edge conditions in the waterfront areas of Danish coastal cities, such as Middelfart, Aarhus and Vejle).

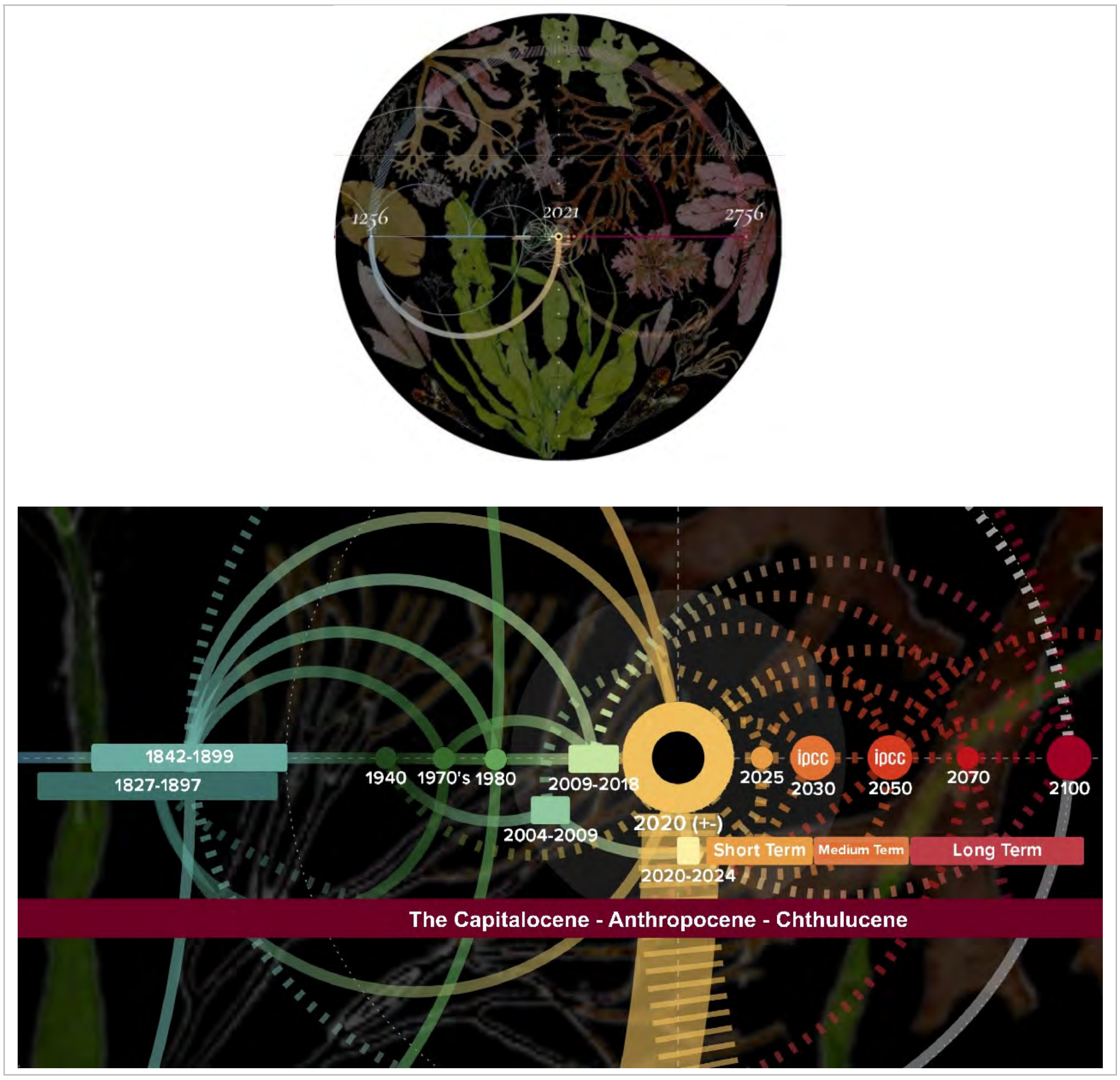


Table 2. Summary of the content and the purpose of the three Kumu maps created for this research.

The following sections will elaborate on the methodological reasons behind the overall structure and the operation of the three main maps to show how these maps worked as investigative, analytical and projective tools contributing to the RtD method[110]. It is important to note that Kumu as a mapping tool has been re-appropriated to be used differently from the program's original intention of being more as a social network map to incorporate territorial forms of mapping used in the design disciplines into the network map.

110 Also refer to the section: Preface: The online format of the research – Website and Kumu map.

2.3.1 MAP 1 (Master map): Multi-scalar Map – A critical analysis of Kanten/The Edge competition

The main multiscalar map is divided into seven[111] major scales/network nodes, as shown in Figure 44 below. The maps span from the node at the top, which refers to the macro level – Global scale/network (in red) – to the node at the bottom, which refers to the micro level – Cyclic scale/network (in purple), as shown in Figure 44. These different scales are conceived from the viewpoint of a particular water body and its corresponding networks. For instance, the global water scale/network pertains to the global oceans, where the increasing ocean warming and acidification are impacting kelp to move to the colder waters of Scandinavia, representing the national scale/network level. Although the map is organised hierarchically in a verticle line, as shown in Figure 44, the connections between the various scales/networks are circular, highlighting that these scales/networks affect each other in a non-linear way. The different scales should be read more as a spectrum (a categorial fluidity). For instance, the agricultural runoff at a regional watershed scale/network level impacts the Vejle Fjord scale/network and then eventually flows to the larger water bodies of Danish national waters showing the interconnectedness of the different scales.

As will be apparent in section IV, in which I analyze the design entries of Kanten/The Edge competition, the main intention of Map 1 is to *start* the analytical journey from the smallest "Kanten/The Edge scale/network" level only to progressively go beyond the site of concern by zooming in and out through the different water scales/networks. Thus, the "Kanten/The Edge scale/network" node is highlighted as the biggest blue node, as shown in Figure 44 below.

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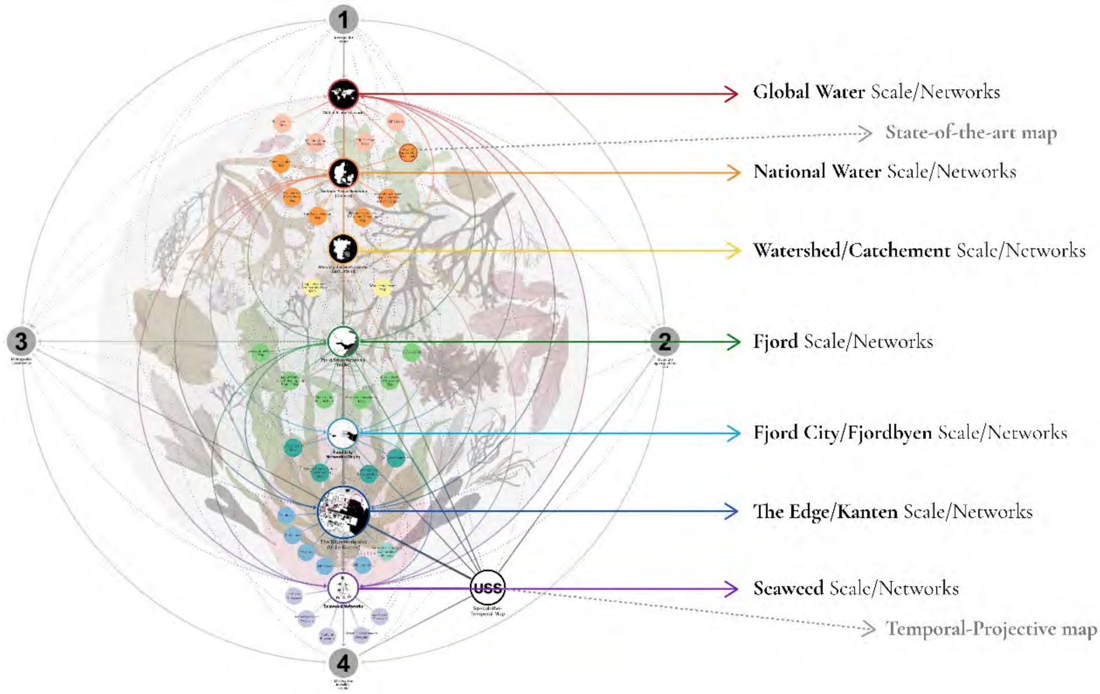
111 Reason behind the choice of seven major scales: During the contextual analysis process (literature review), it was apparent that when considering the integration of marine life such as seaweed in Vejle, several factors outside of the immediate site of concern (i.e. Kanten/The Edge scale from the competition) determined the success of seascaping with seaweed as part of marine nature-based solution. For instance, global warming had an impact on the chance of survival, stretching the site of concern to a global scale, while at a micro/cyclic level, the unbalanced food web in Vejle Fjord of exploding crab population had an impact on the survival of seaweed (as food for crabs). Therefore, the global and the seaweed (micro/cyclic) scale/network determined the maximum and minimum ends of the multi-scalar approach. Moreover, the national scale/network became relevant as the aim of the research contribution is to be able to be applied to other contexts in Denmark and that urban development model for coastal cities in Denmark have followed a similar path. The regional watershed/catchment scale became an important scale as it determined the source of water pollution and its influence on the corresponding water body (i.e. Vejle Fjord). Seeing Vejle Fjord along with its river valley as a whole became an important scale/network to consider as implementing marine nature-based solution required interventions upstream (i.e. river and streams) to catch the pollutants before they entered the fjord, and certain types of seaweed (i.e. kelp) required deeper waters of the mid-outer fjord for them to grow. Finally, Vejle's Fjordbyen and Vejle's Kanten scale/network was due to the result of working with Kanten/The Edge design competition.



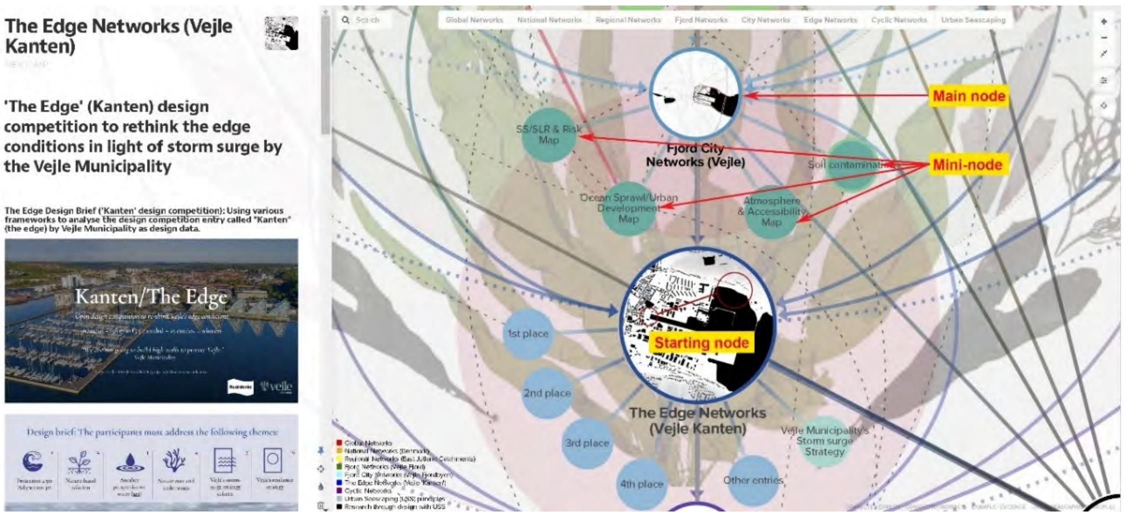


Figure 44. (Top image) Map 1 - Multiscalar map with the seven different types of scale/networks of water bodies bound by the four Urban Seascaping propositions. Each of the seven major scales (i.e. main nodes) is associated with "mini-nodes" that each contains various information that is relevant in aiding the analysis of Kanten/The Edge competition winning entries. The connection between the nodes is differentiated as direct connections/correlations are solid lines (coloured), and indirect connections/correlations are dashed lines (black). Each coloured circular node is embedded with maps, drawings, films, text and hyperlinks, which are shown in the left-hand panel that appears when you click on a node (as shown in Figure 45).
(Bottom image) Zooming into The Edge and Fjord City scale/network as the starting node and its associated mini-nodes.

Thus, each main node (scale/network) is connected (either by direct or indirect connections) to several corresponding mini-nodes hosting territorial maps based on various sources such as spatial data from GIS (see Appendix 1, Table 5 for all the source references) and other visual mediums[112]. A QGIS program was used to layer different information, embedding these into the corresponding mini-nodes, as shown in Figure 45. For instance, Figure 45 shows a close-up of the National Scale/Network node with six corresponding mini-nodes (i.e. Danish waters map, pollution and protection map, land reclamation map, Economic values and coastal exposure map, more-than-human map, and state-of-the-art project map). Some of these maps are recreated through QGIS and Photoshop/Illustrator, and some are directly referenced from other sources.

112 Such as texts, diagrams, drawings, videos, territorial maps, animated GIFs. Animated GIFs are used to show the various associations and changes between different factors that influence a particular territory. For instance, the pollution and protection map in Figure 45 (in Kumu map) is an animated GIF that changes from coastal water pollution to phosphorous concentration on land and nitrogen concentration on land due to agricultural activity.

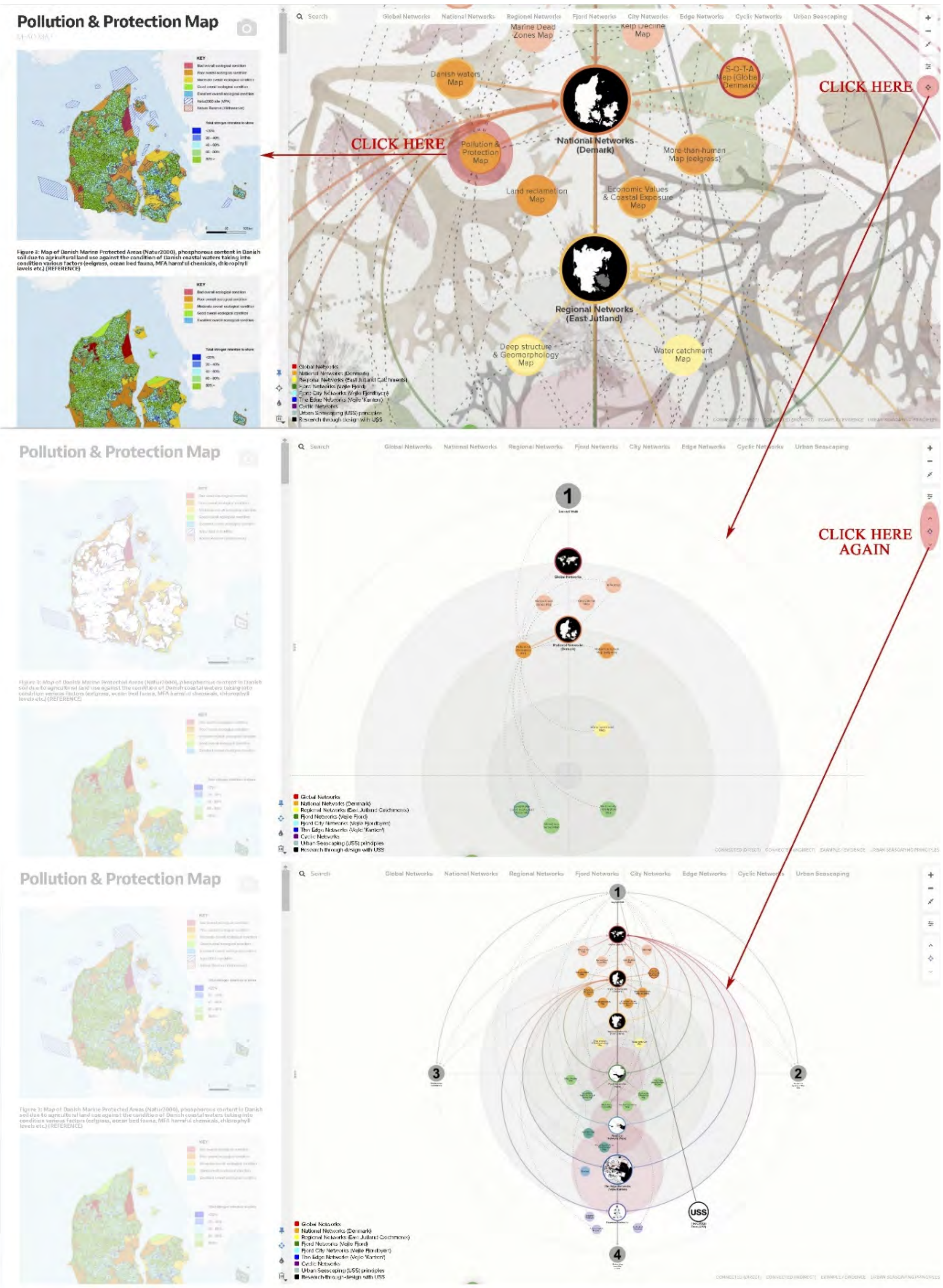
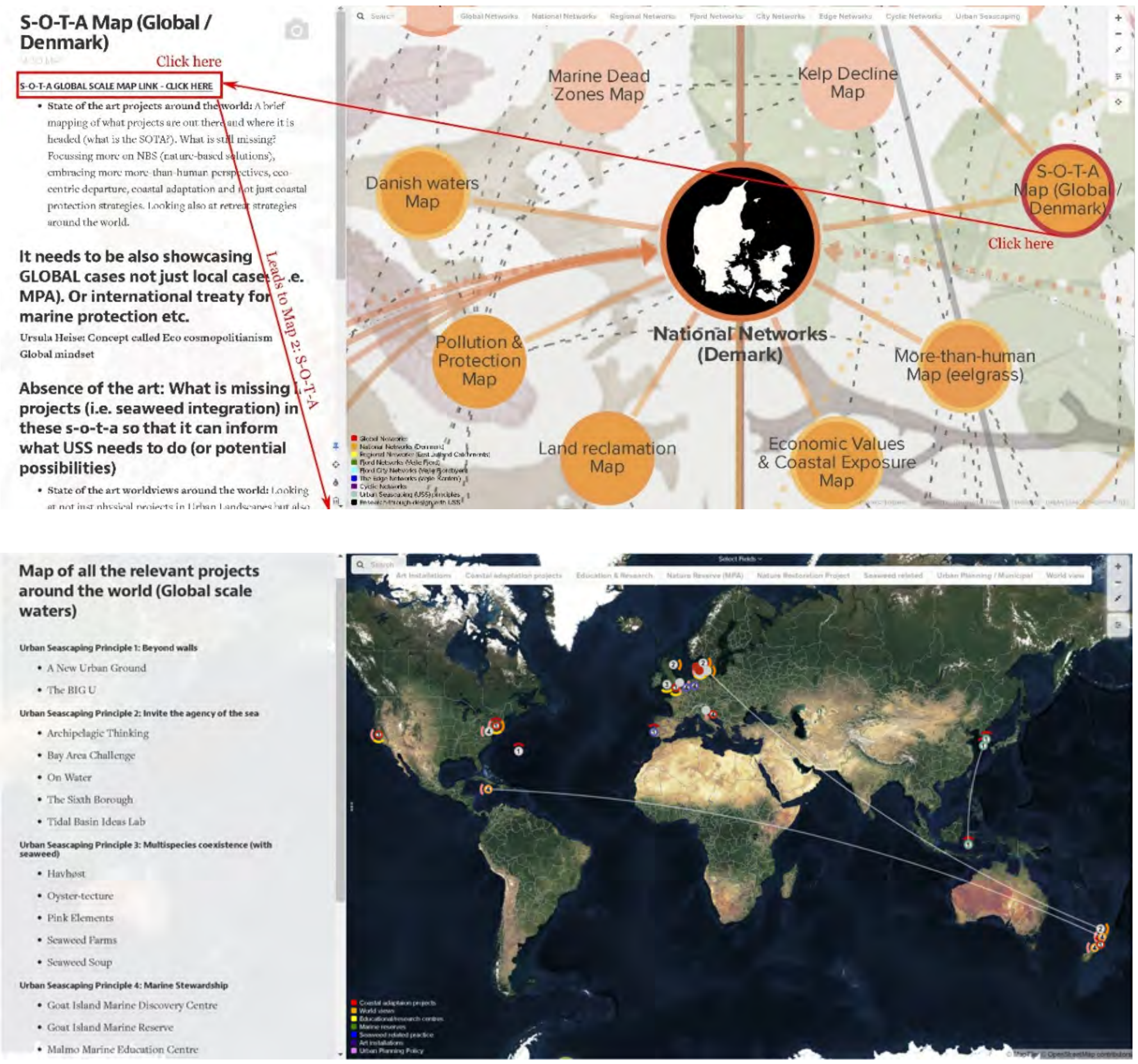


Figure 45. Showing the progression of how to isolate and see the various levels of connections of each node in the Kumu map.
(Top row image) Showing the main national scale/network node and its corresponding mini nodes. By clicking on the mini-nodes, the left-hand panel displays related information, such as maps and drawings.
(Middle and Bottom row image) By clicking on the arrows on the right side, the user can isolate a node and its corresponding degrees of connection degrees or by hovering over the node with the mouse.

2.3.2 MAP 2: The State-of-the-art Map: Mini case studies

Various "mini case studies" of state-of-the-art projects (S-O-T-A) (i.e. speculative, unbuilt and realised projects) and various ontological standpoints (i.e. theoretical and legal frameworks) have been referred to and discussed to support the arguments presented throughout this monograph. These have also been collated and consolidated into one geographical Kumu map under "S-O-T-A analysis", which can be accessed between the global and national scale/network nodes (see Figure 46 below).



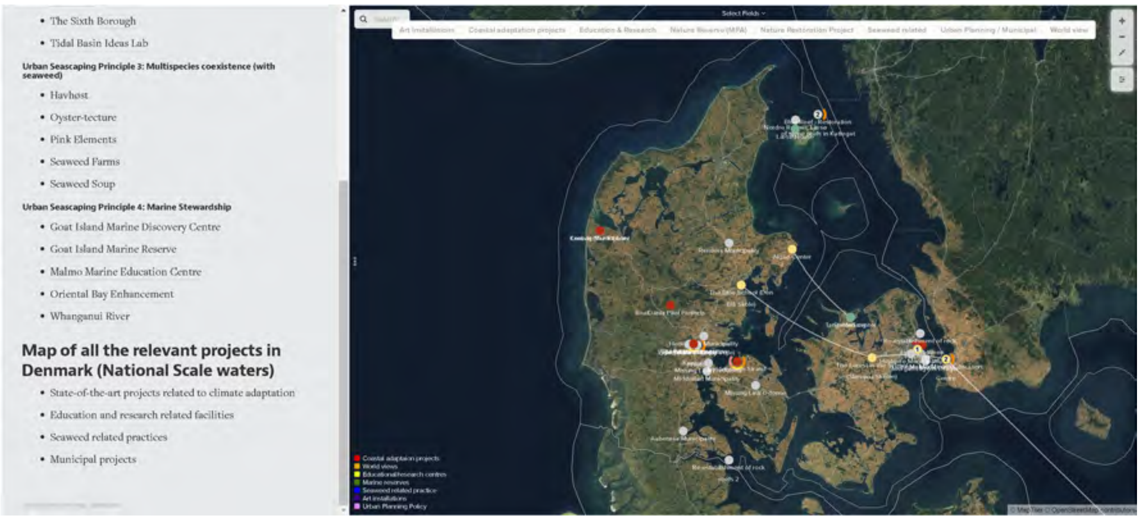


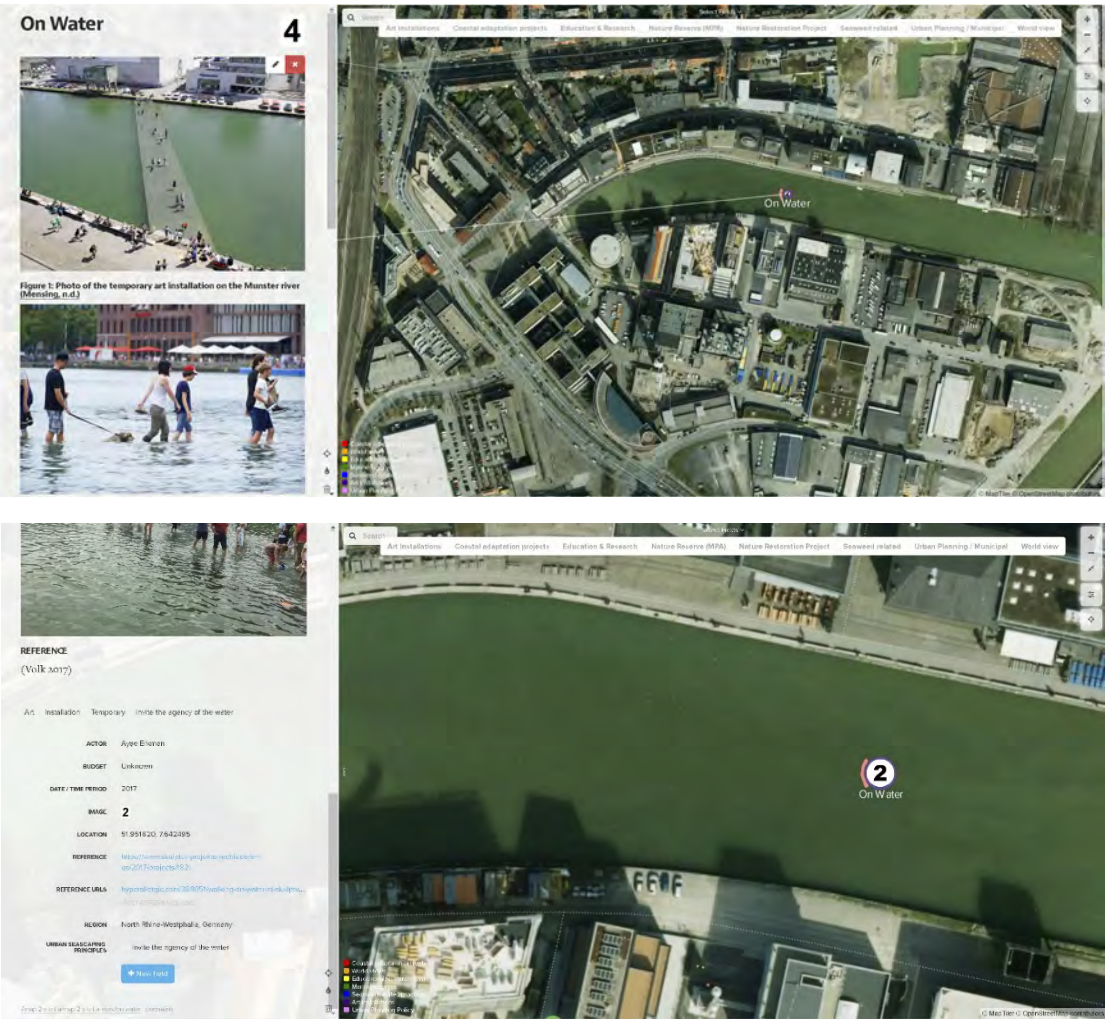
Figure 46. Critical survey of the state-of-the-art projects worldwide and in Denmark. This map is a geographical aerial photo of the world with various nodes embedded with relevant information. These nodes contain different S-O-T-A projects and ontologies, categorised and marked with a corresponding USS proposition it adheres to. For examples of the different S-O-T-A nodes, see Table 3 below.

These S-O-T-A projects worldwide were mapped as nodes with connection lines to other relevant nodes in the Kumu map. They are defined and categorised into nine main categories[113] that aid in exploring the Urban Seascaping propositions and answering the research questions presented above. The criteria for selecting relevant state-of-the-art works were based on whether they adhere to any of the critical propositions outlined by Urban Seascaping (see section 3.3[114]). Thus, these S-O-T-A projects have also been categorised according to the various USS propositions each of them adheres to, as shown in Table 3, category 1. Screenshots of some of the examples of various S-O-T-A projects in the Kumu map are shown in Table 3 below.

113 These nine categories (1. Art installations, 2. Coastal adaptation projects, 3. Education & Research, 4. Marine nature reserves, 5. Marine nature restoration projects, 6. Seaweed-related endeavours, 7. Urban planning/ municipal policies, 8. Alternative world views of water) were initially based on my attempt to look for precedents that could help answer the main research question. Therefore, category 2, 4, 5, 6, and 7 became relevant with its focus on coastal adaptation with marine nature (especially seaweed). Furthermore, in looking at Kanten/The Edge design competition brief as a case study, where it asked the entrants to consider alternative views on water, artistic and educational merits (see section 4.1.1 on the competition brief), category 1, 3 and 8 became relevant.

114 The four main critical propositions of Urban Seascaping are: First, "multispecies coexistence (i.e. with seaweed)", second, "invite the agency of the sea", third, "beyond the edge" (i.e. beyond hard approaches to coastal adaptation) and last, "make the invisible (marine realm), visible." See section 3.3 for the development of these four main USS propositions.

<table>
<tr><th>Nine main categories of S-O-T-A</th><th>Different manifestations of the category</th><th>Examples of actual and/or hypothetical projects</th></tr>
<tr><td>1. Art installations</td><td>i.e. urban artistic sculptures or initiatives that integrate the agency of the water and/or marine lifeforms.</td><td>e.g. A temporary artistic installation bridge called “On water” by Ayşe Erkmen in Münster, Germany, where Erkmen uses the submerged bridge to engage with the water differently by getting the citizens to get their feet wet.</td></tr>
<tr><td colspan="3">Refer to the node in Münster, Germany, called “On Water” in the Kumu map. This precedent has been referred to in Part III, Section 3.2.4, Figure 90 (see the example screenshot below).

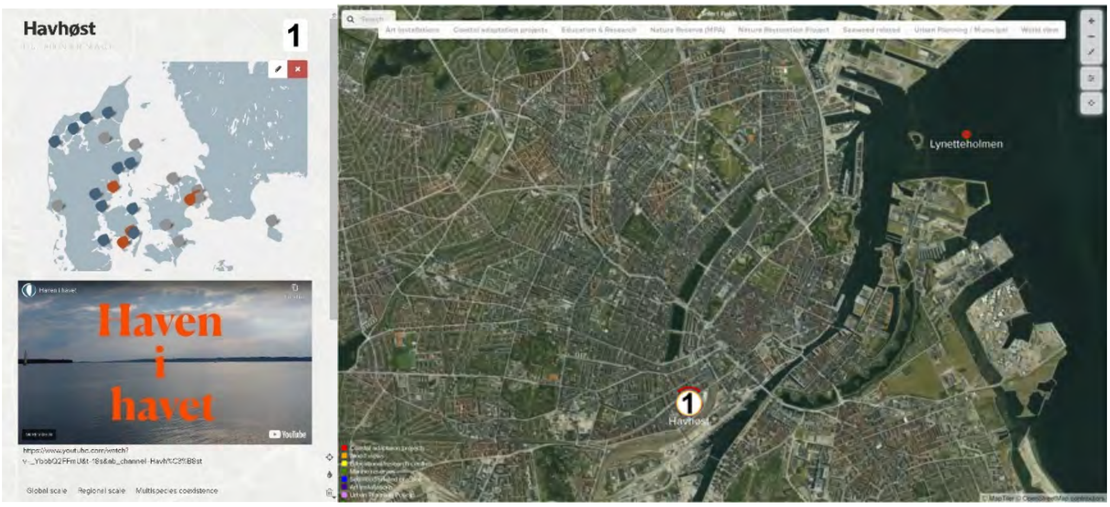


NB: This project adheres to the second USS proposition of “inviting the agency of the water” (labelled number 2 and in pink border) by utilising the water as part of the design and experience. This project is an art installation (in purple) and, therefore, is categorised as such. Each node contains basic facts about the project, such as the main actors involved, budget (if known), year of completion, location/region, references, and which USS proposition it adheres to.</td></tr>
</table>

<table>
<tr><td>2. Coastal adaptation projects</td><td>i.e. soft approaches, hybrid approaches, (marine) nature-based solutions, blue commons, blue infrastructure, water-sensitive urban design, coastal adaptation, etc.</td><td>e.g. Project such as the New Urban Ground in NYC is an unbuilt state-of-the-art coastal adaptation project using nature-based solutions such as wetlands.</td></tr>
<tr><td colspan="3">Refer to the node in NYC, USA, called "A New Urban Ground" in the Kumu map. This precedent has been referred to in Part III, Section 3.2.3, Figure 88 (see the example screenshot below).


NB: This project adheres to the first USS proposition of "multispecies coexistence" with wetlands (labelled number 1 and in red border) and the third USS proposition of "Beyond walls" (in yellow border) through nature-based solutions and increasing permeability through greening the streets.</td></tr>
<tr><td>3. Education and research</td><td>i.e. marine stewardship, ocean literacy, marine centres</td><td>e.g. Malmo Marine Education Centre in Sweden, educates the public about ocean life through exhibitions, field trips, research dissemination and consultancy. Refer to Part I, Section 1.5.2, Figure 20.</td></tr>
<tr><td>4. Marine nature reserves (MPA)</td><td>i.e. marine protected areas (i.e. Natura2000) and coastal nature reserves</td><td>e.g. The Goat Island Marine Reserve in New Zealand, demonstrate the positive impact on local biodiversity.
Refer to Part III, section 3.2.4, Figure 98.</td></tr>
<tr><td>5. Marine nature restoration project</td><td>i.e. artificial coastal lagoons,</td><td>e.g. Gyldensteen Strand in Fyn was a former wetland converted into farmland via land reclamation, and dikes were reflooded into a coastal lagoon to form a new marine habitat and an education centre. Refer to Part III, section 3.2.4, Figure 95.</td></tr>
<tr><td>6. Seaweed-related endeavours</td><td>i.e. sea gardens (for food), art, education, traditional cuisine, and cultural practice of seaweeding</td><td>e.g. Havhøst sea gardens growing and promoting seaweed and mussels as sustainable local food sources across Denmark. They host various educational activities across the country.</td></tr>
</table>

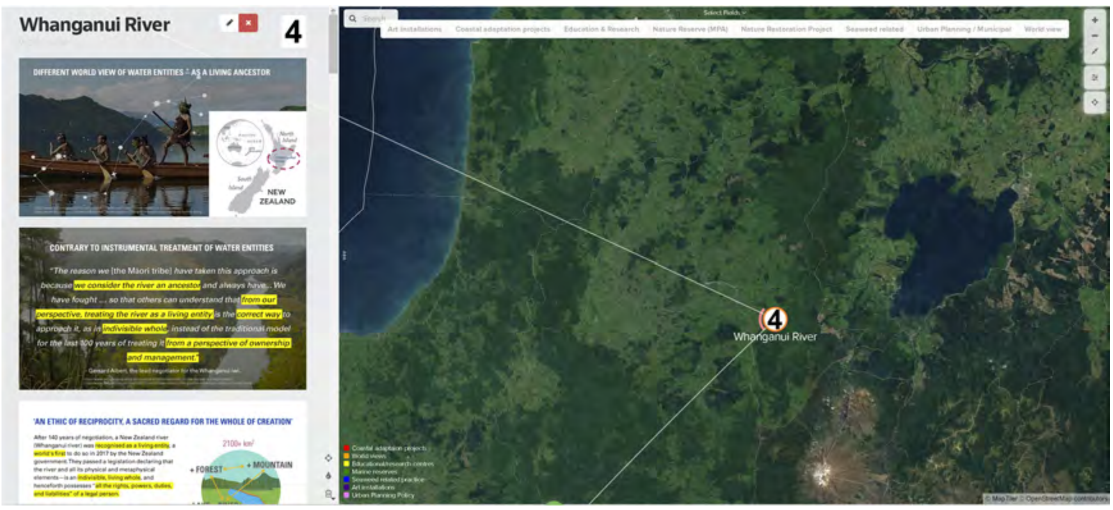
Refer to the node in Copenhagen, Denmark, called "Havhøst" in the Kumu map. Also, This precedent has been referred to in Part I, section 1.5.2, Figure 20 (see the example screenshot below).



NB: This project adheres to the first USS proposition of "Multispecies coexistence" (labelled number 1 and in red border) and the fourth USS proposition of "Making the invisible visible." These two propositions are met through the implementation of the "bølgemarken" (wave market), a floating platform that allows the interaction between humans and nonhumans.

7. Urban planning/ municipal policies	i.e. Urban planning regulations, policies,	e.g. The Six borough as an urban planning proposal to consider the coastal waters of NYC as a borough like land-based ones. Refer to Part III, section 3.2.5, Figure 100.
8. Alternative world views on water	i.e. ontologies and epistemologies that present an alternative understanding of water	e.g. Whanganui River in New Zealand has been granted legal personhood, which is an example of an intrinsic value proposition of a natural entity in light of the Maori worldview of viewing nature as a human, a family member.

Refer to the node in Whanganui, New Zealand, called "Whanganui River" in the Kumu map. This precedent has been referred to in Part III, section 3.2.5 (see the example screenshot below).



NB: This project adheres to the second USS proposition of "Inviting the agency of the water" and the fourth USS proposition of "Making the invisible visible" by recognising the river's invisible entity as a living being into the visible realm via policy (i.e. legal personhood status).		
9. B-A-U / status quo of urban development in coastal cities	i.e. territorial bias, hard approaches to coastal protection, land reclamation projects (ocean sprawl),	e.g. Lynetteholmen and Aarhus Bugt land reclamation projects and waterfront development models such as Aarhus Ø (Aarhus Docklands). Refer to Part III, section 3.1.5, Figure 60.

Table 3. Eight main categories for the critical survey and review of the state-of-the-art precedents that support USS propositions, and another category (9th) to critique the current B-A-U development model in coastal cities. These S-O-T-A and B-A-U cases are presented throughout the monograph to support a particular argument in various chapters.

The S-O-T-A categories presented in this map focussed on looking at alternative approaches to waterfront/harbourfront development, different responses to SLR/SS in coastal cities and ways to integrate and protect marine life. For instance, S-O-T-A Category 2 (Coastal adaptation projects) looked into projects that went beyond the typical hard approaches (based on the third USS proposition of "Beyond the edge"). This meant investigating projects that are soft approaches, including marine nature-based solutions such as integrating salt marshes, oysters, mussels, and seaweed into the urban realm. Within the existing body of research, these "soft approaches" are less explored than the well-known engineered "hard approaches". As such, this area of development represents a research gap that I argue needs to be explored further. While the soft nature-based solutions are typically in the realms of marine biologists (but not excluded from the analysis), I have looked specifically for design projects by architects, landscape architects and urban designers in an effort to situate these within the LUPD disciplines. Many of these S-O-T-A projects are new, speculative and unbuilt projects (or in the process of construction). Moreover, they are mainly examples from the developed world[115] due to their transferability and relevance to the Danish context. However, it was not only limited to them.

For the Danish context, relevant S-O-T-A projects included pilot projects from Realdania (i.e. "Cities and the rising seawater" initiative from category 2, refer to Figure 46), seaweed educators (i.e. Havhøst from category 6) and large-scale land reclamation projects as coastal protection (i.e. Lynetteholmen from category 9) to name a few.

115 For instance, due to the aftermaths of catastrophic events, such as Hurricane Sandy in NYC and Hurricane Katrina in New Orleans, there has been numerous coastal adaptation projects from the United States of America.

2.3.3 MAP 3: Temporal-Projective Map for future strategies in Vejle

Any struggle for multispecies justice – justice for the humans and nonhumans that inhabit cities together - emerges from the juxtaposition of these divergent maps and their combination with compelling narratives about multispecies pasts, presents, and futures.

Ursula Heise, *Mapping Urban Nature and Multispecies Storyworlds in Design with Nature Now* (Heise, 2019, p.92).

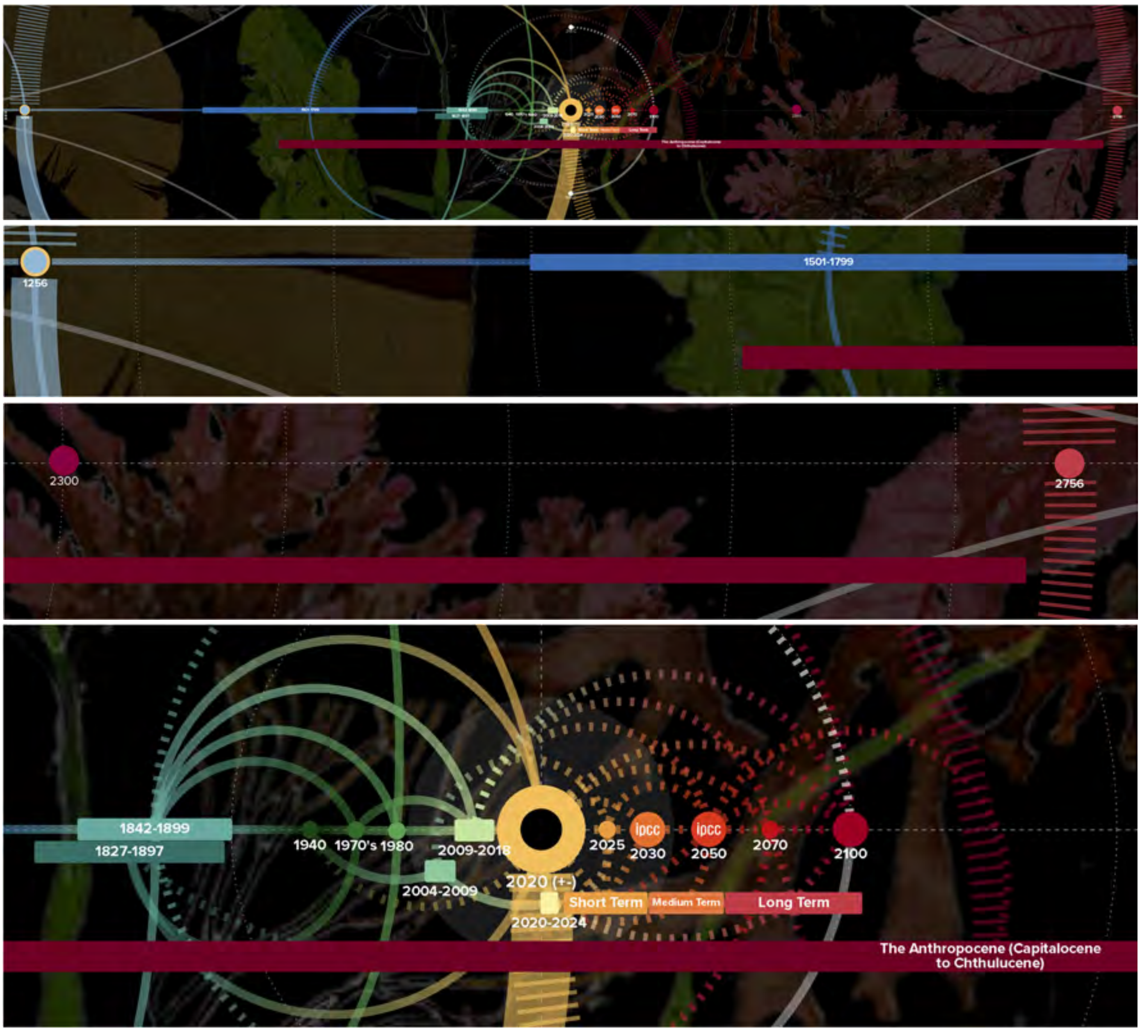


Figure 47. Map 3 is a temporal, projective mapping centred around the present time of this research, from the year 2019 to 2022, represented in a big yellow node for the city of Vejle. The map ranges from the initial conception of Vejle in 1256 to the present day (2020+-), mirroring this period all the way to 2756. Each century is marked on the vertical plane (i.e. 19th, 20th, 21st century and so on), while the timeline is presented on the horizontal plane. There are three major future scenarios: short, medium to long term, based on the IPCC and Vejle Municipality's Storm surge Strategy report's deadline (i.e. 2025, 2030, 2050, 2070).

How to do Urban Seascaping in Vejle with seaweed

The third Kumu map (MAP3) is a reconfiguration of the learnings from the two first maps. This map seeks to construct new perspectives and projections of the urban seascape in Vejle. The design of this map is not only addressing what used to be (past) or what currently exists but also a basis for possible courses of action and making them communicable. According to Langner (2019 and Seggern (2008), the performative character of mapping is a process of understanding the learnings of the past and the present to project the future to construct new meanings that can ultimately lead to action. Thus, the map offers a proposition of how Urban Seascaping might manifest itself in Vejle's future scenarios.

The intention of this map is to understand the relationship between various nodes from the multi-scalar and S-O-T-A maps from a temporal perspective. For instance, there is a relationship between the start of land reclamation of Vejle's harbourfront/waterfront into Vejle Fjord since the 1800s and the future challenges of protecting these land-reclaimed areas (i.e. Fjordbyen) from future storm surges and sea-level rise due to climate change. This type of consequential long-term perspective has been addressed by Wiberg et al. (2022), as illustrated in Figure 48, who argue that the decisions made to develop many Danish coastal towns in low-lying swampy marshland or/and at the bottom of the river valley as early as the 11th– 14th century still have an impact to this day. Although the current urban development models since the initial conception of these coastal market towns have changed significantly (i.e. from the 11-14th century to the 21st century), contemporary coastal towns/cities are dealing with outdated and inflexible infrastructure and buildings (i.e. canals, roads, sewage etc.), issues with ownership, field boundaries and the enormous task of protecting a sizeable city against the consequences of developing in areas vulnerable to water (Wiberg et al., 2022). Thus, the desired outcome of this map is to make visible how the decisions we make today have consequences in the distant future, much in the same way that we are still dealing with the decisions made several hundred years ago. Therefore, Wiberg et al. (2022) highlight that the usual future timespan of 50 years[116] might not be sufficient to plan adequately to deal with the consequences of climate change and issues with water.

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116 Vejle municipalities' coastal protection strategies are planned with SS and SLR predictions for 2025 (short term) and 2050 (medium term), with little strategy for 2070 (long term) (Vejle Municipality, 2020c)(refer to section 4.1.1).

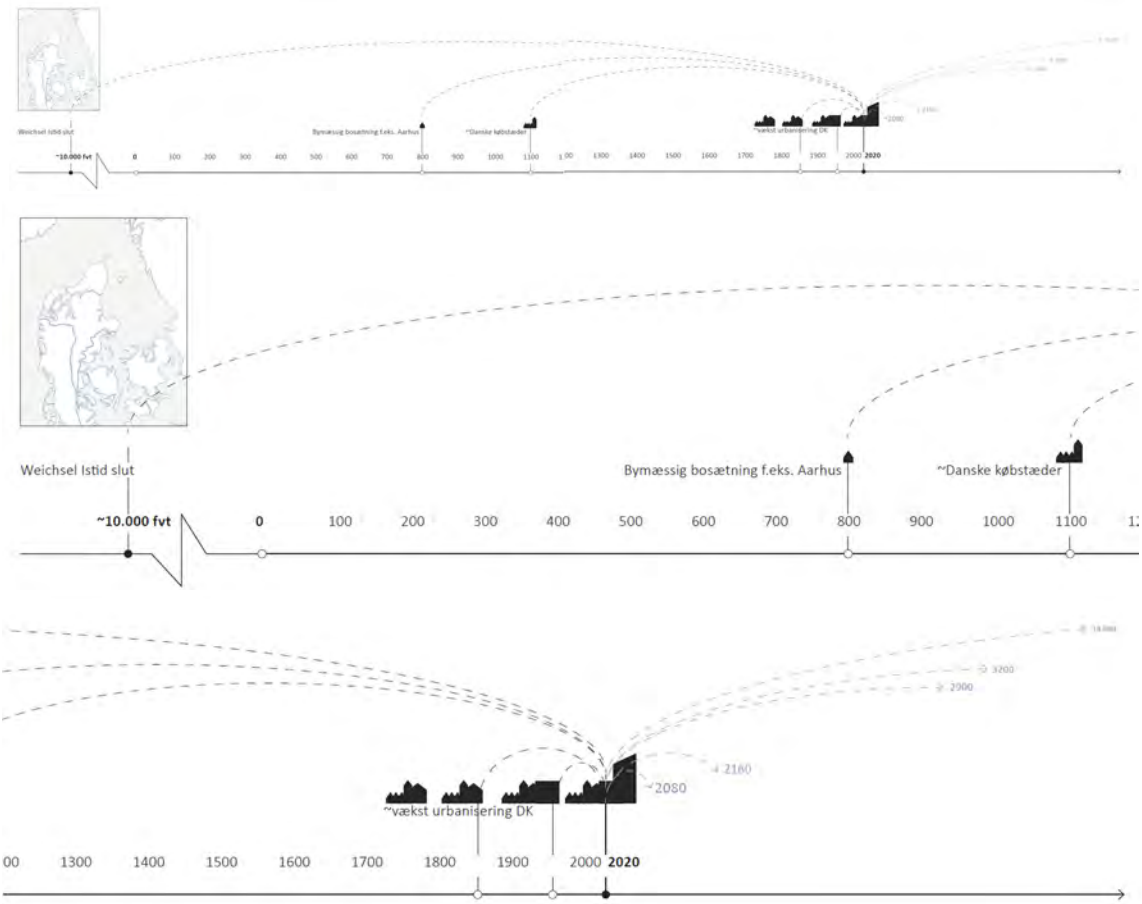

Figure 48. This timeline illustrates the long history of Danish coastal cities. For example, Aarhus was part of coastal market towns from the 1050s to the 1300s. Historic decisions on infrastructure and issues surrounding urban development still influence contemporary realities of coastal cities - even though the city has undergone a significant urban transformation. The timeline illustrates that the decisions made several hundred years ago impact the present; thus, there is a potential that present decisions could have consequences farther into the future than we predict (Wiberg et al., 2022). Image credit: Katrina Wiberg (Wiberg et al., 2022).

Therefore, the methodologically speaking consequential timeline perspective by Wiberg et al. (2022) has been adopted for this temporal-projective map for Vejle for Part IV of the research in aiding future coastal adaptation strategies and waterfront development models for Vejle. First, I mapped the significant past events that have compromised or reinforced the city of Vejle's current situation with future scenarios of water issues (i.e. SLR/SS) and the ecological health of the fjord. Second, I mapped the future timeline (post 2020+-) with the two IPCC deadlines of 2030 (half global emissions) and 2050 (net carbon zero), along with Vejle Municipality's Storm surge strategy's[117] proposed short-term (2025), medium-term (2050) and long-term (2070) plans (Vejle

117 Vejle City Council decided in 2016 to prepare a storm surge strategy, which designates a direction for how Vejle should protect itself in the future. On 9 December 2020, Vejle's storm surge strategy was adopted by Vejle Municipality. The adoption follows a public consultation period from February to September 2020 (Vejle Municipality, 2020c).

Municipality, 2020c). Finally, the last additions to the map are the three main projective explorations of coastal adaptation strategies for Vejle Municipality.

The analytical contents from the temporal-projective map are covered in Part IV to present alternative coastal adaptation strategies based on Urban Seascaping propositions in the context of Vejle (see section 4.2).

Figure 49. Close-up view of the main structure of the temporal-projective map centred around the present period of 2020+- (in yellow), with the left-side nodes as past events (in green) and the right-side nodes (in red) as future scenarios, deadlines and projections.

The connections between the nodes are indicated by a solid line representing causal relationships from the past and a dashed line representing speculative causal relationships in the future. The connections (solid and dashed lines) also hold information (by clicking on the lines) that shows the details of the causal impact of past decisions on the present and the future. Moreover, The nodes can automatically be isolated with varying degrees of connection by hovering over the nodes or changing the degree of "focus" on the right-hand menu (circled in red in Figure 50).

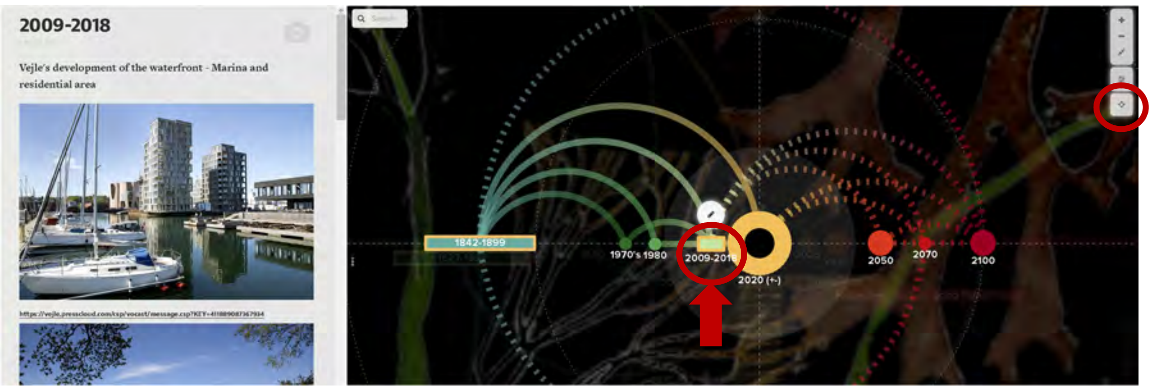

Figure 50. An example of a time node (2009-2018 – see red arrow) has been isolated to show only its connecting nodes by hovering the mouse over it (or by clicking on the focus button on the top right-hand corner in red). Therefore, this screenshot only shows all the connected time nodes to 2009-2018, such as the influence and connection to the nodes: "1842-1899", "1970s", and "1980s" in the past. A dashed line represents future connections, such as to 2050, 2070 and 2100, which indicates the impact of the current waterfront development on the future predicament of protecting Vejle from a future rise in sea level and frequent storm surges. These time nodes address urban development patterns in relation to that period's legal, socio-cultural and economic factors.
Image credit: Nils Rosenvold (n.d., n.d.).

To conclude

The traditional role of designers is changing. With the increasing importance of addressing climate change-related issues, designers are more than ever before required to deal with increasing complexities from a trans-disciplinary perspective. In turn, transdisciplinary research requires unifying frameworks that can synthesise and embrace the different epistemologies, concepts, values and methods from different disciplines. Therefore, developing new ways of understanding, representing and navigating these complexities is critical, especially in the visual medium.

To address this issue, multi-faceted hybrid Kumu maps were developed for this research. The maps are provided as a means of answering the research questions, which are examined through the aforementioned research-through-design methodology.

Moreover, it is important that the Kumu maps as (geo) visualisation and analytical tool are situated in relation to the corresponding theoretical and critical discourse (which is addressed in Part III). Therefore, this research develops both an act of mapping (i.e. Kumu maps) and a telling of a story narrative (i.e. ethical and critical proposition of Urban Seascaping) that each influence each other. Furthermore, the development of the hybrid, multiscalar, temporal, networked mapping tool extends the ability of the LUDP disciplines to analyse and speculate the various ways we inhabit the meeting place between city and sea, human and nonhuman (which is explored in Part IV). Therefore, Urban Seascaping (illustrated in Figure 51 below) explores the inter-relationships between various spaces, actors and mediums.

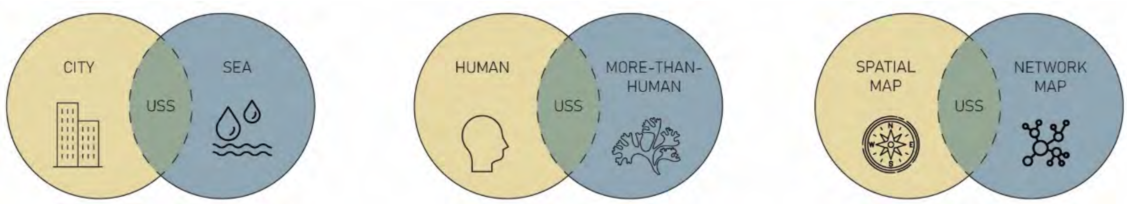

Figure 51. Urban Seascaping is a critical proposition and concept rooted in thinking from inter-relational and transdisciplinary perspectives. It is an approach to investigating the various inter-dependent relationships between city-sea (site/context/spaces), human-nonhuman (actors/stakeholders) and spatial-network maps (visual tools/ medium) in coastal cities. Urban Seascaping has a unique position of focusing on seaweed as the representative lens of the marine realm in the Anthropocene.

PART III: STATUS QUO & ALTERNATIVES

Introduction to Part III

Part III presents an overview of the dominant and alternative approaches to addressing the wicked problems of climate change's impact on coastal cities. The chapter starts with a critique of the current business-as-usual (B-A-U) urban development patterns of the last century, which have relied primarily on defence-based coastal protection systems. The chapter reviews examples from both the Danish context as well as several international cases. Reviewing these examples, the chapter focuses on how B-A-U developments obstruct the integration of marine life in coastal water bodies.

The latter part of this chapter is dedicated to representing the current alternatives. These approaches are primarily referred to as soft approaches and nature-based solutions, which include natural ecosystems as part of the coastal adaptation, both of which also have their limitations.

Finally, the chapter outlines the four main critical propositions of Urban Seascaping, which have been developed to depart from the current B-A-U approach. Taken together, these four principles aim to theorize waterfront development as a hybrid, interconnected and dynamic zone that incorporates marine ecosystems as an active part of the socio-cultural cityscape and future resilience in Danish coastal cities.

3.1 The Scale of the Problem

Figure 52. One month into my research, a 120-year-old, 23m tall lighthouse called "Rubjerg Knude" in Northern Denmark was relocated 80m inland at the cost of 5 million kroner (€670,000 approx.) due to coastal erosion in October 2019. When it was first lit in 1900, it was approximately 200m from the shore, but it shrank to only six meters 120 hundred years later. However, experts estimate that the lighthouse, with its new location further inland, will only be close to the edge again in approximately 40 years. This lighthouse became a visual symbol of sea-level rise and shoreline retreat in the 21st century (Associated Press in Copenhagen, 2019; Miljøministeriet Naturstyrelsen, 2022). Image credit: Hans Ravn (Ritzau, 2019).

(Extracted from Kumu S-O-T-A map – Rubjerg Knude node in North Jutland, Denmark).

3.1.1 The wicked problem of living on the edge

Even if emissions are reduced to limit warming to well below 2 °C, global mean sea level would likely rise by 0.3–0.6 m by 2100, and could rise 0.3–3.1 m by 2300. Even with climate stabilization, adaptation to this residual rise will be essential – adaptation strategies are needed where they do not exist – especially in low-lying coasts, small islands, deltas and coastal cities

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WCRP (WMO/IOC/ISC) *Sea-level Rise and Coastal Impacts*
(Met Office/WMO/WCRP, 2019).

As global warming increases, coastal cities will face the brunt of water-related issues. Not only is there no precedence to refer to in human history with regard to the current rate of sea-level rise, but there have never before been such huge coastal cities like New York, Copenhagen and Jakarta encumbered with waterfront developments and extensive infrastructures at low elevations to worry. Therefore, sea-level rise (SLR) is an urban problem that will impact land use of every sort, on parks, natural areas, transportation infrastructures, sewers, buildings, and thus people. "Each coastal nation has unique problems to solve in a time of rising sea level, depending not just on the physical and biological nature of its coasts but also on its resources, politics, and culture" (Pilkey and Young, 2011, p.131).

The severity of the impact of water in the future will depend on many complex factors, one of which is a significant need for global GHG reduction[118] (National Center for Atmospheric Research/University Corporation for Atmospheric Research, 2018). Unfortunately, the current emissions rate indicates that global temperatures are expected to surpass 1.5°C of warming[119] (IPCC, 2021). The predictions are now faring more towards the worst-case scenario and continued sea-level rise, contributing to the severity of more frequent and severe coastal storm surge events by the end of this century. As such, it is becoming increasingly likely that coastal cities will need to prepare for the inevitable.

This research focuses on low-lying coastal cities in Denmark that are particularly vulnerable to the impact of water-related issues[120] (CNN, 2015; Jebens, Sorensen, & Piontkowitz, 2016), not to mention worsening coastal erosion and shoreline retreat on Danish beaches (Arnbjerg-Nielsen, 2011; Jebens, Sorensen and Piontkowitz, 2016; Sørensen, n.d.). The challenges of addressing water-based issues in contemporary coastal cities in Denmark are exacerbated by the increase in urban densification that contributes to the rise in impermeable surfaces (as shown for the city of Vejle in Figure 53). These surfaces increase stormwater runoffs, amplifying the floods' impact. Worryingly, many existing urban infrastructures are not sufficiently designed to handle the uncertain impacts of climatic changes in the future (Zhang et al., 2018). Some examples are the old combined sewage[121] and stormwater drainage pipes in many Danish cities that will overflood in the event of storm surges (contributed by sea-level rise) and heavier cloudbursts. Another example is that many existing buildings (both old and new developments) in risk areas are not equipped to handle inundation and are inflexible to retrofit to adapt to future climatic changes. These properties in these vulnerable areas (such as Vejle - refer to Figure 6) run the risk of high costs for future water-related protection and damages (see Figure 53).

118 According to Pilkey and Young (2011), "due to the certain momentum of global warming and sea level rise, in the short term, reduction of GHG will not halt sea level rise. Therefore, we must expect that sea level rise will be with us for a long time" (Pilkey and Young, 2011, p.178).

119 The recent release of the sixth assessment report by the IPCC warns that radical, immediate and swift reductions in global GHG must happen within the next few decades as warming is accelerating (IPCC, 2021).

120 Many local and global factors contribute to the level of sea rise in each region, which is why the rate of sea level rise in different in various part of the world (Pilkey and Young, 2011). Denmark's adaptation strategy expects a sea-level rise of 0.1-0.5m by 2050 and 0.2-1.4m by 2100 (Olesen et al., 2014; DMI, 2018).

121 For the city of Vejle, the old combined sewers are planned to be updated after 2040 (Vejle Spildevand, n.d.).

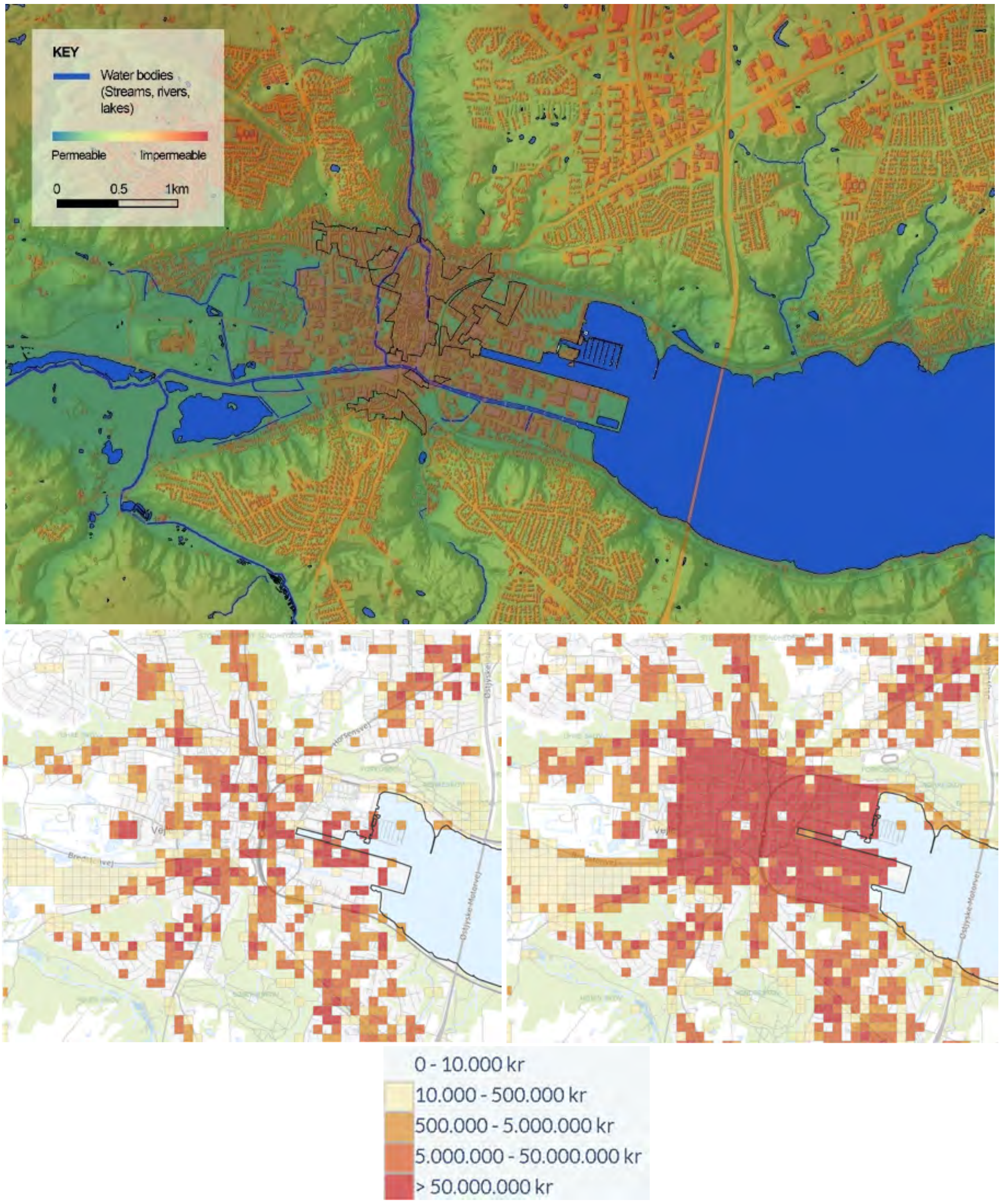
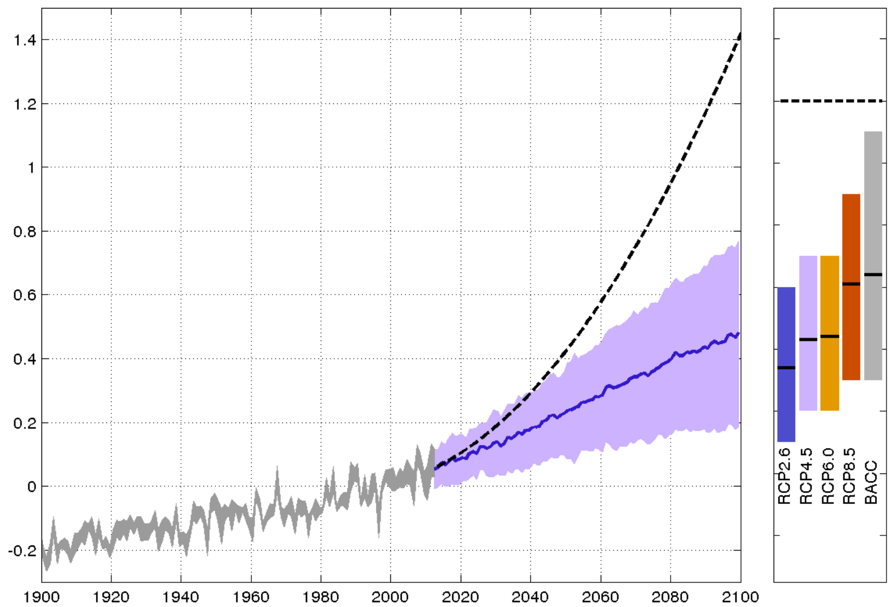


Figure 53. (Top image) Impermeability of the risk area Fjordbyen at the bottom of the river valley of Vejle. Image credit: Extracted from SKALGO (n.d.).
(Bottom image) The areas in red are associated high valued buildings in Fjordbyen that would incur high costs for damages due to SLR and SS. The left image is the cost incurred from 2021, and the right image is the economic cost associated with future damages based on predictions for 2100. Image credit: Vejle Klimakort(n.d.).
(Extracted from Kumu Multiscalar map – Fjordbyen scale node).

Whichever coastal strategies get implemented in these risk areas will significantly impact the rest of the city. These coastal zones are contested sites with various actors with varying (at times contrasting) values and interests that call for collaboration and compromises.

3.1.2 Risk of inundation in coastal cities of Denmark

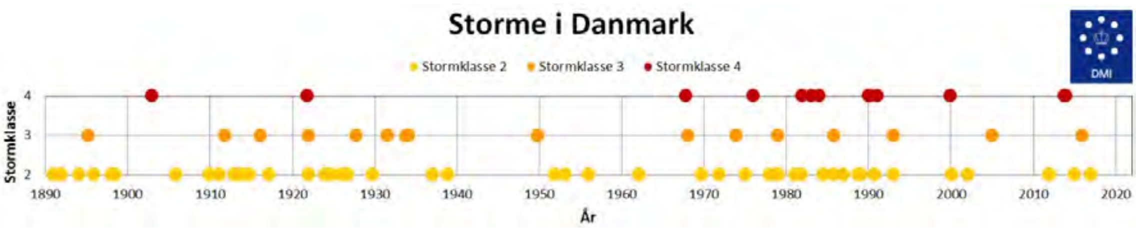
Sea-level rise is dependent on various complex factors, each of which introduces varying levels of uncertainty. - Various estimates of mean sea-level rise (SLR) are dependent on the different scenarios of future GHG emissions ranging between 0.2 to 1.4m SLR[122] by the end of this century in Denmark (see Figure 54). However, there is a particular risk that sea level rises will become more intense due to unforeseeable cascading impacts. The Danish Meteorological Institute assesses that towards the end of this century (1981-2100), the water level around Denmark is expected to rise 0.1 to 0.6m for the most optimistic scenario (RCP2.6) and 0.3 to 0.9m for the highest scenario (RCP8.5) with the upper estimate by Danish Meteorological Institute (DMI) to reach up to 1.4m (Klimatilpasning, 2021).

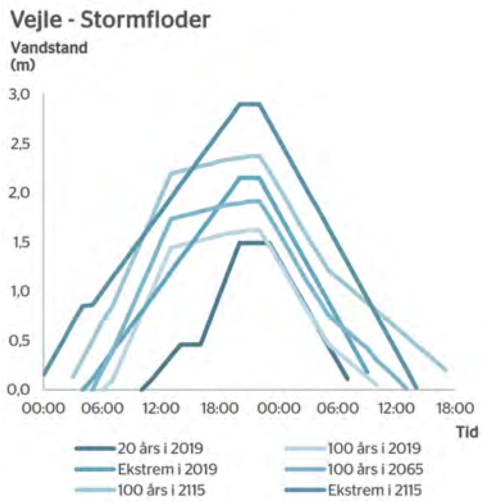


122 According to DMI's Climate Atlas, it is expected that the average water level will rise by approximately half a meter towards the end of this century compared to today (RCP8.5). If the current political ambitions for emission reductions are achieved on a global scale (RCP4.5), sea level rise can be limited to approx. 35 cm.by 2100 (Payne, Anker Pedersen and Fonseca, 2022). However, for the future sea level rise, even fairly high increases cannot be completely ruled out. The uncertainty over the median rise is therefore large. Thus, the 95th percentile for rise in mean water level in the high climate scenario (RCP8.5) at the end of the 21st century is estimated at 1.4 meters (DMI, 2019). The rise in sea level after the year 2100 is more uncertain than the increases this century, but the SROCC gives the likely range of the global rise for the year 2300 at 2.3-5.4 meters in the high climate scenario (RCP8.5). It is expected that the increases around Denmark will be close to the global average (ibid.).

Figure 54. (Top) The graph above shows the absolute mean water level around Denmark in metres for the years 1900-2100. The grey-shaded curve for the years 1900-2012 shows the observed annual mean water level measured by Danish water gauges, adjusted for isostatic uplift. The thin blue curve for the years 2012-2100 shows the IPCC's best estimate of the mean water level in the North Sea for the RCP4.5 scenario, and the light purple shadow indicates the uncertainty of this scenario. The dotted line shows the Danish Meteorological Institute's (DMI) estimate of an upper limit for water level rises for use in uncertainty calculations. To the right of the figure are shown the mean value and uncertainties for the period 2081-2100 for the four IPCC RCP scenarios as well as for the University of Copenhagen's BACC assessment of the A1B scenario in grey (Olesen et al., 2014; DMI, 2018). Image credit: Olesen et al. (2014).
(Bottom) Map of Little Belt (Lillebælt) Denmark shows the change between 1981-2010 and the future period 2071-2100 in mean water level (cm) for the high emissions scenario RCP8.5. Change in mean water level: 54cm and uncertainty range: 10-99cm (Pedersen et al., 2020; DMI, 2022a). Image credit: Danish Meteorological Institute (DMI, 2022).

When the mean sea level rises, the maximum water level in the event of a storm surge can be expected to rise similarly or faster. The frequency and severity of storm surges are expected to increase, and the IPCC warned that a 100year storm surge event would likely happen every year by the end of the century if we carry on the B-A-U trajectory (IPCC, 2021a; 2021b). This is also the case for Denmark, where storm surges are expected to increase both in frequency and strength towards the end of this century. For instance, today's 20-year and 100-year storm surge events can happen every one or two years in Denmark (Payne, Anker Pedersen and Fonseca, 2022), with a range of 1.62 to 2.9m in storm surge levels by the end of the century (for Vejle), as indicated in Figure 55 below (Kystdirektoratet, 2020).





20 års stormflod i 2019	149 cm
100 års stormflod i 2019	162 cm
Ekstrem stormflod i 2019 (Stormfloden 1872)	215 cm
100 års stormflod i 2065	191 cm
100 års stormflod i 2115	237 cm
Ekstrem stormflod i 2115	290 cm

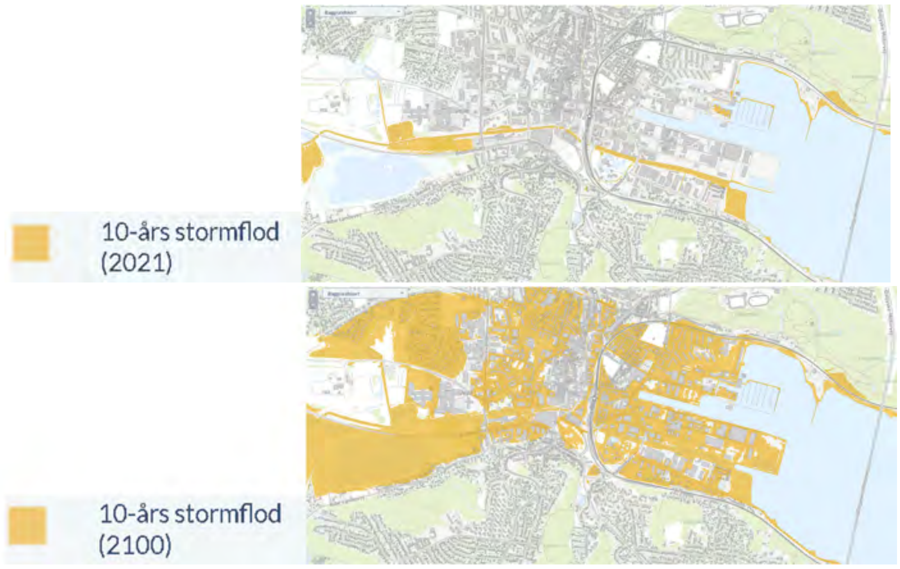


Figure 55. (Top image) An increasing number of wilder storms in Denmark (Class 4 in red – classified based on wind speed and strength) within 130 years from the end of the 19th century. The recorded storms and hurricanes average 15 per decade, ranging in various storm surge heights (DMI, 2022c).
(Middle row image) An example of the growing storm surge risk is the coastal city of Vejle, where the range of storm surge could reach almost up to 3m by the end of the century. Image credit: Kystdirektoratet (2020).
(Bottom row images) Two maps of the city of Vejle with the impact of 10-year storm surge events for 2021 and 2100. By 2100 the bottom of the river valley where the city is located will be completely underwater compared to 2021, in which the water barely impacts the city. Image credit: Vejle Klimakort(n.d.).
(Extracted from Kumu Multiscalar map – Vejle Fjord node).

These estimates (see Figure 56) inevitably complicate implementing urban planning policies for coastal protection, which needs to take into consideration the minimum height of dikes and the elevation level of land reclamation projects[123]. For Denmark, the current elevation (called "kote" in Danish) level is set for 2.5m coastal protection and 3m coastal adaptation (Vejle Municipality, 2020a). There are concerns that these levels may be underestimated to keep up with constant worsening estimates for 2100. Many Danish coastal cities currently have hard concrete edge (bulkheads) conditions with no sea walls installed yet, as outlined in Figure 57. The elevation of the waterfront areas usually ranges from less than 1m to under 2m above current water levels (Klimatilpasning - KAMP, n.d.). However, if the sea level rises to a likely worst-case scenario of 0.5m-0.9m by the end of this century, then even a relatively frequent and mild storm surge event is likely to happen every year (such as Storm Malik in 2022, reaching 1.4m increase in water levels in Vejle – refer to section 1.2) would not only inundate all coastal cities of Denmark but cause damage to properties and a way of life (see Figure 56). Any storm surge event with a sea-level rise of 0.9m or more will negate most of the world's current storm surge floodgates (Pilkey and Young, 2011).

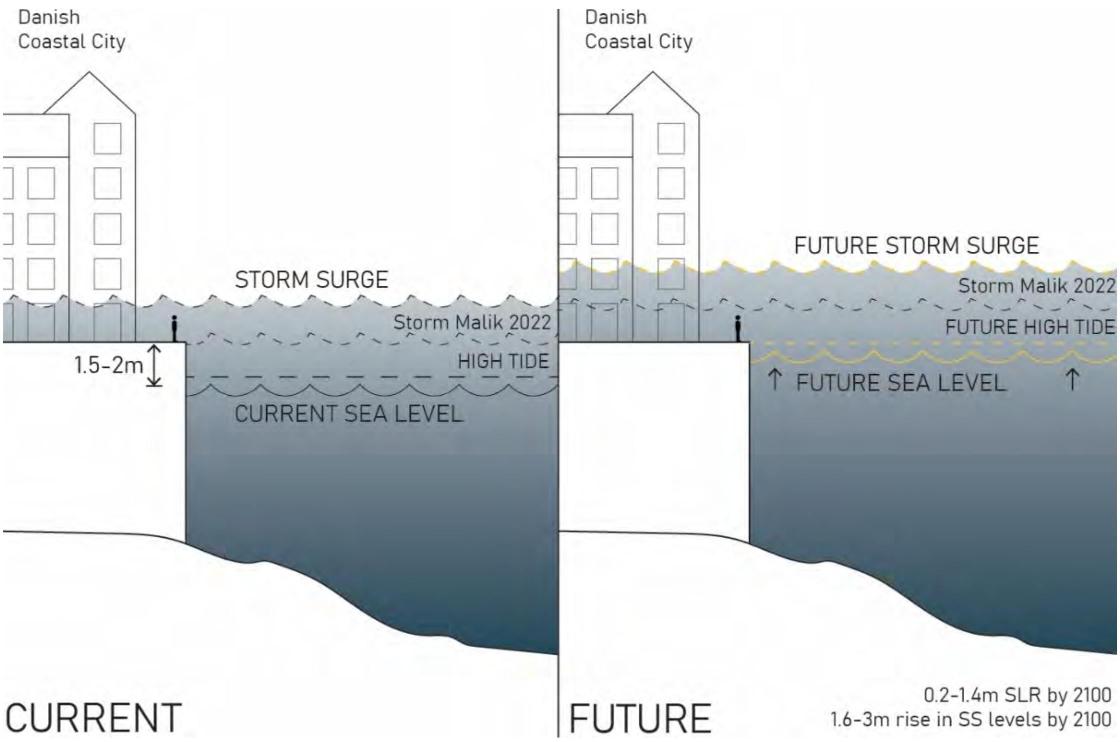


Figure 56. A diagram showing the relationship between SLR and SS in its impact on inundating coastal cities in Denmark with Storm surge range for Little Belt Sea (Lillebælt where Vejle is). SLR alone will not cause inundation of coastal cities (even in a worst-case scenario), but SLR coupled with frequent and more intense SS has the potential to wreak havoc in a worst-case scenario situation. Image credit: Soo Ryu and Agnes Jarmund.

123 Pilkey and Young (2011) recommends as a bare minimum to consider a minimal 0.9m for SLR in 50-100year planning horizon in coastal communities where the politics would not permit the consideration of more forward-looking coastal management. Pilkey and Young (2011, p. 179) also considers 2m SLR by 2100 being a real possibility.

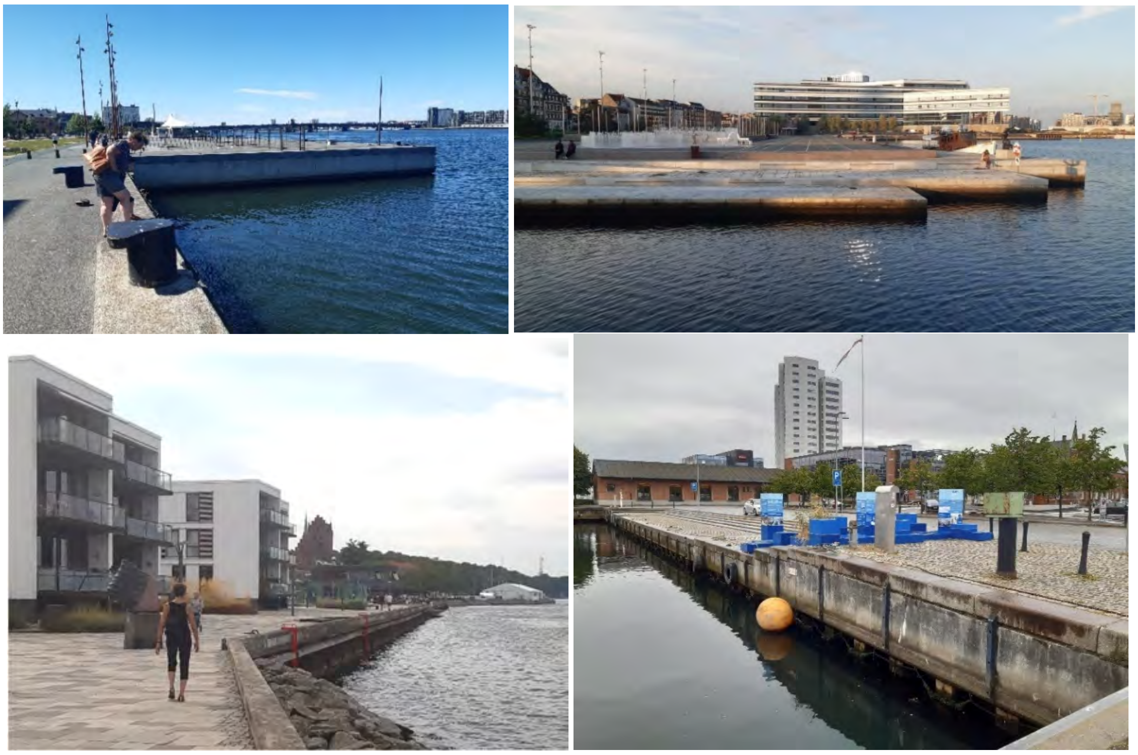


Figure 57. The current elevation (1-2m) above the normal water level in the form of fortified concrete bulkheads represents the hard edge conditions of many coastal cities in Denmark, such as Aalborg, Aarhus, Middelfart and Vejle. Furthermore, these typical urban coastal edge conditions are defined and segregated, the hard boundary between city and water that severs a closer and more tactile connection with the water and its life forms. The public space on the waterfront is mainly made of concrete surfaces fit for humans. Little consideration is given to terrestrial plants, and there is almost no designated space for interacting with the marine world. Image credit: The photos of the hard-concrete edge conditions of waterfront spaces were taken by the author in Aalborg (Top left), Aarhus (Top right), Middelfart (Bottom left) and Vejle (Bottom right) in Denmark during 2020-2022.

3.1.3 The "hard approach" and its limits

To prevent the water from inundating coastal cities, the dominant coastal protection model[124] for many Danish coastal cities has been to implement human-made engineered structures that attempt to keep nonhuman forces (such as water) at bay (Faragò et al., 2018). This approach is often referred to as the "hard approach" (ibid.). It consists of seawalls, dikes, locks and levees, which are engineered infrastructures working as defence systems to manage and contain the water. These systems are designed to cater to rising sea levels and the increasing threat of storm surges.

While these infrastructures have an important role in protecting low-lying coastal cities in the immediate short term, due to future sea-level rise being somewhat unpredictable, it is difficult to design defence systems, such as sea walls, based on uncertainty (Pilkey and Young, 2011). Moreover, past disasters around the world have shown that reliance on hard approaches can be catastrophic,

124 A review of coastal protection technologies in Denmark and in an international context by Faragò et al., (2018) indicate an overwhelming dominance of hard approaches dating from 16th to the 21st century.

especially in the event of structural failure of hard approaches. Furthermore, levees (i.e. sea walls, dikes) are constructed based on a maximum height that can protect the city up to a certain flood level. However, there is no guarantee that the flood will not surpass the protection capacity or penetrate below the sea wall via groundwater. For instance, Hurricane Katrina in New Orleans overtopped the seawalls and broke through the coastal barrier. In that case, the seawall prevented the water that had toppled the wall into the city from flushing out back to sea, causing a pond-like effect, and causing huge damages (UC Berkeley News, 2005; Pilkey and Young, 2011). Furthermore, these engineered solutions are very expensive and inflexible to refurbish. Therefore, without undermining the importance of technological solutions, they are temporary solutions with limitations in engaging with the complex phenomenon of climate change (Pilkey and Young, 2011).

Moreover, a heavy reliance on protection/barrier systems such as dikes and sea walls can be said to rest on a false sense of security, as they are not sufficiently designed to be adaptable to future changes in climate. This phenomenon is called the "levee paradox",[125] which describes the irony of the presence of levees that leads to less awareness of the flooding risks and, in turn, increased development in the so-called "protected" risk area (Smith, 2002). Thus, their very existence and presence encourage an increase in the density of development, making long-term response all the more difficult and expensive (Pilkey and Young, 2011).

While allocating resources around unforeseeable future risks is difficult, it is even more difficult to imagine better practices without first uncovering the limitations in the existing infrastructural systems (Orff, 2016). Thus, coastal cities' challenges with water will require going beyond implementing coastal protection strategies, as these approaches do not address the actual source of these issues.

Barriers to retreat

An underlying but crucial problem with the defence strategies of the hard approach is not only that they cannot guarantee 100% protection, but they rarely suggest relocating people away from high-risk areas (Pilkey, Pilkey-Jarvis and Pilkey, 2016). There is an inertia in Denmark to retreat from the most vulnerable areas of coastal cities. For instance, there is currently no national comprehensive retreat plan of risk areas or designating risk areas as "no build areas" [126] in urban

125 Levee paradox is a good example to discuss a fragile system, where risk and vulnerability increases in an area because people have a belief that the area is safe, so they do not get out of harm's way, resulting in a more dangerous situation (Pilkey and Young, 2011; Orff, 2016).

126 There is no formal "no build zone" in Danish coastal cities. However, in the Danish Planning Act, "beaches and other stretches of coast areas (i.e. non-urban areas) where there is no contiguous seagrass or other land vegetation, and on areas located within a distance of 100 m from where this vegetation begins, for purposes other than coastal protection, there can be no development unless with specific permission from the Minister of the Environment" (translated from Danish) (Kystbeskyttelsesloven: Bekendtgørelse af lov om kystbeskyttelse m.v.) (in § 16a 4) Stk. 3). This is in contrast to other contexts such as, in Australia they have also restricted development on the coast due to sea level rise and in South Carolina in the USA, retreat from sea level rise is an official state policy (Pilkey and Young, 2011).

areas for the future. The current political and economic climate[127] is geared towards development[128] over retreat. For this reason, it is not surprising that managed retreat (also known as realignment or relocation) as a coastal adaptation strategy is the least discussed option when deciding how to respond to the water issues for coastal cities in Denmark[129] and around the world (Pilkey, Pilkey-Jarvis and Pilkey, 2016; Siders, 2019). Prolonging a sensible retreat plan for critical areas can make future responses to sea-level rise and storm surges more difficult and expensive in the future (Pilkey and Young, 2011). Nevertheless, retreat is a difficult issue to discuss and implement for different factors that can act as barriers that reinforce each other (i.e. psychological, perceptual, regulatory, institutional, practical and physical barriers) (Siders, 2019). Research by Rupp-Armstrong and Nicholls (forthcoming[130]) investigated some of the main barriers to implementing managed retreat in England, Scotland, the Netherlands and Germany. Moreover, Siders (2019) and Pilkey et al. (2016) investigated cases in the United States. Here are some of the findings that are barriers to retreat (not an exhaustive list) that may also apply to the Danish context:

- The lack of public acceptance is due to the negative perception of loss of land and real estate value in risk areas (Leggett, Harvey and Cooper, 2004; Rupp-Armstrong and Nicholls, forthcoming).
- Not being able to get proper or decent compensation for their loss of land and not being satisfied with the proposed solutions (Rupp-Armstrong and Nicholls, forthcoming; Siders, 2019).
- High costs associated with retreating existing urban infrastructure due to its size, inflexibility and complexity behind legal liabilities due to different coastal land owners over the area (buy back costs) (Rupp-Armstrong and Nicholls, forthcoming; Siders, 2019).
- The lack of available land to safely relocate to (i.e. this is particularly the case for the Netherlands, where they have high population density and lack of suitable land to safely relocate to) (Rupp-Armstrong and Nicholls, forthcoming; Siders, 2019).
- Overestimating the capacity of techno-centric engineering solutions with a view that one can always engineer oneself out of these issues (Pilkey and Young, 2011; Pilkey, Pilkey-Jarvis and Pilkey, 2016). This belief is often termed "optimism bias", which refers to the tendency of people to believe nothing bad will happen to them (Siders, 2019).

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127 For instance, if the developer is able to protect new developments from flooding by implementing measures that mitigate the flood risk, the local governments can allow new developments in flood prone areas (i.e. in high risk areas set by the EU Floods Directive) according to the Danish Planning Act. In these areas the local governments are obliged to develop flood risk management plans and any development on these flood prone areas must ensure coastal protection as part of the Danish Planning Act (Kystbeskyttelsesloven: Bekendtgørelse af lov om kystbeskyttelse m.v.).

128 The local government can allow new developments in flood prone (designate high risk area in the EU floods directive) areas according to the Danish Planning Act if developers are able to protect the new developments from flooding and the local municipalities are obliged to develop flood risk management plans (Miljø- og Fødevareministeriet, 2020).

129 This is based on the findings that storm surge or coastal adaptation strategies by Municipalities do not have an official strategy or long term plan for retreat/relocation in their documents.

130 Also refer to UN Climate Technology Centre & Network (n.d.).

- An existing community with a strong place attachment (i.e. historical, cultural and/or psychological factors) to the coastal area and livelihoods depend on the risk area. Moreover, people that want to maintain the status quo and resist action due to "status quo bias" (Siders, 2019).
- A lack of collective "flood memory", short-term thinking and/or the lack of perception and awareness of threat (Siders, 2019).
- Actors (i.e. residents, local and state governments, real estate industry) who hold power to make decisions on managed retreat have financial incentives to prevent retreat plans from being implemented. At the same time, stakeholders with an incentive to support retreat (i.e. federal taxpayers, federal agencies and future generations) have little to no power. This is particularly the case in the USA (Siders, 2019, p.218).
- Property developers are encouraged to build on risk areas like the coast to make short-term profits but are free from the long-term consequences of their development. (Siders, 2019, p.219).

3.1.4 The Death and Life of Great Danish Coastal Nature

Mostly, people talk about the challenges that climate change poses for humans, our cities and infrastructure. In this new national analysis, we focus on how climate change affects nature and our coastal landscape's biodiversity. And, unfortunately, this is not good news. The climate crisis will worsen the biodiversity crisis. There is already a lack of space and suitable habitats for the vulnerable, rare species, and when the coastal nature gradually disappears from the seabed, it has nowhere to move to due to infrastructure, dikes and other land use.

(Translated from Danish) Torben Ebbensgaard, biologist and project manager at COWI and leader of the research project *'The impact of sea level rise on the coastal nature' (Havvandsstigningernes betydn for kystnaturen)* (COWI, 2022).

Rising sea levels pose an imminent threat to urban environments. However, urban environments are not the only ones under threat. New research by COWI and SDU has found that sea level rise also poses a significant threat to coastal nature by the sea. In Denmark, this has implications for biodiversity over the next 50-100 years[131] in Denmark (COWI, 2022; Ebbensgaard et al., 2022b; 2022a). The climate-induced sea level rise will significantly transform the Danish coastal

131 The projections have been made based on the climate models from the IPCC and the scenario RCP8.5. COWI and SDU have taken the years 2070 and 2120 as a starting point to show the gradual loss of coastal nature over time (COWI, 2022; Ebbensgaard et al., 2022b; 2022a).

landscape[132] and drastically reduce the populations of rare birds, amphibians and plants in the coastal areas to the brink of extinction (ibid.). Due to climate change, sea level rise and frequent storm surge events, more than half of these coastal habitats will be permanently flooded (ibid.). The calculations from the research show that approximately one-third of the protected nature areas (in low-lying areas), such as the Natura2000 areas[133] and the internationally protected habitat areas, will be affected by saltwater floods at least every ten years (ibid.).

Furthermore, the dominant hard approaches as a solution for coastal protection also impede the survival of these coastal natures. First, it interferes with the local hydrology, sediment flows and nutrient exchange from land to the ocean and vice versa, which can deprive many existing coastal ecosystems – such as coastal wetlands, salt marshes, eelgrass, and seaweeds – of needed nutrients for survival by trapping them within the physical structures (Pilkey and Young, 2011; Quintana, Kristensen and Petersen, 2021) (see Figure 58). Second, these hard structures can prevent coastal ecosystems (mainly meadows and marshes) from migrating upland as the sea level rises (termed "coastal squeeze"), effectively removing their vital contribution to biodiversity, carbon sequestration, water filtration, wave attenuation and so on, as shown in Figure 59 (Ebbensgaard et al., 2022b). Third, these hard approaches often remove the existing coastal habitats, which play a critical role in the ecological connectivity[134] between land and water (Bishop et al., 2017) (see Figure 58).

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132 Around 32,500 ha of nature, which is protected under the Nature Protection Act, will disappear permanently by 2120 (especially the salt meadows and the freshwater lakes). The loss of at least 52% of Denmark's area of salt marshes (15,500 ha) is considered to be particularly problematic because Denmark contains 79% of Europe's total area of salt marshes in the continental biogeographical zone. It will impact nature areas in 76 out of 98 Danish municipalities (COWI, 2022; Ebbensgaard et al., 2022b; 2022a).

133 Some of these Natura2000 areas are beech forests near the coast, which are considered an epitome of Danish "nature" as mentioned in the Danish national anthem's lyrics (written by the poet Adam Oehlenschläger). The anthem gives insights into romanticised Danish landscape imagery tied with national identity. The anthem starts with (translated), "There is a lovely country, it stands with broad beech-trees, near the salty eastern shore... Our old Denmark shall endure as long as the beech tree reflects on the blue wave" (danmarkshistorien.dk, 2012).

134 Life on land and sea are closely connected by a network of estuaries and coastal ecosystems which are strongly dependent on each other. Marine life forms move back and forth and exchange energy and materials that make up the ecological connection of this boundary zone between land and sea. The ecological connectivity among streams, coastal waters, and among coastal habitats such as continuous zones of salt marshes, seaweeds, and seagrasses is critical for species to feed, reproduce, distribute over large spatial scales (Bishop et al., 2017).

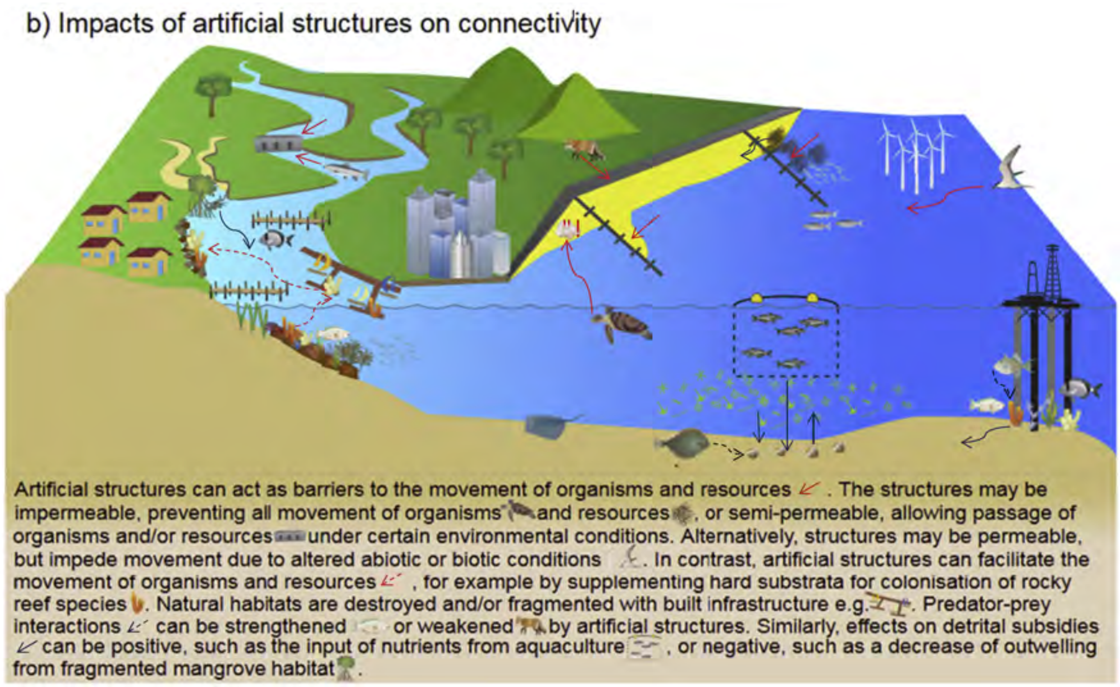

Figure 58. Conceptual diagram of the way in which artificial structures modify ecological connectivity vital for coastal ecosystems (Bishop et al., 2017). In heavily built urban environments, these ecological connections have long been destroyed as the development of buildings and infrastructures in the harbourfront areas are prioritised over preserving coastal ecosystems (Pilkey and Young, 2011; Bishop et al., 2017). Image credit: Bishop et al. (2017).
(Extracted from Kumu Multiscalar map – Cyclic scale node).

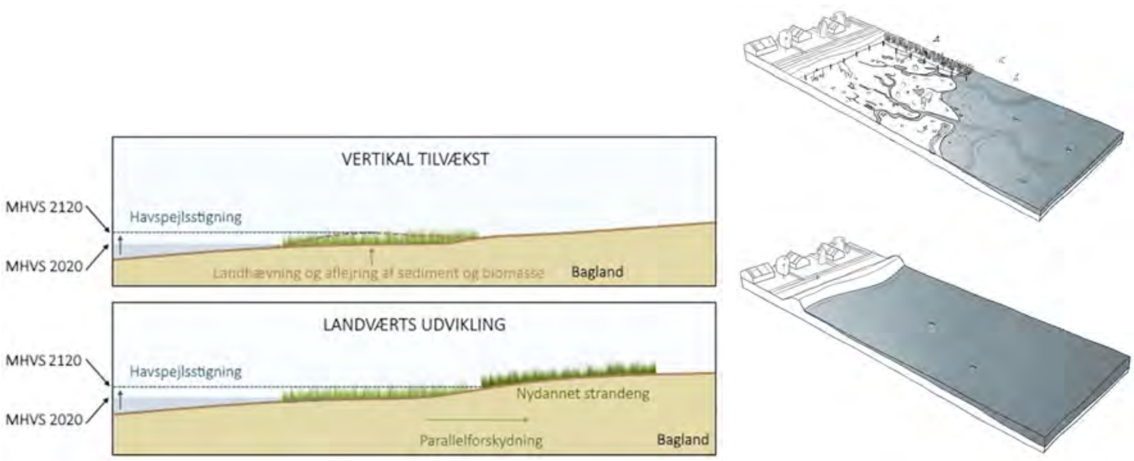

Figure 59. (Left image) Coastal nature is able to migrate landward as sea level rise, preventing coastal squeeze. (Right image) Diagram showing an urban scenario where a rise in sea level drowns the existing salt marsh in front of cities due to the creation of a dike to protect the city from flooding.
Image credit for both images: COWI and Arkitema, 2021 (Ebbensgaard et al., 2022b).

3.1.5 Urban transformation of coastal cities - Urban sprawl to ocean sprawl

The sea itself has been so transformed that it has become an enigmatic urbanised space, charged with the task of increased economic production both from traditional and new maritime sectors while at the same time it has been emptied of imaginative narratives and cultural significance.

Nancy Couling and Carola Hein, *The Urbanisation of the Sea* (Couling and Hein, 2020, p.6).

The aforementioned problems associated with living on "the edge" is fuelled by the increasing market demand to work and live *by* the sea. Since the industrial revolution, Denmark and many other contemporary coastal cities saw an onset of rapid urban development, and the space next to the water became a valuable economic commodity (Firth et al., 2016). The term "ocean sprawl" (Duarte et al., 2013) refers to the act of expanding human activity into the sea by land reclamation via dredging to create new arable farmlands, ports and harbours to expand economic activity. In the past few decades, the urban development trends in coastal cities have been to reclaim land for commercial, recreational and residential use, especially for the highly sought-after waterfront real estate, as shown in Figure 60 and Figure 70. As a consequence, coastal cities in Denmark are still undergoing an urban transformation from harbourfront cities to waterfront cities as the increase in urbanisation in major coastal cities is extending the city out into the water for new spaces, as the city centres built near the water outgrow their initial capacity. Thus, the most convenient and prime real estate became by the water, close to the city centre with its amenities and infrastructure. One can argue that the urban development model of urban sprawl goes hand-in-hand with ocean sprawl in coastal cities.

The contemporary issue with reclaimed land is that they are increasingly becoming the most vulnerable areas facing the brunt of rising sea levels and frequent storm surges in the future. These reclaimed lands are often elevated above the current sea level and are based on former predictions of future SLR/SS, which, as explained above, may no longer be sufficient (refer to Figure 60 of Aarhus Docklands/Aarhus Ø). Furthermore, the buildings built on reclaimed land are often not designed to be inundated, nor flexible to be relocated, or elevated on stilts to allow the water through. These areas often have extensive impermeable areas not designed to absorb and hold excess water in the future (refer to Figure 60). With the influx of residential waterfront properties along with recreational and commercial opportunities, these areas now make up a significant part of a coastal city with significant investment (refer to section 3.1.2). Thus, the question is how much longer does it make sense to continue building land-reclaimed B-A-U waterfront developments in risk zones? Moreover, is it worthy of public funds to protect them in the future?

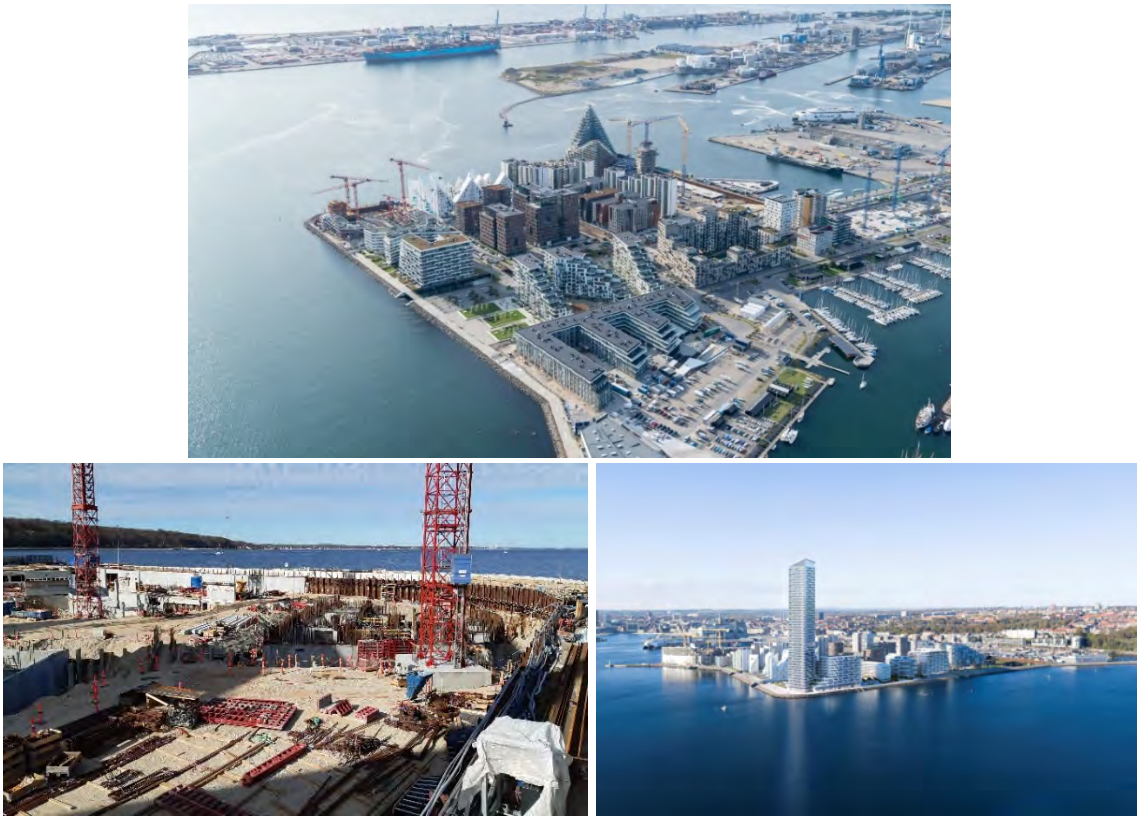

Figure 60. (Top image) An aerial photo of current waterfront residential development models in the coastal city of Aarhus in Denmark. The residential and commercial development on Aarhus Docklands (Aarhus Ø) started in 2007 on a former container terminal that was reclaimed land. The area spans 100,000m^2 with plans to house over 10,000 residents. The Docklands are elevated 2.5m above the previous normal water level based on a future increase in sea level of 0.5m, with stone reefs as coastal protection to dampen the waves. However, the Docklands is considered a storm surge risk area, and it has been described as unable to deal with future predictions of SLR and storm surges by the end of the century (Aarhus Kommune, n.d.; Klimatilpasning, 2015). Image credit: Jesper Larsen and JFP.dk.
(Bottom images) Land reclamation process of the tallest apartment complex in Aarhus, Denmark, called "The lighthouse." It is 142m high, with over 400 units on reclaimed land which requires a resource-intensive construction process, as shown (Lighthouse, 2021). Image credit: (Left image) Taken by the author on April 2020. (Right image) Nybolig (n.d.).

A good example of the demise of land reclamation projects due to storm surges is New York, where land reclamation steadily claimed more and more land from the sea starting from the 1650s (Farberov, 2013). Figure 61 shows that Hurricane Sandy in 2012 inundated all the land reclaimed area on Manhattan Island, taking the shoreline back to its "original" over 400 years ago. Hurricane Sandy in Manhattan exemplifies the irony of land reclamation, where the sea that was "reclaimed" into the land is starting to come back in the form of sea-level rise and storm surges, slowing reclaiming back what it once lost (Farberov, 2013).

Figure 61. (Left image) A series of land reclamations, the first of which took place in 1646 (outlined in red). Around the time of the American Revolution in 1774, NYC began selling "water lots", allowing entrepreneurs to use landfill to create additional usable land. By the 2050s, 800,000 people could be living in a flood zone in NYC that would cover a quarter of the city's land' (Farberov, 2013). Image credit: Farberov (2013).
(Right) An overlay of a map from Microsol Resources (2015) shows the area impacted by a 13-14 foot (approx. 4-4.3m) storm surge by Hurricane Sandy in 2012 (Farberov, 2013). The images are superimposed by the author.

In the next sections, I explore the four major historical trends of land reclamation as an urban development model for coastal cities in Denmark. The intention of this historical exploration is to understand the current barriers and potential opportunities for urban transformation that are conducive to addressing the challenges of the Anthropocene and the research question of integrating marine life. The four main periods are:

1. **16th -20th C:** The start of land reclamation to gain new arable land for *agriculture*
2. **19th-21st C+:** A surge of land reclamation projects for *harbourfront* development due to increasing economic trade (occupied by industries)
3. **20th-21st+:** Land reclamation projects are driven by *waterfront* (and harbourfront) development (increase in urbanisation, lifestyle, recreation and commercial use)
4. **21st C+:** The start of land reclamation for *coastal protection* (to cater to increasing urban densification for residential, recreational, commercial and industrial use)

First phase: 16th -20th C: The start of ocean sprawl in Denmark

To understand the long history of land reclamation in Denmark and its affinity[135] towards land reclamation as a practice, one needs to look back earlier than the industrial revolution of the late 19th century. While land reclamation truly peaked in the 19th century, known as the "Land hunger period" or the "Golden age of land reclamation", the practice started as early as 1530 in the 16th century due to intensifying agricultural activity[136] that drained areas to make fertile land (Spirn, 1998; Stenak, 2005; Peder Clausager, 2022). Much of the land reclamation projects took place on marshlands, bogs, and meadows in shallow areas suitable for draining to make space for grazing and cultivation (Stenak, 2005). Land reclamation driven by agriculture hugely impacted the Danish coastal ecosystems, where in some cases, entire fjords[137] (i.e. Lammefjord) were drained to convert into arable fields (ibid.). Research by Stenak (2005) mapped all the land reclamation projects diked, drained and converted coastal water bodies into arable farmland[138] (the total size of land reclamation for only agricultural purposes roughly equals the combined size of the islands Falster and Møn).

Moreover, pasture landscapes dominated Denmark due to their contribution to economic prosperity, frequently depicted in the 19th-century Golden Age[139] paintings (see Figure 62) (Hedin and Oelsner, 2018). These pastoral landscape imageries became a long-lasting representation of Danish "nature" and, thus, intertwined with the national identity as an agricultural nation (Hedin and Oelsner, 2018).

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135 There is a very famous Danish saying, "Hvad udad tabes, skal indad vindes", (which roughly translates to: "what was lost outwards, must be gained within"). It is believed to be written by the author H.P. Holst in 1811. According to Stenak (2005), the saying was used to tell a tentative story (a cultural myth) to reinforce the land reclamation projects during the golden age of land reclamation from 1830 to 1890 (Stenak, 2005; Kayser Nielsen, 2019). This saying took on another meaning when it was adopted by the Danish Heath Society (Hedeselskabet) to reclaim land (Schleswig-Holstein) lost to Germany (Prussians in 1864) by regaining it from the sea (however, there is a dispute that the motto was used by the Danish industry instead (Kayser Nielsen, 2019)). This loss of territory to Germany had a lasting impact on Denmark, where it turned its gaze inward, accompanied by national romanticism epitomised by the saying by Holst.

136 Coupled with the invention of the pump technology, access to easy capital and loans, which led to peaked in the grain sale period in the middle of the 19th century. Furthermore, agriculture is one of the key reason behind Denmark's considerable economic growth in the 19th century (Løkkegaard, 1994; Henriksen, 2006; Hedin and Oelsner, 2018).

137 For instance, one of the biggest and most well-known land reclamation works is the drying out of the Lammefjord in Zealand/Sjælland since 1870, which consists of drying out 5,500hectares of land, equal to 10,000 football fields. The rich soil of the Lammefjord was perfect for turning into agricultural land (Lammefjorden, 2022; Odgaard and Vestergaard, n.d.). Today about 3,246 people live on the former fjord bed at a level of between 0 to minus 7.5 meters below sea level, now under threat from sea-level rise like with many other lands reclaimed areas facing the same predicament (Lammefjorden, 2022; Odgaard and Vestergaard, n.d.).

138 Currently, 63% of Danish land use is for agriculture which 81% of it is food grown for animal feed (for for pigs) and only 9% for direct human consumption, 10% for other use (Anon., 2018).

139 The Danish Golden Age (In Danish: Den Danske Guldalder) covers a period of exceptional creative production in Denmark (i.e. music, art, literature, architecture, philosophy), catalysed by Romanticism from Germany. The Golden Age had a lasting impact in Denmark and around the world, especially during the first half of the 19th century. The period is probably most commonly associated with the Golden Age of Danish Painting from 1800 to around 1850 (Lykke Grand, Pennington and Thomsen, 2013).

Figure 62. (Top row of images) The Golden Age paintings of the romanticised vision of the Danish pastoral landscape by painters Johan Thomas Lundbye (Painting title: Landscape at Arresø, view of the sand dunes at Tisvilde) and Christen Købke (Painting title: Lot near the calcium distillery with a view towards Copenhagen). Image credit: Lundbye (1838) and Købke (1836).
(Bottom-row of images) Golden Age paintings depicted coastal nature, such as beach meadows and salt marshes near the coast, that were also used for grazing. Image credit: Paintings title: "Beach area at Vejle Fjord" by Hans Christian Fischer (1884) and "Summer day in Roskilde Fjord" by L.A Ring, (1900).

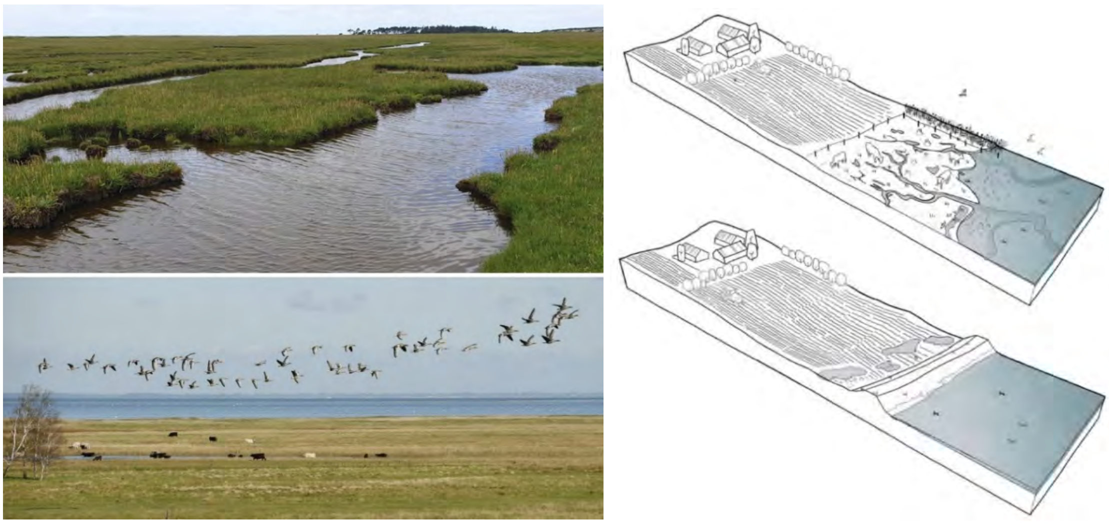
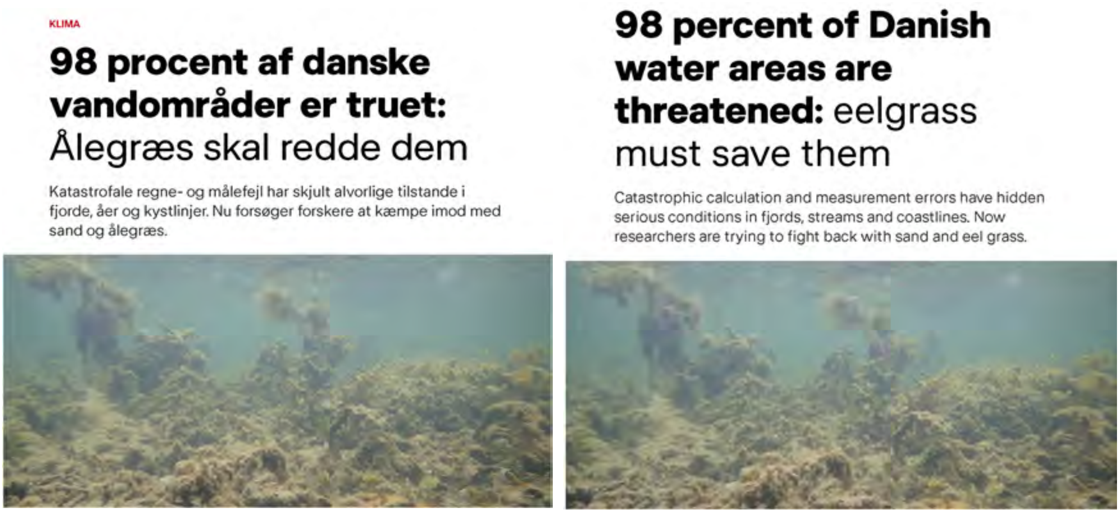


Figure 63. (Left column of images) A photo of typical Danish coastal nature consisting of salt marshes and salt meadows for grazing. Image credit: Carsten Horup (Ebbensgaard et al., 2022b) and COWI (2022).
(Right column of images) A diagram showing how a former wetland can be diked to be converted into farmland. Image credit: COWI-Arkitema, 2021 (Ebbensgaard et al., 2022b). The image has been slightly altered by the author to illustrate the before and after land reclamation for agriculture.

One of the land reclamation processes involves removing rocks and stones[140] from the sea bed to make newly reclaimed land for farming easier (i.e. enhancing soil quality). The rocks and stones were also used for constructing reclaimed land as compaction and fill, i.e. for harbour piers, houses and landscaping (Naturstyrelsen, 2013). Stone and rocks were already scarce in Danish waters, so when the land reclamation process removed these stone/rock reefs, there was no place for seaweed to attach. Furthermore, the process also entailed removing nurseries and hiding places for small animals and fish (refer to Figure 11 of the consequence of removing shallow areas ideal for marine biodiversity) (Dahl et al., 2003; Naturstyrelsen, 2013; Organo Quintana, 2020). An estimate from a report by DTU Aqua (Helmig, Møller Nielsen and Kjerulf Petersen, 2020) states that, from 1900 to 1999, due to industrial fishing and construction activities removed 55 square kilometres of habitats in coastal areas (reaching up to 10m in depth), equivalent to the area of the Danish island Fanø (Stubgaard, 2020; Tække, 2022). Furthermore, the agricultural practice of tilling the land and the exponential increase in the use of artificial fertilisers increased floating particles in the water worsening its clarity, as shown in Figure 64 (Bredsdorff, 2018a; 2018b; Organo Quintana, 2020). Poor water clarity greatly impacted the coastal ecosystems that depended on it, as seen in the huge loss of eelgrass (a key coastal marine species in Denmark due to its geophysical conditions) (Boström, Baden and Krause-Jensen, 2003; Touveneau, 2018). Consequently, many marine restoration projects[141] in Denmark are trying to revive this lost coastal vegetation and marine habitats due to its various ecosystem services.


KLIMA

98 procent af danske vandområder er truet: Ålegræs skal redde dem

Katastrofale regne- og målefejl har skjult alvorlige tilstande i fjorde, åer og kystlinjer. Nu forsøger forskere at kæmpe imod med sand og ålegræs.

98 percent of Danish water areas are threatened: eelgrass must save them

Catastrophic calculation and measurement errors have hidden serious conditions in fjords, streams and coastlines. Now researchers are trying to fight back with sand and eel grass.

Figure 64. A Danish newspaper article discusses the need for proactive marine restoration to address the dire conditions. Danish coastal waters are in due to heavy agricultural activity resulting in eutrophication. These conditions are invisible to the human eye from above (Bredsdorff, 2018a; 2018b; Touveneau, 2018). Image credit: SDU (Touveneau, 2018).

140 Since 2010, the removal of stones and rocks from the Danish seabed was finally banned. Stone reefs are included in the Habitats Directive's list of protected natural habitat types (Naturstyrelsen, 2013).

141 For instance, the Blue Reef project off the island of Læsø and Sund Vejle Fjord project in section 1.4.1 is buying back stones and rocks to be put back into the water for the marine life forms such as fish, seaweed and mussels (Naturstyrelsen, 2013; Sund Vejle Fjord, 2022). And many other projects that are trying to revive salt marshes and eelgrass in Denmark, such as the Sund Vejle Fjord project (see section 1.4.1).

Finally, land reclamation projects can be said to reflect a certain attitude towards the sea – a space that needed to be *re*claimed[142] and thus instrumentalised for human use, usually for economic gain. In turn, we see this attitude reflected in the later phases of land reclamation in Denmark, which I examine below.

Second phase: 19th-21st C+: Container City – Keeping up with the global supply chain

Port development has been another main driver of ocean sprawl in Denmark and coastal cities worldwide. The scale of expansion is unprecedented, and the current development trend indicates no signs of receding[143]. The demand for global consumer goods has led to the need for an expansion of current harbours running at full capacity (Campling and Colas, 2021). Containers have become an inevitable aesthetic (and critical function) for many contemporary coastal/port cities, as shown in Figure 65. As the global economic system became more reliant on continuously increasing rates of growth and consumption, the sea increasingly became an economic commodity to channel this activity, an "untapped resource" to be exploited (Campling and Colas, 2021; Magnason, 2021; Skiveren and Andersen, 2022).

Consequently, the next 19th to the 21st century saw a proliferation[144] of port expansions. While these industrial port areas have become an inevitable part of catering to a modern city, their spatial function is not intended to be accessible to the public (for security and safety reasons). Because they occupy the crucial space between land and sea, they tend to block off huge areas of the waterfront/harbourfront areas physically and visually. Furthermore, these port extensions were not necessarily designed with marine lifeforms in mind, ultimately contributing to marine dead zones (refer to Figure 11) (Palmgren, 2019).

142 Even the term (semantics) land "reclamation" reveals the attitude towards the sea as a space that needs to be claimed back to its rightful place as a land-based territory. In Danish, it has the same semantics as English, "landindvinding", which literally translates to land reclamation.

143 A study has found that melting ice in the Arctic Ocean due to global warming could open up new trade shipping routes in international waters (Kimball, 2022).

144 According to Michael Palmgren (2019), it is easier and cheaper to reclaim land in shallow waters, due to less structural requirements such as pile depth which made land reclamation on shallow waters popular at the expense of eliminating biologically productive shallows. Therefore, to recreate the shallows again with rock reefs and replanting eelgrass is a laborious and expensive process that require the sea bed to be covered with sand, limestone, clay, rubber and rocks to minimise contaminated soil from former industrial harbour activity.

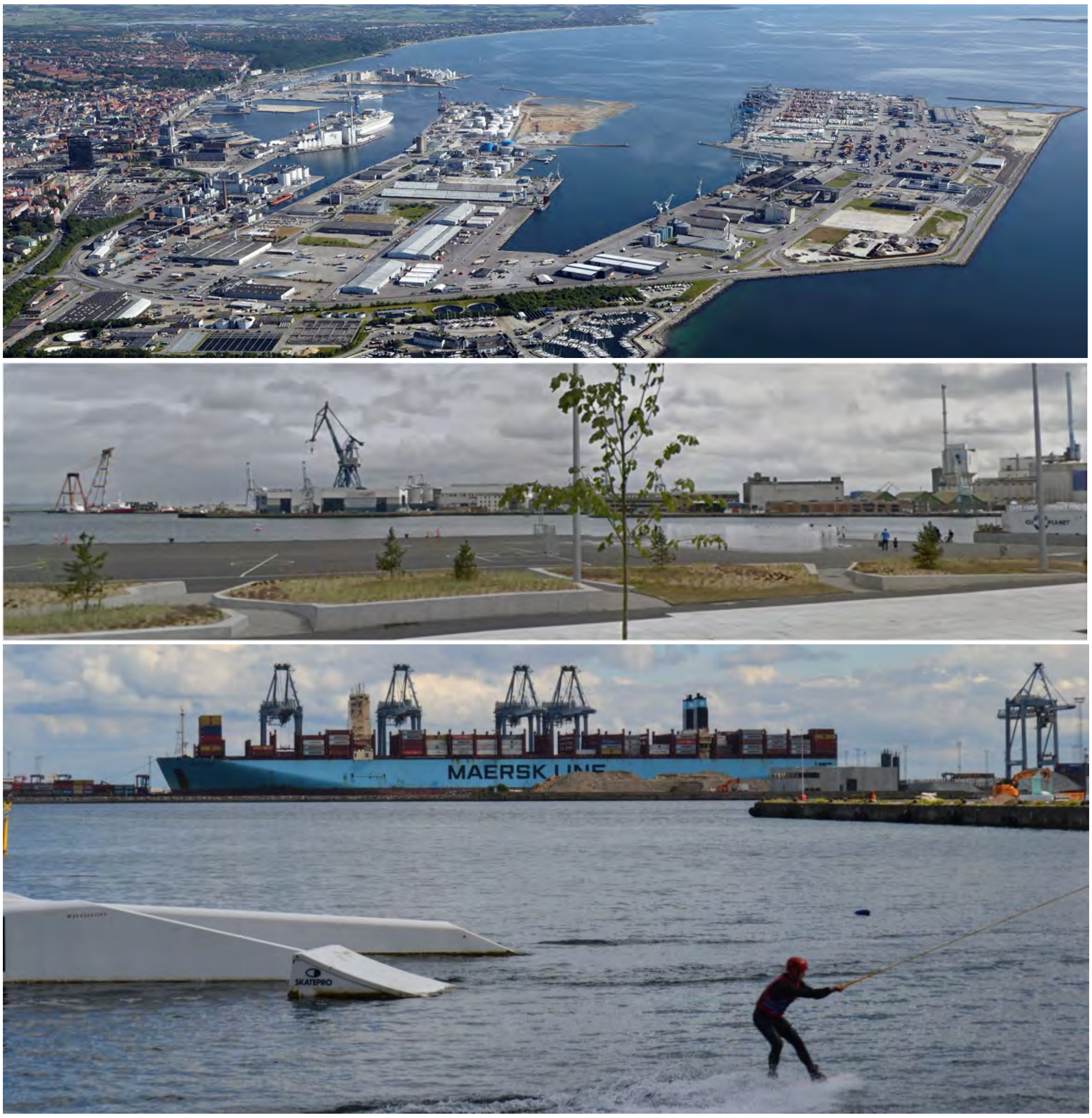


Figure 65. (Top image) The process of land reclamation is by pumping the water out while filling the new land. The image is the draining of the new Frederikshavn harbour in Denmark for expansion. Image credit: Rohde Nielsen (n.d.).
(Second-row image) Aerial view of the land reclaimed Aarhus Port/Harbour contains various industrial and commercial activities along with the ferry terminal that connects Aarhus to other parts of Denmark and for tourists (cruise ships and ferries). The majority of this huge area is inaccessible to the public. Image credit: Carl Elgaard Shipping (n.d.).
(Third-row image) Looking from the waterfront area of the city to the port area. The harbour has a visual presence in many Danish coastal cities where they are located close to the city and is part of the coastal city's identity and function. Image source: Google Maps street view taken on 15/01/22.
(Bottom image) Mærsk is a Danish shipping country famous for its scale of operation. It is in the harbourfront area of Aarhus, while the waterfront recreational activity is in the foreground. Image taken by Nicolai Skiveren (Skiveren and Andersen, 2022).

Projekt Aarhus bugten/Project Aarhus Bay

Another example of the second phase of land reclamation is "Project Aarhus Bay/Projekt Aarhus Bugten". It is a new proposal that is currently being discussed for implementation in the coastal city of Aarhus in Denmark totalling 104 hectares/1 million square meters (equivalent to 140 football pitches), approximately 5m above current sea level, at the cost of 3 billion Danish kroners (Bak Lyck, 2022; Johannsen, 2022). It is a controversial proposal to expand the port of Aarhus via land reclamation, facing backlash from environmental groups and citizens of Aarhus[145] (Massiv kritik af havneudvidelse i Aarhus, 2022). The main reason behind the backlash is due to the negative environmental impact[146] of the land reclamation process, such as clapping and dumping polluted sludge[147] onto the nearby waters compromising marine life and the recreational benefits of the surrounding beaches (see Figure 67) (Plesner and Flindt, 2022). The people of Aarhus are also against blocking the sea view with the "ugly" industry and the congestion of construction trucks it will bring into the city (see Figure 66) (Johannsen, 2022).

145 Due to the backlash, several remediation efforts have been proposed, such as developing a dry port on land instead of out at sea (Havbæk Madsen, 2022). The expansion will provide space for a new container terminal, tank farm, logistics terminal, cargo and production and office (COWI and Aarhus Municipality, 2022).

146 According to the report by COWI and Aarhus Havn (2021) the probability of negative environmental impact on marine life during construction is high to very high with long term duration but with moderate consequence. Some of the environmental impact on marine life include: excavation of marine habitats during dredging, effects on marine nature due to raw material extraction, effects of the sediment material on benthic fauna organisms and effect of underwater noise from hitting sheet piles on the seals and porpoise (COWI and Aarhus Havn, 2021; COWI and Aarhus Municipality, 2022).

147 Much harbour sludge dumped via the clapping process is contaminated with nutrients and heavy metals such as lead, mercury, copper, nickel, cadmium and arsenic, in addition to oil and hormone-disrupting substances which harm marine life. These contaminants dissolve in the water, dispersed by the current and wind, making the water murky and causing eutrophication. The magnitude of this impact is often not properly investigated (Plesner and Flindt, 2022).

Figure 66. (Top left image) Aarhus harbour today (all on land reclaimed area). Image credit: Aarhus Municipality (Bak Lyck, 2022).
(Top right image) The proposal for the port expansion, new piers with container ports and the new ferry terminal. It is expected to be fully completed by 2050. The land reclamation process will involve filling the sea with surplus soil from the land, such as construction sites and raw materials extracted from the Kattegat (Aarhus Havn, n.d.). Image credit: Aarhus Municipality (Bak Lyck, 2022).
(Middle row) – Image of the proposal of the Aarhus industrial port expansion for 2050 (in orange). Image credit: Aarhus Municipality.
(Bottom) – Before and after rendering of the view of the sea from Marselisborg beach. Image credit: Aarhus Municipality (Bak Lyck, 2022). (Extracted from Kumu S-O-T-A map – Aarhus Bay node).

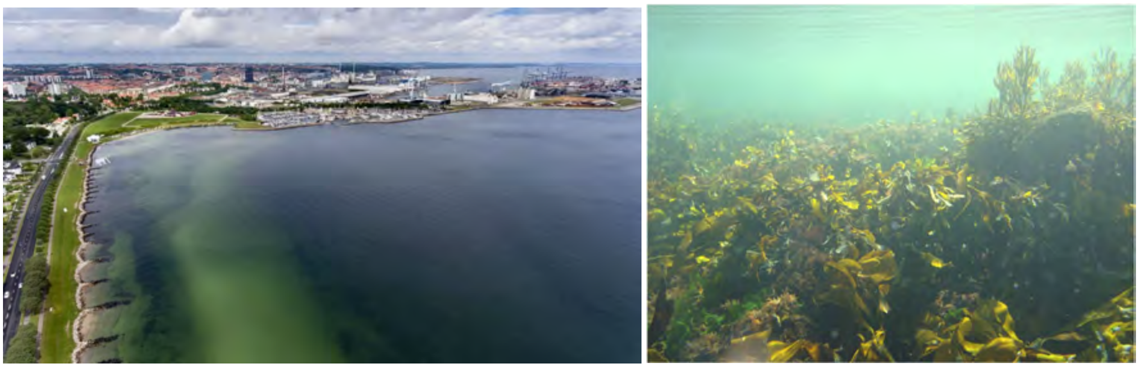


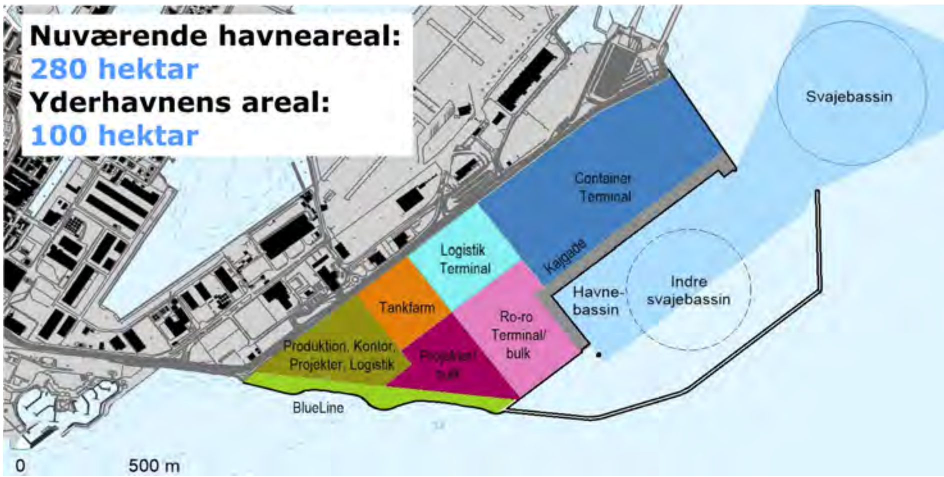
Figure 67. (Left) Photo of Aarhus Bay, a popular recreational area by the citizens of Aarhus. Image credit: Axel Schütt (Johannsen, 2022).
(Right) Evidence of seaweed growing on the stone reefs in Aarhus Bay. Image credit: Mette Møller Nielsen, DTU Aqua (Helmig, Møller Nielsen and Kjerulf Petersen, 2020). (Extracted from Kumu S-O-T-A map – Aarhus Bay node).

From a landscape-seascape point of view, the interesting aspect of this land-reclaimed port extension is the proposal of a "Blue Line" as a new biodiversity area consisting of a promenade stretching approximately a kilometre and which will take the form of a park accessible to the public, as shown in Figure 66 and Figure 68. The initial proposal is by a well-known Danish

Architecture firm C.F Møller Architects (2019). The report by COWI and Aarhus Municipality (2022) states that the Blue Line could provide new recreational opportunities (i.e. fishing, yachting, kayaking and viewing areas). This recent trend of providing an additional recreational space that is also dedicated to improving biodiversity is a small progressive step for land reclamation projects, departing from the previous B-A-U approach, as shown in Figure 69. However, compared to the sheer overall size of the entire project, it may seem like a meagre response to remediating the negative environmental impact on marine life.

Furthermore, despite the initial proposals of the Blue Line's attempt to address the transitional meeting space between the urban landscape to the harbour landscape and the coastal landscape, the proposal has a terrestrial urban landscape focus in the visual representations (see Figure 68). For instance, the urban landscape design proposal is sensitive to human needs by providing smaller recreational spaces, viewing platforms, paved areas for cycling, greenery and shelter from the harsh coastal wind conditions, but it does not indicate[148] (yet) to what extent stone reefs will extend out from the port extension, nor spatially connect the land-sea boundary for a better engagement with the water. Moreover, the proposed stone reef seems unlikely to cover sufficient area[149] for a decently-sized new marine habitat. This view is supported by the project's title and the design approach of it being a "blue line", which alludes to the neglect of the understanding that when it comes to the expansive fluid space of the marine realm, there is a need to depart from the notion of a line and towards that of a zone.

Furthermore, the terrestrial bias is evident in the design document by C.F. Møller Architects (2019) that states its intention for the Blue Line as a space for all, a form of a commons, as shown in Figure 68. However, marine life as a (nonhuman) actor or an inhabitant of the Blue Line is absent from the proposal. It is still a spatially dualistic design that delineates the sea on the other side of the landscaped dike. As such, the notion of a "commons" is here informed by underlying anthropocentrism: The Blue Line is accessible for humans and humans alone.

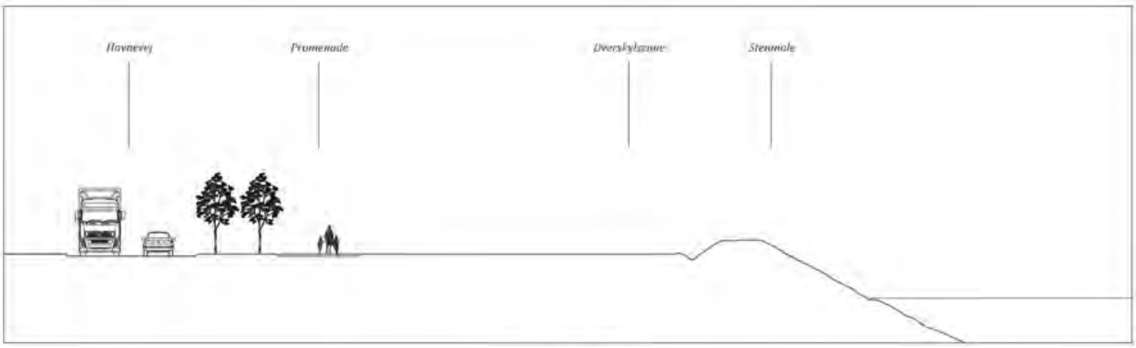


148 Perpetuating the conventional practice of omitting the marine realm in drawings and maps in design proposals concerning the sea (refer to section 2.2.3 Mapping the Invisible).

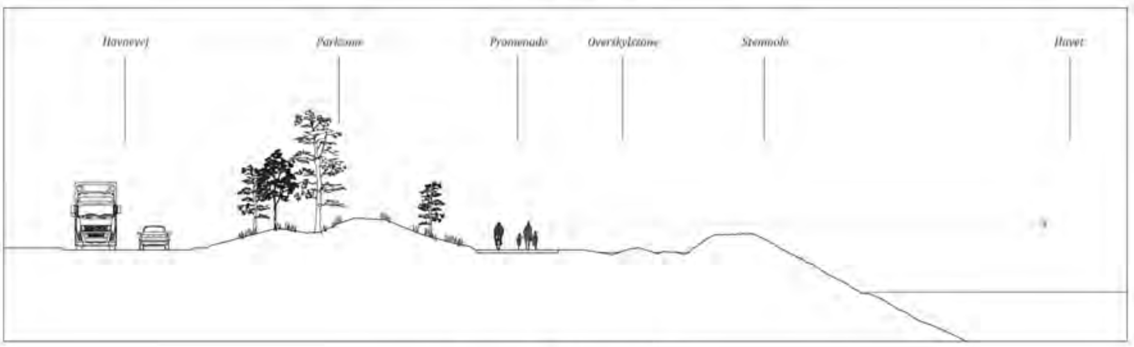
149 The research in section 3.2.2 on marine nature-based solutions shows that for these "blue approaches" to have a "reasonable" impact (i.e. water filtration, blue carbon, habitat, wave attenuation), initiatives such as stone reefs need to cover a larger area than what is proposed.

translated: *"A park for all – A park for everyday life in Aarhus."*

Figure 68. *(First image) Initial design proposals for "The Blue Line" on the southern end of the port expansion. Image credit: Aarhus Havn, COWI and Aarhus Municipality (COWI and Aarhus Municipality, 2022; Aarhus Havn, n.d., pp.22 and 26).*
(Second, third, fourth and last row of images) An initial urban landscape design proposal by C.F Møller Architects. Much of the design visualisations are focussed on land-based landscaping designed primarily for humans. While there are a few areas that open up for more direct access to the sea, it is not clear in the visualisations. Image credit: C.F. Møller Architects (2019).



Traditionelt moleprofil



Nyt moleprofil - Aarhus Blueline Park

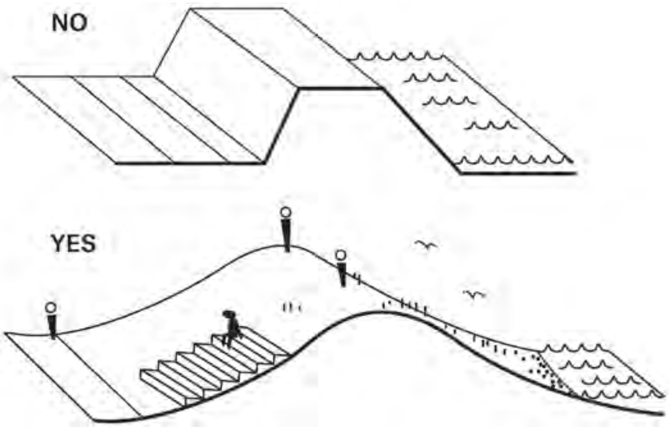


Figure 69. (First and second row of images) The Blue Line signifies a small departure from the previous B-A-U of land-reclaimed harbour constructions, where the traditional edge conditions did not consider any form of landscaping or seascaping (nor accessibility or recreation). Image credit: C.F. Møller Architects (2019).
(Bottom image) Aarhus Bugten is a response to the current trend of "greening" the dikes with landscaping and combining more social functions, such as space for recreation for everyday use (i.e. "non-disaster moments") (Gendall et al., 2015). Image credit: Rebuild by Design by Gendall et al. (2015).

Third phase: 20th-21st+: The Waterfront Lifestyle

Buildings, neighbourhoods and cities are cultural artefacts that symbolically declare to society the place held by each of their members. . . Even though built space shapes the experiences of people's daily lives and the cultural assumptions in which they are immersed, it is easy to accept the physical landscape unthinkingly as a neutral background. But the spatial arrangements of buildings and communities are neither value-free nor neutral . . . They are shaped by social, political and economic forces and values embodied in the forms themselves, the processes through which they are built, and the manner in which they are used. The built environment contributes to the power of some groups over others and the maintenance of human[150] inequality.

Leslie Kanes Weisman, *Routledge International Encyclopedia of Women: Global Women's Issues and Knowledge*
(Kramarae and Spender, 2004, p.86).

The other recent urban shoreline developments in coastal cities of Denmark have been driven by residential and commercial developments, namely a strong interest in living by the water with access to many recreational opportunities. Fuelled by neo-liberal patterns of development, much of the early 2000's waterfront housing developments were high-density apartment complexes not necessarily designed to adapt to the rise in sea level or storm surges (other than elevation above current sea level) nor designed to last more than 50 years from construction[151]. Nevertheless, the residential and commercial developments on the waterfront greatly transformed the area that used to be more dominated by industry (port activity) that was inaccessible to the public, blocking off the interaction with the water to only limited areas. Many waterfront areas in coastal cities have now become an area of recreation and a key part of tourism (as shown in Figure 70). These new developments are driven by the increasing waterfront lifestyle as a brand, promising recreational[152] opportunities by the water, which often fuelled marina expansions, harbour baths and other water sports activities (see Figure 70).

150 I argue in the context of this research, to include nonhuman/more-than-human actors as part of this statement.

151 Different building components and materials depreciate in quality, function, aesthetic and structural integrity over different period of time which would require replacement, refurbishment or demolition. Moreover, economic value of certain buildings can depreciate significantly after a certain time which often result in the demolition of the old building to replace with a new one for financial reasons. 50 year lifespan is the expected for a new building (Munch-Petersen, 2009; Aagaard et al., 2013; Økonomistyrelsen, 2022).

152 I do not intend here to dismiss the beneficial potentials of providing recreational activities by the water, what I am critical of is the business-as-usual waterfront developments that brings a certain type of recreational lifestyle that is not sensitive to the marine environment and use recreation as the rationalisation for such unsustainable and unadpatable developments.

Figure 70. (Top image) A photo of the reclaimed land recreational area of the waterfront of Aarhus. It is largely made up of the impermeable surface of asphalt and concrete (heat island effect in summer); it makes very little consideration for the engagement of coastal ecosystems nor any buffer space for excess water. Image credit: Kultur Aarhus and Dennis Borup Jakobsen.
(Middle row of images) All the high-rise waterfront residential complexes in Aarhus Docklands (Aarhus Ø), Denmark. Stone reefs envelop the reclaimed area to mitigate the strength of waves from storms and provide marine life habitat. Image credit: (Left) Nybolig (n.d.) and (Right) taken by the author on September 2021.
(Bottom row of images) The recent urban development of the waterfront in Aarhus Docklands/Aarhus Ø is coupled with the marina and various other amenities such as restaurants, bars, harbour baths and access to other water sports activities. Havnebad (Harbour Bath) is designed by Bjarke Ingels Group. Image credit: Google maps and Organo Wood (2018).

While there are clear recreational benefits and better access to water in these waterfront developments, there is an eroding notion of the waterfront as a commons for *all* living things as these areas become more gentrified. The character of the waterfront has changed by the development of unaffordable housing, resulting in the influx of the wealthier economic class, attracting new businesses and services at the expense of displacing inhabitants that are nonhuman marine life. Thus, the research explores in the next sub-section of this third phase of land reclamation the impact of current contemporary urban waterfront development that perpetuates a reductive and anthropocentric relationship with the sea, fuelled by the preoccupation with the sea merely as a view.

The paradox of the seaview – The human gaze

> *[T]he landscape idea throughout much of this century has come mostly in the form of picturesque rural scenery, whether for nostalgic, consumerist purposes or in the service of environmental agendas.*
>
> James Corner, "*Recovering landscape as a critical cultural practice" from The Landscape Imagination: Collected Essays of James Corner 1990-2010,* (Corner, 2014, p.117).

The sea has been subject to the human gaze (or the anthropocentric gaze) in waterfront developments, where it has been reduced to an aesthetic snapshot through which a particular lifestyle can be marketed and sold. In turn, this perspective is usually devoid of any in-depth understanding and appreciation of the complex agencies of the sea. This act of objectification of the sea has increasingly resulted in the sea becoming a passive commodity for consumption in the real estate housing market and is readily promoted as such, as shown in Figure 71 below.

Unique homes

Exceptional location

Make the dream of Aarhus' best view a reality

In Lighthouse you can begin your next chapter - in a home with well-chosen materials and stunning views.

Here you can experience nature up close, see guinea pigs swimming in the bay, experience the most beautiful sunrises, see the lights being turned on in the buildings in Aarhus when the sun goes down and enjoy the change of seasons in Riis Skov. Here you get the best of all worlds with both city life and nature as well as peace and pulse. So you dream of a home with a location out of the ordinary? Then Lighthouse can become your next dream home. Explore the many homes and find your future home.

Figure 71. (Translated by the author from Danish) Marketing narratives for a high-rise apartment complex in the Aarhus Docklands called "The Lighthouse" in Denmark. This development is another form of anthropocentric waterfront area from reclaimed land with hard edges. The landscaped greenery is often an add-on for marketing visualisations and is designed to serve aesthetic and recreational pleasure for the residents. The project is very "seaview centric" as one of the key marketing features and claims that this project is the meeting place between the city and the sea. Image credit: 3XN Architects (Lighthouse n.d.).

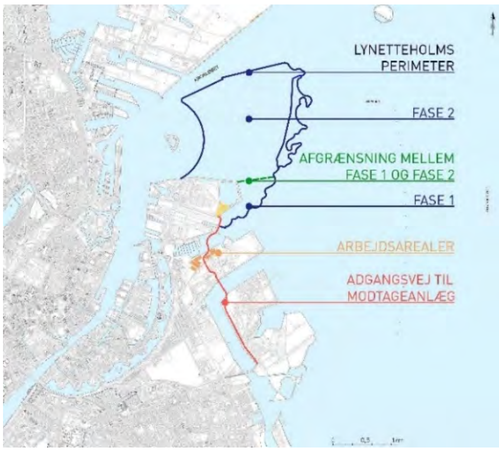
The obsession with seaview has been the catalyst for the huge market demand for expensive waterfront properties. This unsustainable form of urban development on waterfronts all over the world has been heavily criticised as a symbol of failed urban planning in the face of sea-level rise, storm surges and loss of biodiversity, to name a few (see Figure 72) (Pilkey and Young, 2011).

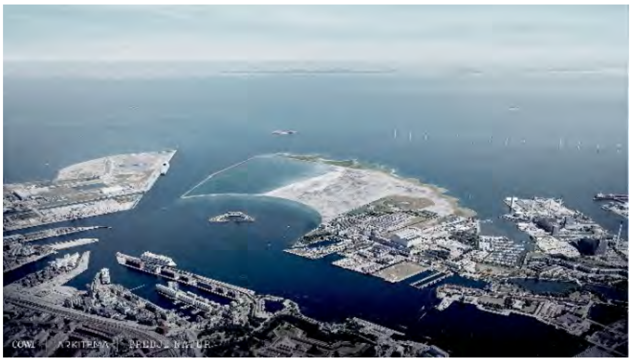
Figure 72. A highly publicised waterfront apartment in Vejle called "The Wave (Bølgen)," where the view out to the water (Vejle Fjord) is commodified for high-income buyers. Ironically, while this apartment complex's main selling point is the access to the fjord as a view, it blocks the view of the fjord for the rest of the city behind the complex. Image credit: (Top image) Mikkel Berg Pedersen / Ritzau Scanpix (Ryrsø, 2022). (Bottom row of images) Mette Frandsen (Skøtt Gadeberg, 2015).

The waterfront developments capture the current market-driven notion of the ocean merely as a flat horizon to gaze upon. It is devoid of any depth or presence of life in its representations. The current way in which seaview waterfront properties are marketed is a phenomenon that reflects the reductive, nostalgic and consumerist engagement with the sea that has fuelled unsustainable waterfront developments in the past decades.

Fourth phase: 21st C+: Land reclamation in the name of coastal protection – Lynetteholmen, Copenhagen

Considering the varied land reclamation projects in Denmark, an interesting paradigm has recently begun to take form. The new narrative for land reclamation is now supplemented by "doing it in the name of climate protection" (albeit not exclusively). The logic behind this new argument claims that the very act of land reclamation can be an inhabitable[153] form of coastal protection where the new land formed from the sea could be at a higher elevation that could act as a new "sea wall" to reduce the distance and costs required to install flood gates (see Figure 73) (Therkildsen, 2021; Tredje Natur, n.d.). This is the case for a controversial inter-generational land reclamation island project off the coast of Copenhagen called Lynetteholmen, which is unprecedented in size, duration and cost. It is expected to finish construction by 2070 and is estimated to cost between 20-80 billion kroner increasing Copenhagen city's area by 2% (2-3 million square meters of new land) to provide new areas for housing, amenities and jobs (Ida, 2020; Lindqvist, 2020; Nørgaard, 2021). Lynetteholmen is to be constructed as a dumping area for excess soil from construction sites and as a way to future-proof Copenhagen from increasing urbanisation and water-related issues due to climate change (Nørgaard, 2021).





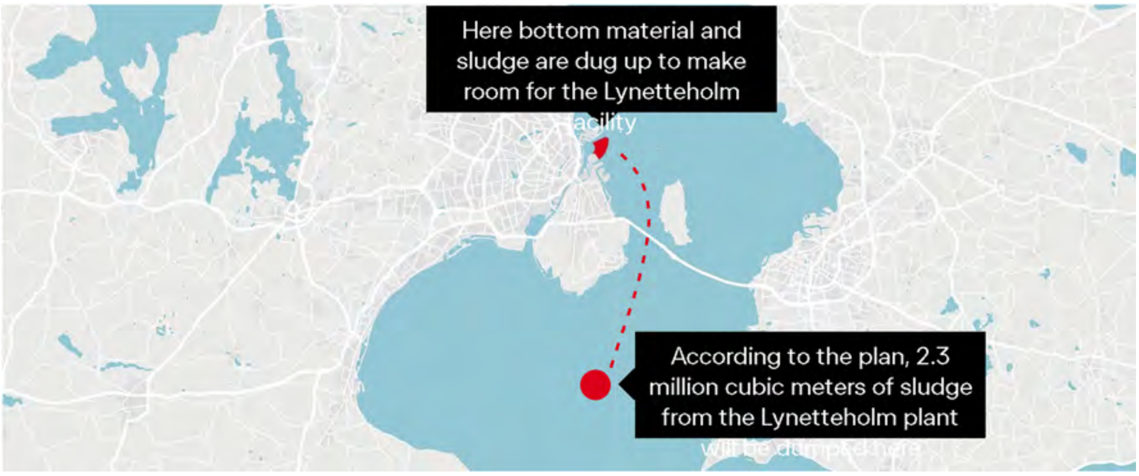
153 For instance, the land reclamation project called "Lynetteholmen" in Copenhagen is expected to house up to 35,000 new inhabitants with a new business district providing 12,000+ jobs (Nørgaard, 2021).

Figure 73. (Top left image) A map of two main construction phases of Lynetteholmen. The size of the project is outlined in blue. It is an extension from Refshaleøen to Nordhavn. Lynetteholmen will block Copenhagen city's visual access to the water (Øresund) and become more of an enclosed area. Image credit: By og Havn (Nørgaard, 2021).
(Top right image) A visualisation of what Lynetteholmen would look like by the year 2035 (part of the initial phase of filling the sea). The future use of this newly reclaimed land is still shrouded in uncertainties. Image credit: Arkitema, COWI and Tredje Natur (Nørgaard, 2021).
(Second-row image) The edge of the Lynetteholmen that fans out to Øresund is allocated for storm surge protection that doubles as a recreational area with new landscaping to increase biodiversity. Image credit: By og Havn (Ida, 2020).
(Third row) Visualisations of some of the nature-based edge conditions consisting of stone reefs to mitigate the strength of storm surges and new buildings that could occupy the new district of Copenhagen to mitigate the increasing urbanisation. Image credit: Tredje Natur (Tredje Natur, n.d.) and Lynetteholmen (Lynetteholmen, 2022).

Similar to the Aarhus Bugt project, much of the controversial negative press has been due to the issue around the environmental impact[154] of the construction of this scale, especially the large

154 My interview with a marine biologist in Malmo who has been working with stakeholders in developing Malmo (which faces similar urban development patterns of ocean sprawl via land reclamation), argues that land

amount of dredging and dumping of toxic soil in the sea (i.e. called clapping – which is a necessary process required for land reclamation projects) (Deiborg, Ejbye-Ernst and Frandsen, 2022; Naturfredningsforening, 2022) (as shown in Figure 74). Clapping represents a long-withstanding approach that the sea is so expansive that it can neutralise sources of pollution (Patton, 2006) – thus, the justification for building Lynetteholmen is a dumping ground for excess soil (Nørgaard, 2021). While the opinion on the pros and cons of Lynetteholmen has been divided (Dahl, 2019; Hove Olesen, 2021; Lonning-Skovgaard, 2021; Ritzau, 2022), what is interesting from an urban development perspective is that Lynetteholmen is presented as a coastal protection project, a necessary economic means to fund coastal protection in Copenhagen (Ida, 2020). Urban densification is also presented as another justification for land reclamation projects like Lynetteholmen (Lonning-Skovgaard, 2021). However, there are questions regarding the potential of developing and strengthening the networks of the nearby towns/suburbs near Copenhagen as an alternative to land reclamation by those who oppose an alternative to Lynetteholmen as a new residential and commercial development (Dahl, 2019). Moreover, the aforementioned inability of coastal cities to enact (or even consider) "no development of B-A-U" (i.e. unsustainable and unadaptable buildings via land reclamation) in risk areas as part of the coastal adaptation strategy is particularly apparent.



reclamation is not a good solution to provide coastal protection because it creates boundaries which prevents water flow impacting marine life and decreasing water quality to name a few. He advocates for more "soft areas" (i.e. nature-based solutions) with buffer zones for the excess water (Palmgren, 2019).

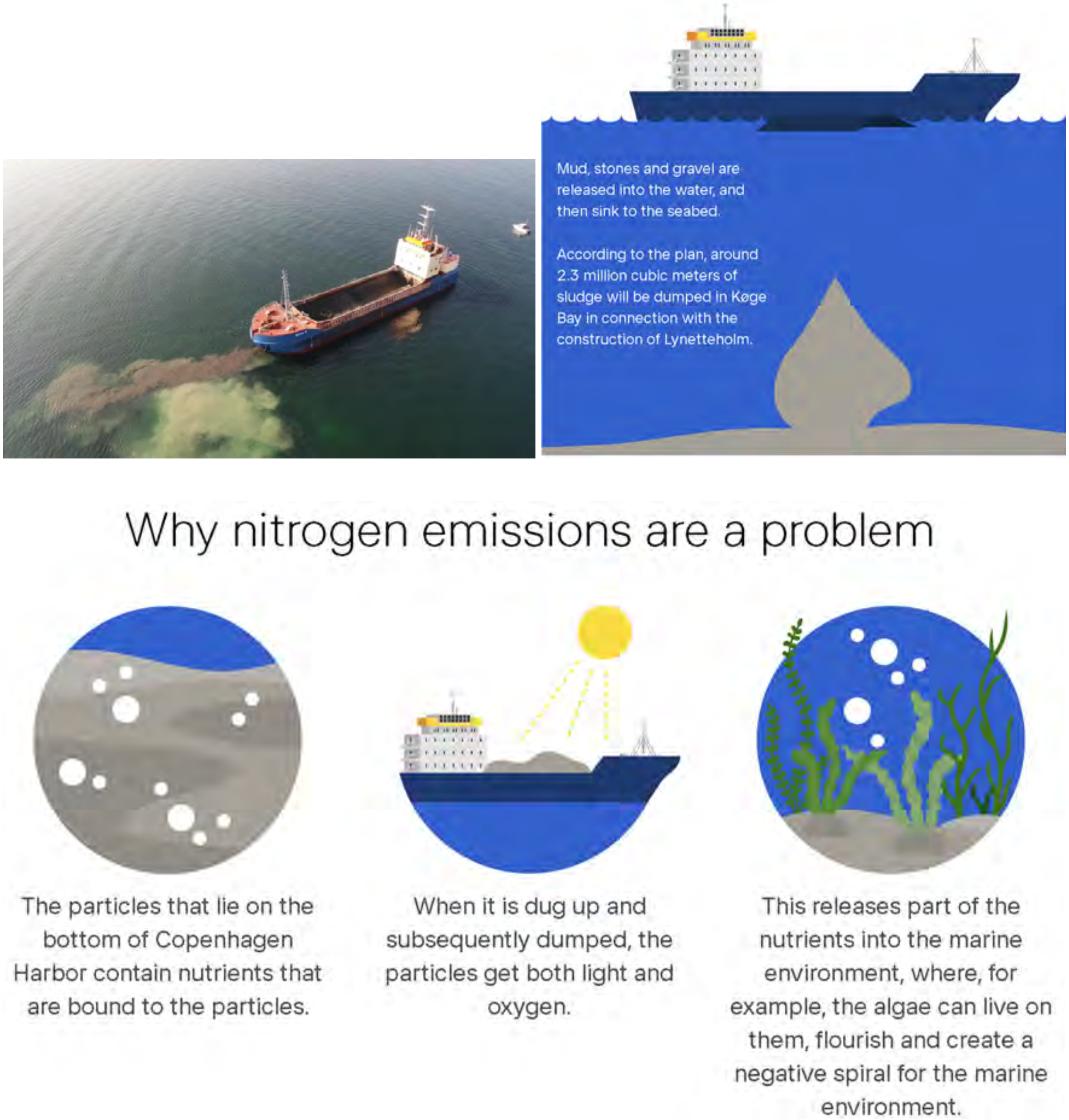


Figure 74. The impact of clapping/dredging on habitat-forming marine species like seaweed. Therefore, clapping could hinder any efforts to integrate marine nature as part of nature-based solutions (i.e. urban seascaping) near the impacted area. Image credit: Signe Heiredal and explanatory text by Jonas Deiborg (translated from Danish to English) (Deiborg, Ejbye-Ernst and Frandsen, 2022).

Nevertheless, there is a sign of commitment to reinstate marine coastal nature to envelop Lynetteholmen with a green-blue coastal infrastructure in the form of stone reefs which functions as coastal protection but reap the benefits of ecosystem services (refer to definitions and section 1.5.2). The landscape architecture firm responsible is trying to introduce more coastal marine “nature” restoration (not only terrestrial) as part of land reclamation, unseen in other land reclamation projects to date, as shown in Figure 75.

Figure 75. Lynetteholmen will also host a green-blue coastal landscape of 78 ha with nature-based solutions as part of coastal protection from storm surges and a green-blue recreational nature area for the residents (Tredje Natur, n.d.). Image credit: Tredje Natur.

Having reviewed the four historical phases of coastal development in Denmark, it is evident that land reclamation as an urban development model is likely going to stay in Denmark. However, this practice introduces immense complexities surrounding the future role of coastal protection. But despite the environmental problems associated with large-scale land reclamation projects and the problem with continuing B-A-U ocean sprawl in the face of SLR/SS, there is a minor paradigm shift to incorporate coastal nature with these land-reclaimed urban developments does occasion some optimism, especially from a designed urban landscape-seascape perspective. That being said, further studies are required to assess the actual impact of these larger-scale marine nature-based solutions against the construction of land reclamation, along with its potential for public engagement. But before I examine in more depth the S-O-T-A alternatives to the hard approach, it is necessary to briefly review two of the underlying conceptual and culturally informed dynamics that tend to underwrite many of the practices discussed in this first section of Part III, namely the notions of "terrestrial bias" and the "nature-culture binary".

3.1.6 "Terrestrial bias"

This land-based, city-focused approach has led to research in urban studies that occasionally looks out to sea, but either focuses on abstract economic dimensions or logistic flows, or on select and limited spaces of network structures, for example, in relation to port cities... researchers have rarely explored people and infrastructure in the sea space - the foreland - or reflected on how they are directly linked to the hinterland. Land-side decision-makers, often working in capital cities away from the coast, exert a profound influence on the sea, shaping its spaces and practices often with land-based tools. Institutions and scholars studying the North Sea region also often have a land-centred bias and study ports, cities, and their regions through select lenses.

Nancy Couling and Carola Hein, *The Urbanisation of the Sea* (Couling and Hein, 2020, p.9).

Figure 76. This is representative imagery of terrestrial thinking by Heatherwick Studio in New York City's Hudson River that transfers land-based green public space on top of the water[155]. A terrestrial green park with trees, grass and flowers is placed directly on the water rather than incorporating more water-based vegetation (i.e. a form of "blue" park). Image credit: Heatherwick Studio (2021).

155 A similar project has been proposed in Denmark called "Havnepark" (Harbour Park) in Pier 2 of Aarhus Ø (Willumsen, 2021).

Terrestrial bias is a broad term that refers to the tendency of human beings to prioritise land-based issues over water-related issues. The normative land-focused approach is prevalent in various fields such as urban planning/design, landscape architecture, media representations, logistics, marine management, and so forth. In "Wild Blue Media, thinking through Seawater", Jue (2020) argues that terrestrial bias in media theory. Importantly, she highlights that, in principle, there is nothing wrong or inaccurate about terrestrial bias. Rather, it signals that most of our perceptions, senses of risk and ambitions for development are almost always restricted by "the fact that we live on land, are bound by gravity when we walk, and experience daily life as immersion in invisible air rather than water... In philosophy and beyond, the Earth's surface under an atmosphere has been taken as the default environment for human thought[156] and the foundation of intuition about spatiality" (Jue, 2020, pp.11–12). She states that terrestrial bias is one of the land-based lenses through which humans have formed a common imagination of the environment. Despite this persisting bias, Jue (2020) argues that it does not represent the whole picture: "Terrestrial contexts are one milieu for cognition to press up against; thought might develop entirely differently in an aquatic environment like the ocean" (Jue, 2020, p.12). Thus, one of the requirements for studying the ocean as an epistemic environment for thought is to attend to the material specificities of the ocean and, in particular, the bias of the observer/perceiver interacting with the ocean (Jue, 2020).

Within the context of coastal cities (in the field of LUDP), I claim that there are various forms of terrestrial bias at work and that these are both marked and made visible through their material and physical outcomes. For instance, terrestrial bias is present in the harbourfront/waterfront areas in the form of land reclamation out into the water (as outlined in Figure 57 and in section 3.1.5), as highlighted in Figure 71, where reclaimed land is adorned with terrestrial plants as part of the landscape proposal replacing former marine life/vegetation. There are even more evident physical representations of terrestrial bias, as indicated by a project by Heatherwick Studio in Figure 76, where a terrestrial green public park was constructed literally on top of the water, perpetuating and extending the land-based perspective. This phenomenon of building on water resembles many "floating cities[157]" narratives in the architecture industry, perpetuating the terrestrial bias onto the water by literally extending B-A-U buildings directly on top of the water (i.e. as shown in Figure 77).

156 Supported by the current mapping representations that is also limited in the depiction and the understanding of the marine realm. See section 2.2.2 for more details.

157 I would like to reiterate that I am not critiquing (or, in principle, against) the concept of floating buildings. Rather, I am emphasising the issues associated with replicating business-as-usual buildings on top of the water, with little regard for the marine life nor the understanding of the building's impact on the local hydrology.

Figure 77. Screenshots/excerpts from the Deutsche Welle (DW) documentary called "Climate change – Living on water" (screened on 08 July 2020 on YouTube). The design proposals are from a Dutch Architecture company called "Water Studio" in Rijswijk, The Netherlands.
Image credit: Climate change – living on the water, DW Documentary (2020) and Water Studio (n.d., n.d.).

Terrestrial biases are also present in the distribution and allocation of public and private funds allocated to infrastructural projects. For instance, in the city of Vejle, there has been a significant amount of expenditure spent on grey infrastructure, such as the highway Vejle bridge for motor vehicles built in the 1980s, to ease traffic congestion by going directly across the Vejle fjord (costing 350million kroner/47million euros in the 80s) (ETH Zurich, 1982; Visit Vejle, 2022c). Here, there is another discussion of building a new bridge or a tunnel to go across Vejle fjord for high-speed trains to also reduce commute time by mere 12 minutes at the expense of 4-5 billion kroners (approx. 540-570million euros) (Vejdirektoratet, 2016; Andersen, 2021a; Transportministeriet, n.d.). In contrast, the "Sund Vejle Fjord" (Healthy Vejle Fjord) marine restoration project, as mentioned in section 1.4.1, struggles to get a more permanent source of funding for the longevity of the restoration project, relying on temporary private and public funding with reliance on volunteers (Sund Vejle Fjord, 2022; Vejle Ådal & Fjord, 2022). In comparison, the restoration budget for Vejle fjord is a mere 25 million kroners for the period of 5 years[158] (approx. 3.4 million euros) to prevent irreversible damage to the Vejle Fjord (see Figure 78). Of course, there is potential for Sund Vejle fjord's nature-based solutions to be upscaled than its current operation, which is showing signs of improvement (Miljøstyrelsen, 2021; Sund Vejle Fjord, 2022). In that case, there is a possibility that it can be considered as a blue ecological infrastructure comparable to grey infrastructure that provides various critical services for the citizens of Vejle, such as carbon sequestration, mitigating coastal erosion, wave attenuation, water filtration, habitat, food, feed, biofuels, organic fertilisers and so on (as outlined in section 1.5.2).

Figure 78. Terrestrial bias in land-based infrastructural projects that prioritise grey infrastructure. In comparison, Sund Vejle Fjord (Healthy Vejle Fjord) project is funded by the Velux fund (15 million DKK), with Vejle Municipality providing another 10 million DKK from 2020-2024 (Vejle Ådal & Fjord, 2022). It is uncertain whether the project will continue beyond this period. The project's longevity is paramount and cannot continue without continual investment in the future. Image credit: Holsøe arkitekter (n.d.), BEAM projects (n.d.) and Sund Vejle Fjord.

Even the various nature protection measures (i.e. Natura2000 areas) showcase terrestrial bias, where the nature on land is protected, but the protection does not extend beyond the coastline[159] as shown in Vejle fjord as shown in Figure 79, disregarding the ecological connection between land and sea (refer to Figure 58).

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158 According to researchers, ongoing restoration efforts are needed in Danish coastal waters. To achieve "good ecological condition" of coastal waters will take a long time (i.e. an estimated period of 40 years) (Bredsdorff, 2018a).

159 Furthermore, these nature protection areas have stronger protection for terrestrial animals over marine animals. For instance, in the "Nature and Wild" reserve in Fjordbyen, Vejle, hunting of birds and commercial fishing is banned but recreational fishing is still allowed (Vejle Municipality, 2019b; Miljøministeriet Naturstyrelsen, n.d.). However, marine protected areas (MPA) is greater in size than land-based nature protection area in Denmark, but they are in the deeper waters of Denmark (as shown in Figure 13).

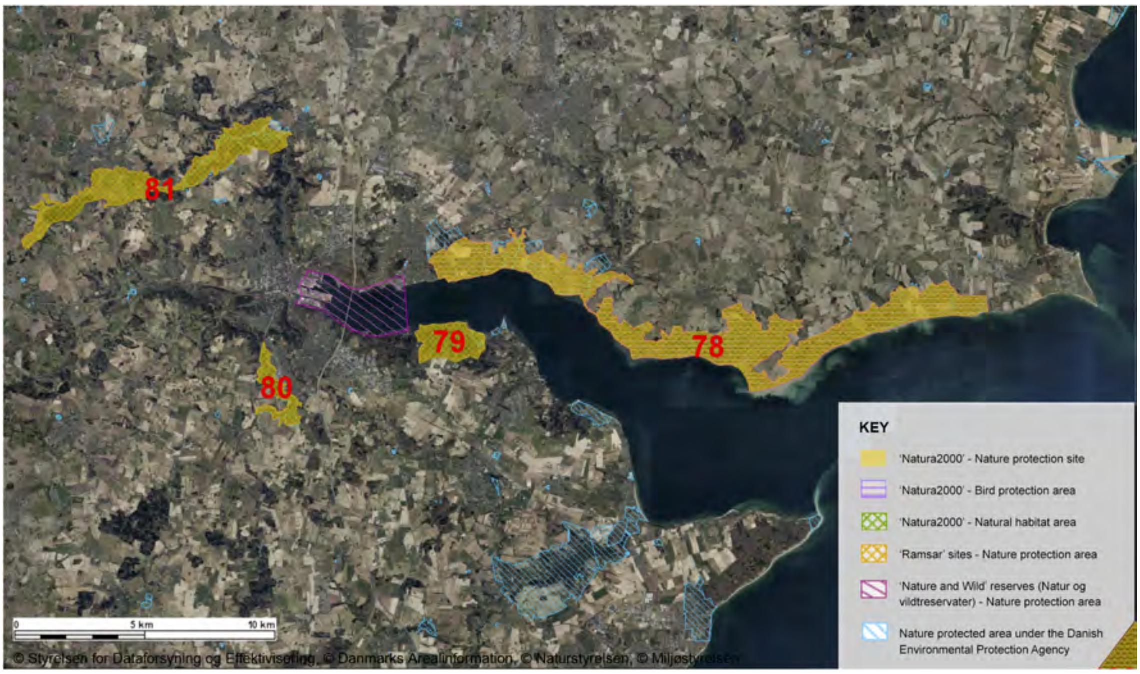


Figure 79. Map of Vejle Fjord and the various nature protection areas surrounding it. They are mainly on land protecting existing forests and meadows as opposed to placing protection areas to help Vejle fjord in reviving the fish, mussels and eelgrass population under the water. GIS data credit: MiljøGIS, Miljøstyrelsen (2016).
(Extracted from Kumu Multiscalar map – Fjord scale node).

Terrestrial bias is an inescapable facet of the current decision-making process when it comes to coastal adaptation and urban development. It is especially evident from the dismissal of the integration of ecologically significant coastal ecosystems at the expense of prioritising the development of waterfront areas on reclaimed land (Galland et al. 2012; Filbee-Dexter and Wernberg 2018). Questions of how we can acknowledge terrestrial bias and help move past thinking beyond terrestrial borders are needed to address the impact of neglecting the invisible world beneath sea level.

3.1.7 Nature vs Culture binary at the coast

Another key reason behind the lack of response to the continual degradation of coastal ecosystems and the lack of inclusion of their presence in our urban shorelines, I claim, is the dualistic modes of thinking that have influenced our relationship with the marine world. Prevailing ideologies such as human exceptionalism (Braidotti 2019; Haraway 2016), global capitalism (Campling and Colas 2021; Claudet, Amon, and Blasiak 2021) and terrestrial bias (Dobrin 2021; Jue 2020) are partly responsible for the conceptual barrier that conceives the marine world (i.e. nature) as something separate from humans and the urban condition. Crucially, this dualistic conception of the relationship between nature (the sea) and culture (the city) does not reflect the reality of the complex entangled network of interdependent connections (Prominski 2014) that make up the urban waterfront. While this dualism has a long and influential history within the Western world, its scientific and philosophical movements from the renaissance and onwards (from Descartes to Kant), it can also be exemplified in the physical manifestations of the striking delineation between land and sea in many contemporary coastal cities. As shown in Figure 57 in section 3.1.3 and Figure 70 in section 3.1.5, the land border's edge on the coast is often constructed from fortified concrete bulkheads with a 1-2m elevation and a sharp 90-degree drop to the water, creating a clear separation in between. This particular spatial composition translates into a rationale that designates the watery world as a space that ought to be tamed "down there", segregated from the urban environment. As a result, the way coastal cities are designed creates a physical and perceptual barrier for people to engage with the intricacy of the entanglements of the marine world (see Figure 80 below).

Moreover, the divided physical conditions at the urban coastal edge highlight the tendency for the cities to only engage with the sea from an instrumental, recreational or romanticised manner propelled by the waterfront property development boom over the past decades. This anthropocentric conception further exacerbates the stark nature vs culture dualism, where nature is something that only consists out in the wilderness worthy of protection and admiration. In contrast, the nature of "everyday" urban spaces is not as valued, despite playing an important accumulative role in climate adaptation, for instance, its capacity to increase permeability in the city (Wiberg, 2018). Those everyday landscape spaces in the city are a prime example of the interdependency and the entanglements of nature-culture.

Figure 80. The waterfront areas of Middelfart, Denmark, show the dualistic spatial division of "nature" and "culture." (Left) Despite having the sea next to the waterfront, there is no tactile way to engage with the water (this is also due to the stronger currents). Instead, a small artificial replacement pool is built only for small children's recreation. There are no "rockpools" that host marine life.
(Right) The waterfront areas have very few areas for landscaping, but, in this case, it is terrestrial and not marine. The waterfront is dominated by impermeable paving. The photos were taken by the author on August 2022.

Fortunately, there have been efforts to transcend the current nature-culture divide in the field of landscape architecture and urban planning reflected in the recent movements[160] of Landscape

160 The influence of ecological approach to planning and design of communities, goes all the way to Ian McHarg's book "Design with Nature" published in 1969.

Urbanism (Waldheim, 2016) and Ecological Urbanism (Mostafavi, Doherty and Design, 2016). These movements refocus on an ecological approach to urbanism that marries ecological health with a mutually beneficial design for both humans and other species (Mostafavi, Doherty and Design, 2016). However, the effort of incorporating nature in the LUDP disciplines has been dominated by green terrestrial forms, only rarely integrating the blue marine environments. Yet, with the emergence of movements like Blue Urbanism (Beatley 2014) and Coastal Urbanism (Segal and Drake, 2021), a paradigm shift is imminent in the LUDP disciplines. Thus, the next sections will explore further how this movement seeks to depart from B-A-U approaches.

3.2 Departing from the status quo

The first part of this chapter (section 3.1) dealt with the current dominant approaches to coastal protection, adaptation and urban development models of coastal cities. While hard approaches certainly play a role in ensuring the continuing operation of coastal cities, it does not necessarily address the increasingly negative impact of climate change on biodiversity, GHG increase and water pollution, to name a few. Therefore, alternative approaches that provide the added value of climate mitigation, water filtration, carbon sequestration, enhanced biodiversity and coastal protection are explored in this latter part of the chapter (see Figure 81 on community and ecology-driven forms of waterfront development). These alternative approaches are not restricted to technological and biological responses but also emerging schools of thought and intrinsic value propositions that can challenge the current status quo of urban development in coastal cities.

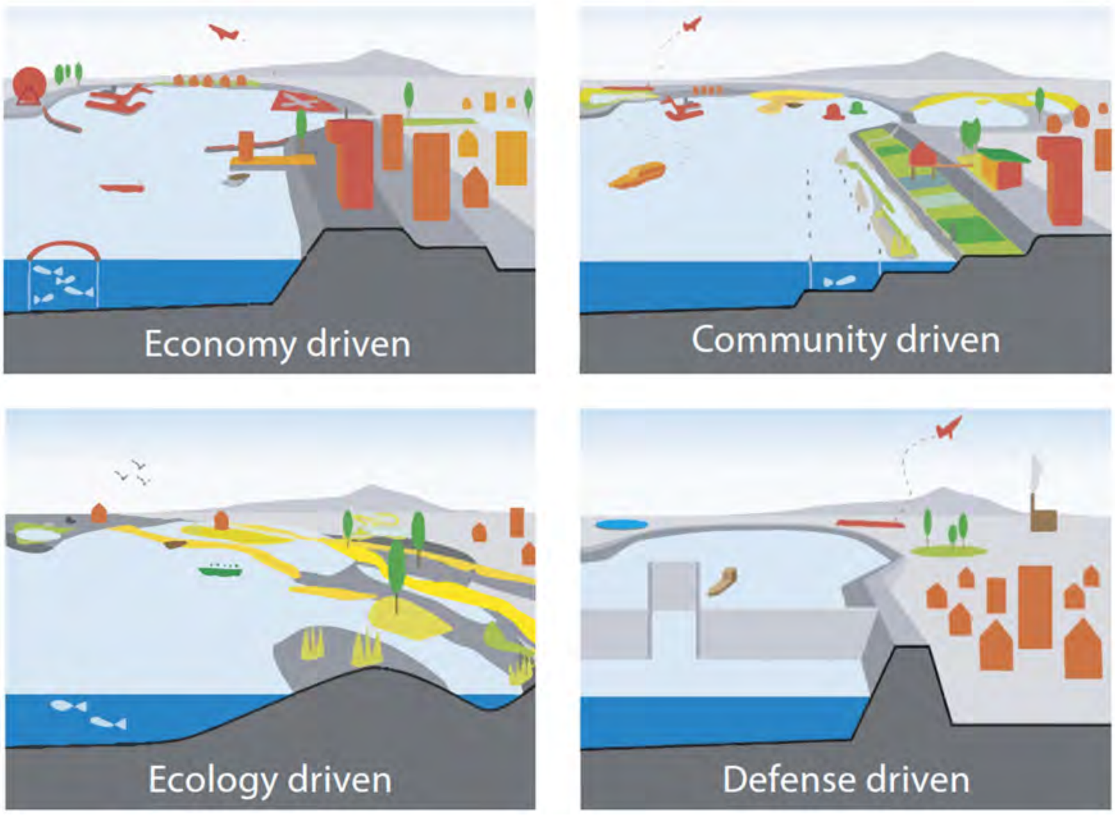


Figure 81. Looking into a more community and ecology-driven approach, departing from the current economy and defence-driven approach (Al and Westerhof, 2018). Image credit: Arcadis.

3.2.1 "Blue Urbanism and Coastal Urbanism" – Beyond the Green

The increasing influence of ecology in the field of landscape architecture and urban planning, such as in the emergence of Eco-Urbanism (Ruano, 1998), Ecological Urbanism (Mostafavi, Doherty and Design, 2016), Green Urbanism (Beatley, 2000), addresses a shift in focus that integrates better the various complex environmental and contextual factors (e.g. hydrological, ecological, geological, climatological) as well as wider territorial scales. These movements increasingly depart from object-orientated interventions to consider intricate, complex and dynamic systems (Orff, 2016). Furthermore, they seek to recognise that baseline ecological conditions of the past's absence of human interference[161] can never be reached again. As the impact of climate change worsens, one of the new challenges for cities is to navigate the precarious scenarios of supporting the vital activities of human populations[162] while simultaneously regenerating and conserving ecosystems under threat.

Nevertheless, the influence of ecology has primarily been focused on green environmental movements within the territorial boundaries of the land (see also section 3.1.6 on "Terrestrial bias). There are many successful examples of re-greening cities by protecting and planting trees that have transformed urban environments' atmosphere and ecology (see an example from Utrecht, Holland, in Figure 82). However, there is a lack of equivalent attention paid to blue public spaces/commons[163] and blue gardens (Kozlovsky and Grobman, 2017)[164]. For instance, Figure 82 presents recent projects that are addressing the "blue aspect" of urban regeneration, such as recreational areas that can function as retention ponds in the event of a heavy cloudburst event in Copenhagen, Denmark (Tredje Natur, n.d.) and reintroducing wetlands as part of the flood resilience in Wei River in China (Landezine, 2019). As SLR and SS become an increasing concern for coastal cities, there are new opportunities for integrating and focusing our attention on the "blue" [165]. For instance, research by Wiberg (2020), Hill (2015), Faragò et al. (2018) and Quintana et al. (2021) assesses the various built coastal protection, adaptation and coastal ecosystem restoration projects in Denmark and around the world. The findings indicate a research gap in

161 This is a big discussion among researchers and academics about when the start of major human interference on the so-called "natural world" began. Some researchers claim that it began from the onset of agricultural revolution that made significant changes to the land from the mid-17th century onwards and others argue that significant human interference started after the industrial revolution towards the end of the 19th century (Clarke 2015).

162 Anthropogenic activities are predicted to increase throughout the 21st century from global population growth and increasing urban densification (United Nations, Department of Economic and Social Affairs, and Population Division 2019).

163 What I mean here by blue public space/commons are not marinas, harbour baths or waterfront promenades, but spaces that integrates marine life forms (such as seaweed, eelgrass, mussels, and so on) as one would do with green spaces where it integrates terrestrial life forms (such as trees, flowers, and so on).

164 For instance, the sea gardens initiatives from Havhøst. Refer to section 1.5.2, or entries from Kanten/The Edge design competition in Vejle as shown in Part IV section 4.1.1.1.

165 Similar movement has been happening in the Arts and the Humanities, in a sub-field called "Blue Humanities" characterised by inter-trans disciplinary practice, synthesising environmental studies, oceanography, marine biology, maritime history, Atlantic history, ecology, science studies, looking into how the ocean has shaped history, science, languages, aesthetics and sensibilities (Gillis, 2013).

more dynamic landforms and the need to integrate more marine nature-based solutions that require further exploration (see Figure 83).

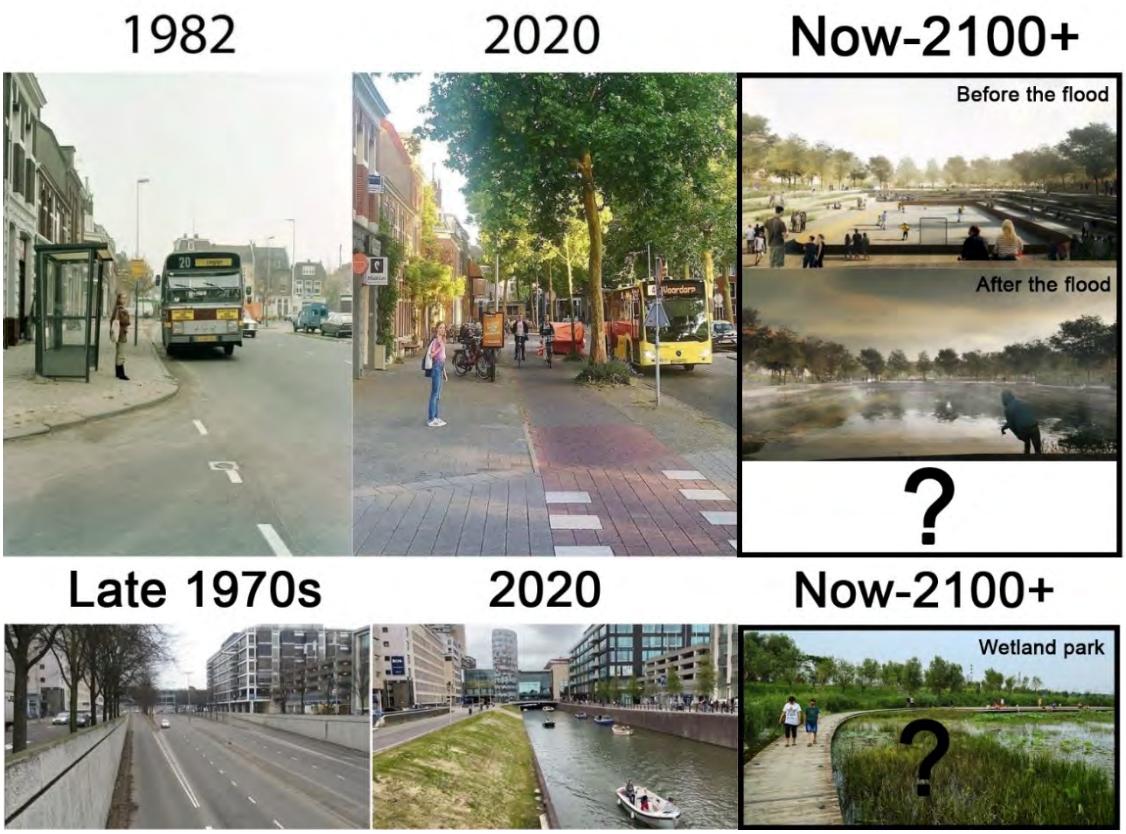


Figure 82. (Top image) An example of more than four decades of terrestrial greening of cities via protecting urban planning in favour of trees is in Utrecht, Holland (Bom, 2022). Image credit: (Bom, 2022).
(Bottom image) An example of undoing the asphalt developments. The canal in Utrecht was restored after 50 years (Williams, 2022). Image credit: Bicycle Dutch.
The last column (Now-2100+) indicates the scope for more blue infrastructures, such as nature-based retention ponds and water-based vegetation landscaping-seascaping, as water gains more prominence in cities due to flooding or SLR/SS by the end of this century. The Top Right image is a project called "Enghaveplads" (Climate Park in English) in Copenhagen, Denmark, by Tredje Natur, and the Bottom Right image is a project called Weiliu Wetland Park by Yifang Ecoscape in Wei River's floodplain outside of Xianyang City, China. Image credits: Tredje Natur (n.d.) and Yifang Ecoscape (Landezine, 2019).
(Extracted from Kumu S-O-T-A map – Enghaveplads, Copenhagen and Weilu Wetland Park, China node).

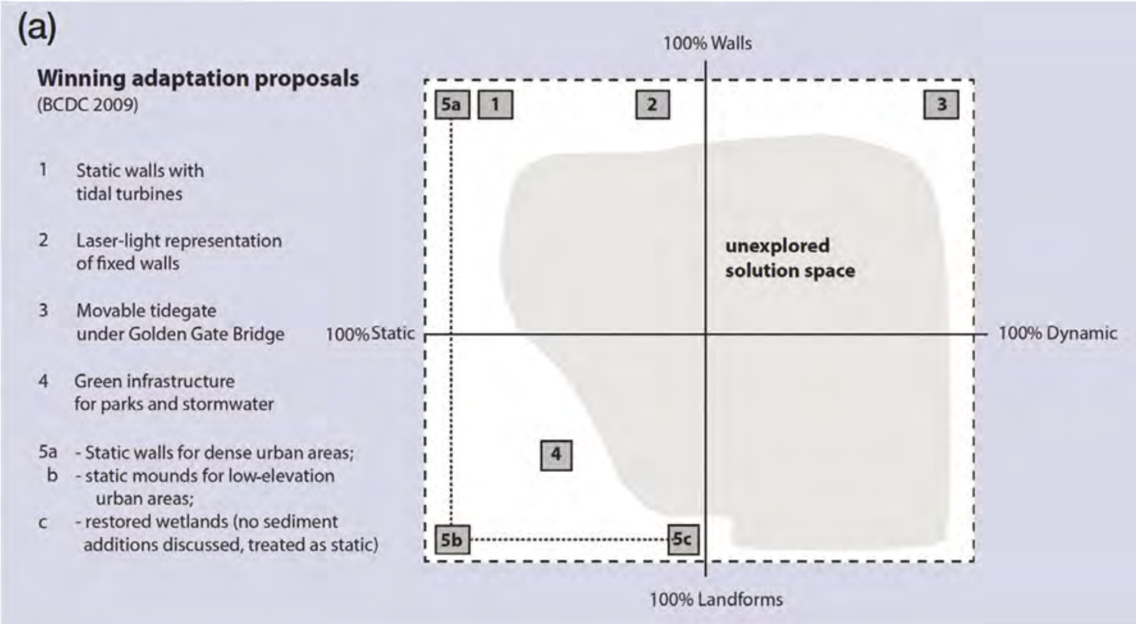
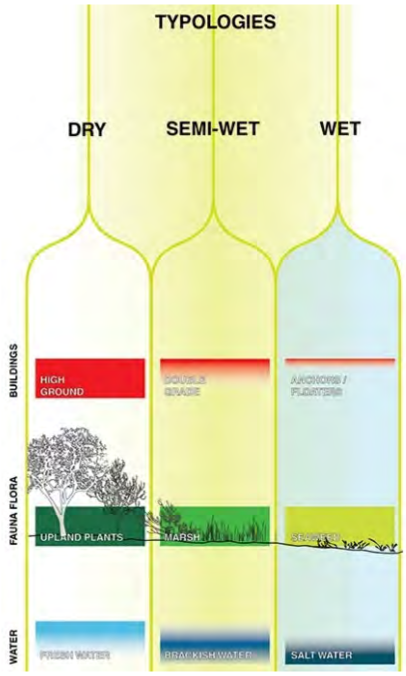


Figure 83. Based on Kristina Hill's BCDC's Bay Policies workshop (in the USA), exploring alternatives for coastal adaptation. Findings indicated a large unexplored solution space for more dynamic landforms (Hill, 2015). Image credit: Kristina Hill (2015).

Nevertheless, there is a growing awareness of the ecological footprint of coastal cities on the sea and the vital role marine ecologies play in addressing global warming. As a response, there is an emerging ethical approach called "Blue Urbanism" by Timothy Beatley (2014). He highlights the need to change the current exclusion of marine environments in modern policy, planning and design of cities (Beatley, 2014). He calls for coastal cities to exercise more proactive conservation and integration of marine ecosystems to tackle the current unprecedented risks to ocean health. Therefore, blue urbanism presents an argument for the importance of heightened awareness and partnership among city governments, planners, designers, scientists and urbanites to become part of a more complementary, mutually sustainable relationship between the city and the ocean (ibid.). The focus for coastal cities should extend beyond the sea level rise and storm surge issues but also the importance of coastal ecosystems and their role in nature-based solutions, along with community outreach and educational programs to enhance ocean literacy.

Moreover, climate catastrophes have driven a paradigm shift to waterfront developments in the USA, especially in the aftermath of Hurricane Sandy in New York City (NYC). Rafi Segal (Rafi Segal A+U) and Susannah Drake (DLand Studio), for instance, developed the notion of "Coastal Urbanism", which presents a set of strategies, principles, and frameworks to change the urbanism and landscape along the coast to relieve the tension between the city and the ocean (Segal and Drake, 2021). The strategies are "an iterative, interdisciplinary, team-oriented design approach, [where] communities can come together with their elected officials to engage in a meaningful adaptation of the waterfront to reduce future damage and loss while securing more resilient and healthy environments" (ibid.).

One of the proposals that exemplify their approach is called "The Bight", which is in the Tri-State region of New York, New Jersey and Connecticut (see Figure 84). The proposal consists of a buffer zone in which land and water inter-mingle, creating new spaces for residence, work, recreation, habitat and future renewable energy production. Rather than constantly trying to maintain a hard edge, the edge becomes a more flexible and transformable surface with new economic, cultural, and environmental value (ibid.). Thus, Segal and Drake (2021) proposed three principles of "Receive, Protect, and Adapt", which aim to redesign the meeting of land and water in this extensive zone (see Figure 84). "Receive" proposes increasing development and density on higher ground by strengthening transit corridors to enhance mobility and connection. "Protect" proposes to maintain and upgrade the vital infrastructure that can double as starting points for amphibious development, such as a living reef that lessens storm surge. "Adapt" proposes various activities in this buffer zone[166] to connect and relieve the pressure on the boundary dividing land and water. It also means that part of the risk area will retreat, as rising waters will make conventional B-A-U development impractical, redundant and dangerous. While buildings that have adapted to deal with more water will likely remain (such as elevated buildings on stilts), no public funding will be dedicated to infrastructure serving single-family homes in these zones (Segal and Drake, 2021). Thus, the three approaches reinterpret the thresholds between wet and dry, in some cases inviting the water to enter areas for water-based transport and recreation. Furthermore, areas of lower density intend to use this spongy land as a resource for cleansing industrial and agricultural runoff through a nature-based solution and, where possible, create renewable energy by capturing tidal energy (ibid.).



166 According to Segal and Drake (2021), the buffer zone refers to "a new Coastal Land Management zone can reestablish the interface of land and water with a transformation from a hard line to an ecological zone - a field of protection and recreation. As such, this zone relieves the tension between the city and the ocean resulting from extreme storm events, high tides, elevated water tables, and flooding".

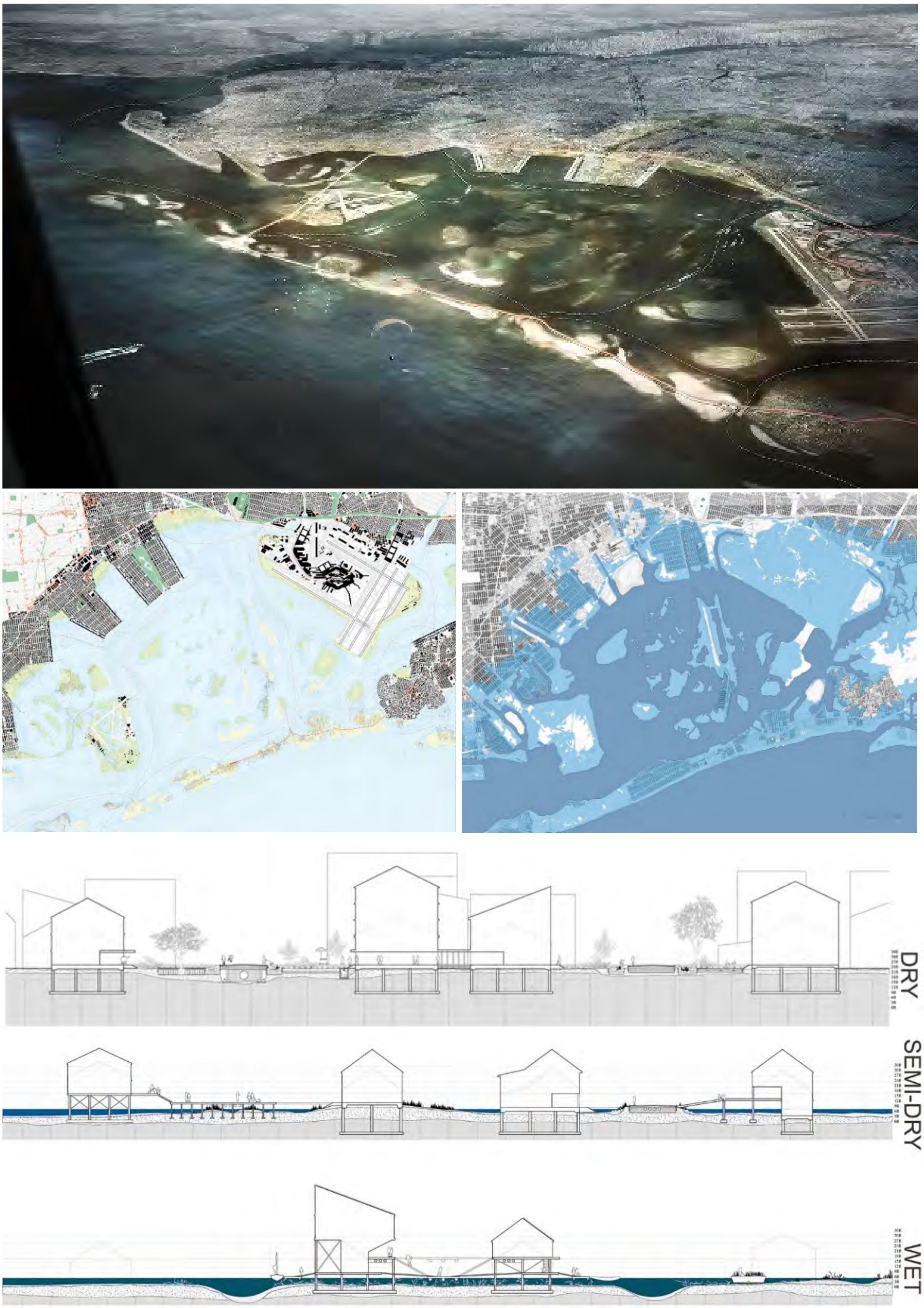


Figure 84. Project by Rafi Segal A+U and DLand Studios (Susannah Drake) – "Bight: Coastal Urbanism" in the Tri-State, USA. This project aims to replace the hard edge that segregates the city and sea with a new "landscape economic zone — a buffer that allows land and water to commingle, creating new spaces for habitation, conservation, work, and play. This project is an example of long-term retreat as part of the coastal adaptation strategy" (DLand Studio, n.d.).

(Top row) The three main principles and three main typologies of Coastal Urbanism.
Image credit: (Second row) - Vision for a new landscape/seascape of the future – a buffer zone between land and sea (that is not based on land reclamation but allowing water to infiltrate).
(Third row) – Before and after mappings of the area where certain risk areas are allowed to be inundated due to SLR and certain critical areas protected.
(Bottom) – Different building and landscape/seascape typologies for areas that will be frequently inundated or permanently inundated due to future SLR.
(Extracted from Kumu S-O-T-A map –Bight Coastal Urbanism, NYC node).

Many of these "blue" projects are still unbuilt and unrealised, indicating a need for more realised projects to study the successes and shortfalls of these projects. Consequently, the next section will delve into a few state-of-the-art projects that work with coastal ecosystems to provide an alternative approach to the B-A-U to coastal protection/adaptation and urban development.

3.2.2 The living coast – The Soft Approach

Urbanites often forget that life on land and sea are closely connected. For instance, estuaries supply nutrients to coastal areas, and the coastal ecosystems protect inner land from flooding via wave attenuation and help mitigate coastal erosion (Quintana et al., 2021). These coastal ecosystems are seen as alternatives to the engineered hard approach and are referred to as "nature-based solutions" (NbS) or the "soft approach." Examples include salt marshes, beach meadows, swamps, coastal wetlands, dunes, rocks and reef-building species like seaweeds, oysters and mussel beds (see Figure 85 for an example of integrating this approach). A softer "division" between land and ocean is a key focus in these efforts. Additionally, these coastal ecosystems' roots, leaves, fronds and shells form characteristic patch-like structures called seascapes (Boström et al., 2011) that provide a range of critical ecological and socio-economic services (otherwise known as ecosystem services as mentioned in section 1.5.2). Well-designed nature-based protection measures are gaining traction in research and practice because they can be more cost-effective in tackling climate change than hard strategies and offer other benefits. Unlike the engineered approach, ongoing and active management of such projects is unnecessary after a certain period (Pilkey and Young, 2011). A state-of-the-art project integrating marine life forms as part of the reef-building process as a form of coastal protection is called "Oyster-tecture"[167] in New York City Harbour by SCAPE Studio (see Figure 85). It seeks to revive the former oyster reefs that used to dominate the coastline to revive oysters through public educational initiatives[168] (Billion Oyster Project, 2019a).

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167 SCAPE Studio's design-research for Oyster-tecture project has evolved to inform multiple ongoing projects, including the large-scale ecological infrastructure proposal called "Living Breakwaters" which is currently being constructed to be completed 2024-2025 (Billion Oyster Project, 2022c; SCAPE Studio, 2022).

168 Oystertecture is part of the "Billion Oyster Project" a non-profit organisation to restore the former oyster reefs of New York's shorelines by 2035. More than 30 million oysters had been restored, with 7 acres (28,000 m^2) of reef area, restored filtering billions of litres of water (i.e. nitrogen). New York harbour water quality is the cleanest in 100 years. Approximately 2,000,000 oyster shell have been recycled. More than 6,000 high school and middle school students have taken part in the project. (Billion Oyster Project, 2022b).

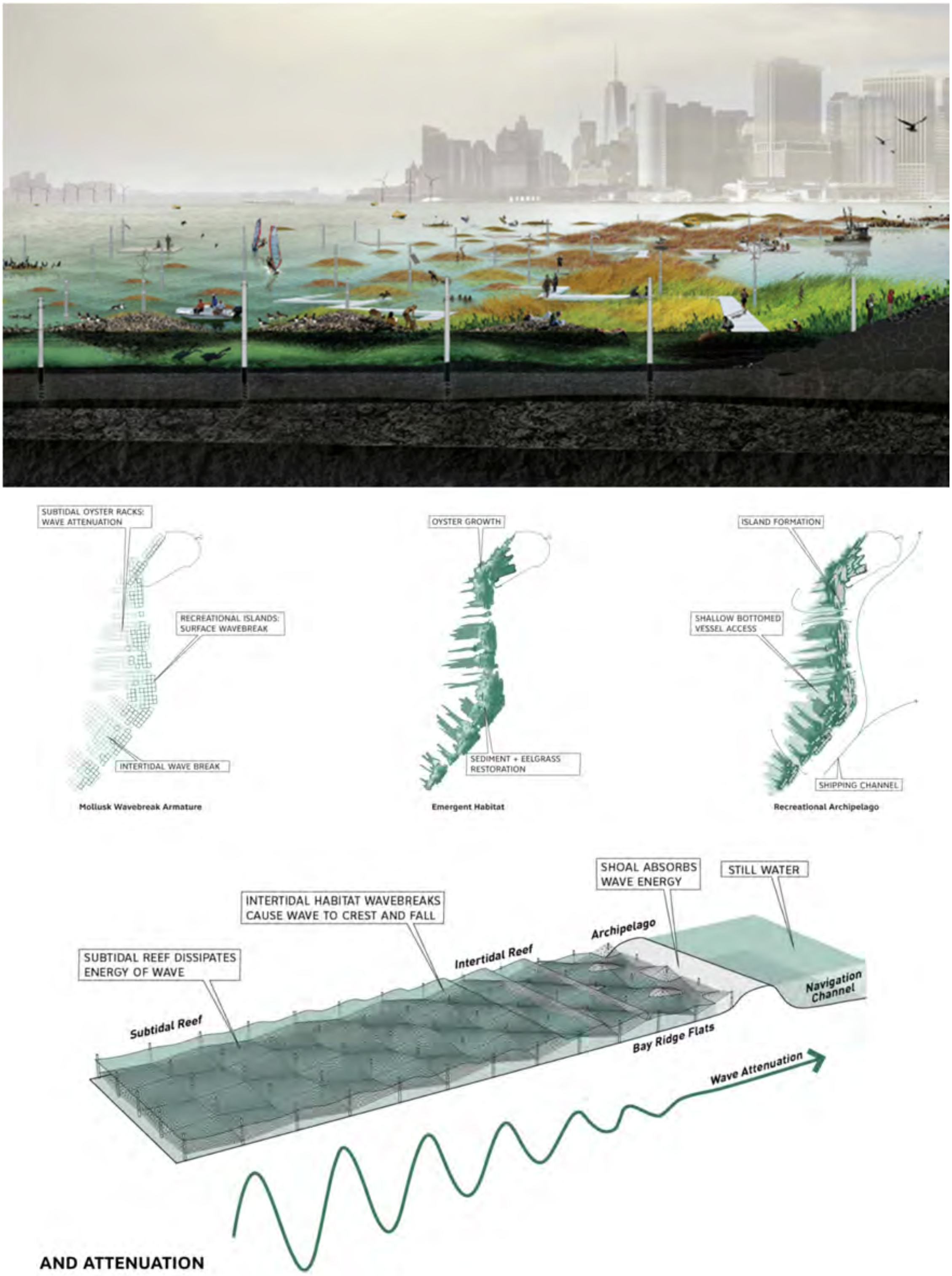

Figure 85. Visualisation by SCAPE Studio of a project called "Oyster-tecture", developed for the Museum of Modern Art exhibit "Rising Currents" (2009) by SCAPE in collaboration with Bart Chezar, Hydroqual Engineering, MTWTF, the New York Harbour School, NY/NJ Baykeeper, Paul Mankiewicz and Phil Simmons (Bergdoll et al., 2011). The project is a proposal for reviving the former oyster beds in New York, USA, as part of its coastal adaptation strategy. In combination with mussels, eelgrass and oyster reefs are used to build reefs for wave attenuation and harbour water filtration (Orff, 2016).

(Extracted from Kumu S-O-T-A map – Osytertecture, NYC node).

While nature-based solutions provide various benefits, it is important to be wary of greenwashing soft approaches that over-promise their coastal protection capacities, thereby perpetuating the false sense of security discussed above (Pilkey and Young, 2011). For a while, soft approaches provide certain levels of protection from storm surges; but they require large-scale intervention (ranging between several hundred meters to several square kilometres depending on the local context[169]) to make meaningful impacts (Orff, 2016). Furthermore, it is complex and difficult to calculate the relationship between storm surges and nature-based solutions (NbS). Therefore, it is essential to predict the ability of NbS to reduce storm surges with computer modelling and 1:1 in-situ testing (taking into consideration various factors such as hydrology, geophysical conditions, wind, salinity etc.). Recent computer modelling and simulation advancements have reduced uncertainties and shown the different levels of coastal protection NbS can offer. For example, computer programs have simulated the dynamics of wave attenuation properties of salt marshes or kelp forests (see section 1.5.2 for more information). This area of research, however, still requires more investigation.

Furthermore, it is important to note that NbS does not protect cities from sea level rise (but can attenuate waves from storm surge events), and they should, therefore, not be promoted as capable of doing so (Pilkey and Young, 2011). There are challenges in establishing soft approaches in environments that suffer from water pollution. For instance, urban areas that suffer from severe water pollution (i.e. eutrophication), poor water clarity due to floating particles from agricultural runoffs, lack of sediment flow due to locks and gates at the mouth of the river, dead marine zones due to stone and gravel extraction, and increasing cloudbursts affecting the salinity levels, to name a few. While hard-engineered approaches tend to ignore these interconnected ecological systems of larger external pressures, working with soft approaches makes us face them (otherwise, they will not work) (ibid.). Therefore, careful analysis and interdisciplinary collaboration are required to successfully implement soft approaches to understand the various factors inhibiting coastal ecosystem restoration efforts (Organo Quintana, 2020). Furthermore, while NbS have the added benefit of providing more than coastal protection by sequestering carbon as part of the climate mitigation strategy, the sequestration of greenhouse gases takes place over long timescales relative to the emission rate of anthropogenic greenhouse gases. Therefore, the effectiveness of these solutions is sustained only for as long as they remain permanent carbon sinks which is difficult to achieve (see section 1.5.2 for the potential for kelp being a more permanent carbon sink) (Beardmore, 2021).

Ultimately, what I wish to propose with regard to the implementation of NbS is that there are limitations in relying heavily on one system (i.e. hard approach), making it vulnerable to responding to the complexity of numerous issues that may arise from climate change. Therefore, I will be suggesting throughout the remainder of this chapter that a diverse set of approaches (some hard, some soft) will become critical to ensure that the most flexible and holistic strategies can be implemented at the coast (Hill, 2015). It is critical that coastal cities move past short-term quick-fix strategies to prepare for future unpredictable scenarios (Hill, 2015; Pilkey and Young, 2011).

169 This is based on findings from a coastal engineer working on nature-based solutions/soft approaches in NYC (Orff, 2016), an interview with marine biologist working with nutrient uptake of kelp in Denmark (Boderskov, 2021) and the wave attenuating properties of natural kelp forests off the coast of Norway (Mork, 1996).

3.2.3 Hybrid Approach

It seems inevitable that both approaches, whether hard or soft, have a role in coastal protection and adaptation. In the short term, hard approaches will continue to protect coastal cities, but relying on this method alone is short-sighted[170] (Gendall et al., 2015; Hill, 2015; Orff, 2016). While soft approaches mitigate and reduce the strength of storm surges and prevent coastal erosion along with other benefits (i.e. sequester carbon), they do not protect against sea level rise. Therefore, many coastal cities are starting to recognise the need for a hybrid approach (see Figure 86) – a combination of the strengths and limitations of both hard and soft approaches to go beyond the singular aim of defence during extreme weather events and sea-level rise by enhancing the city's coastline by increasing biodiversity (Hill, 2015; Orff, 2016; Wiberg, 2019). Combining hard and soft approaches to coastal resilience and adaptation generate a more dynamic system (Depietri and McPhearson, 2017; Sutton-Grier et al., 2015). Hybrid approaches aim to increase many different ways to respond to sea-level rise and global warming (Hill, 2015; Lister, 2007). For instance, hybrid strategies can include increasing coastal edge elevations via beach nourishment, bulkheads, tide gates, armour stone (revetments) and drainage devices, along with minimising upland wave zones via offshore breakwaters, sand dunes, living shorelines, oysters, mussel or rock reefs, coastal wetlands, salt marshes and groins (see Figure 87). Hybrid strategies protect against storm surges through the integrated flood protection system, such as floodwalls, multi-purpose levees and local storm surge barriers (Orff, 2016) but also increase the permeability and absorption capacity of the grey infrastructure, such as roads, by retrofitting them as green infrastructure[171] in the city ("sponge city" concept), as shown in Figure 88.

170 In the long term, it may no longer make economic sense to continue to upgrade hard approaches such as retrofitting the sea walls to be higher and higher to keep up with the rise in sea level and stronger storm surge levels (Pilkey and Young, 2011). Furthermore, in the case with New Orleans, the structural failure of sea walls and dikes could have catastrophic outcome (ibid.).

171 The term green infrastructure refers to trees, lawns, hedgerows, parks, fields, forests, etc. while blue infrastructure refers to water elements, like rivers, canals, ponds, wetlands, floodplains, water treatment facilities, etc. (Bioveins, 2022).

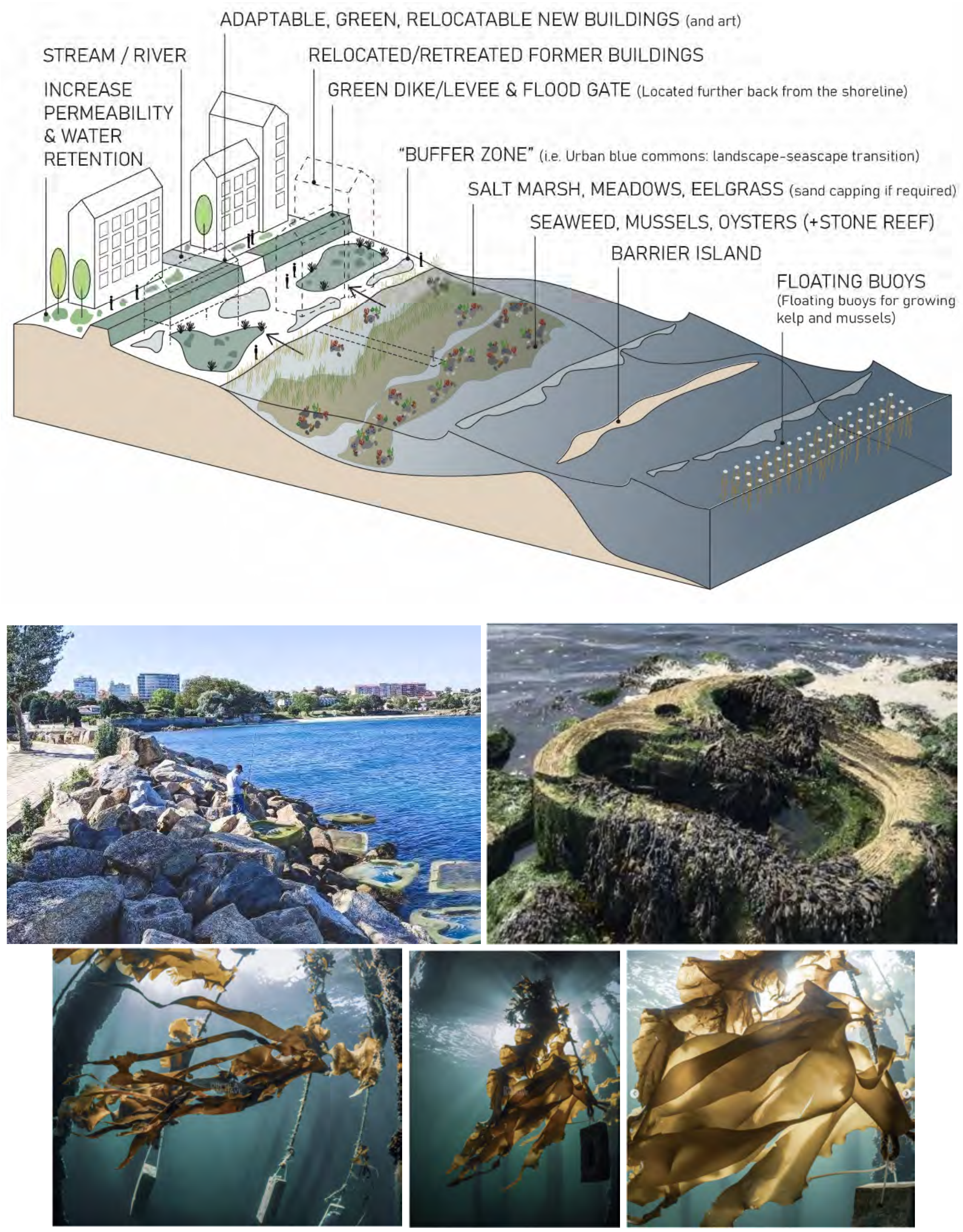

Figure 86. (Top image) An example of a hybrid approach with growing interest and evidence supports the combination of natural infrastructure, built infrastructure and retreat strategy to enhance coastal resilience. Image credit: Redrawn and redesigned diagram by Soo Ryu and Agnes Varmund (based on Sutton-Grier et al. (2015)).
(Middle row of images) ECOncrete – Marine life-friendly coastal armour to enhance shoreline stabilisation that provides both structural and biological value. After a few weeks of installation (in the port of Rotterdam in 2018), it was able to host diverse species of brown and green seaweed (macroalgae) and invertebrates due to material composition friendly to marine life and its design of imitating a small tidal pool. Image credit: ECOncrete (n.d., n.d.).
(Bottom row of images) Kelp (sugar kelp/sukkertang) hanging on cultivation lines below the surface of the sea. There are several structural methods of growing kelp on lines. Image reference: Tim Dencker (n.d.).

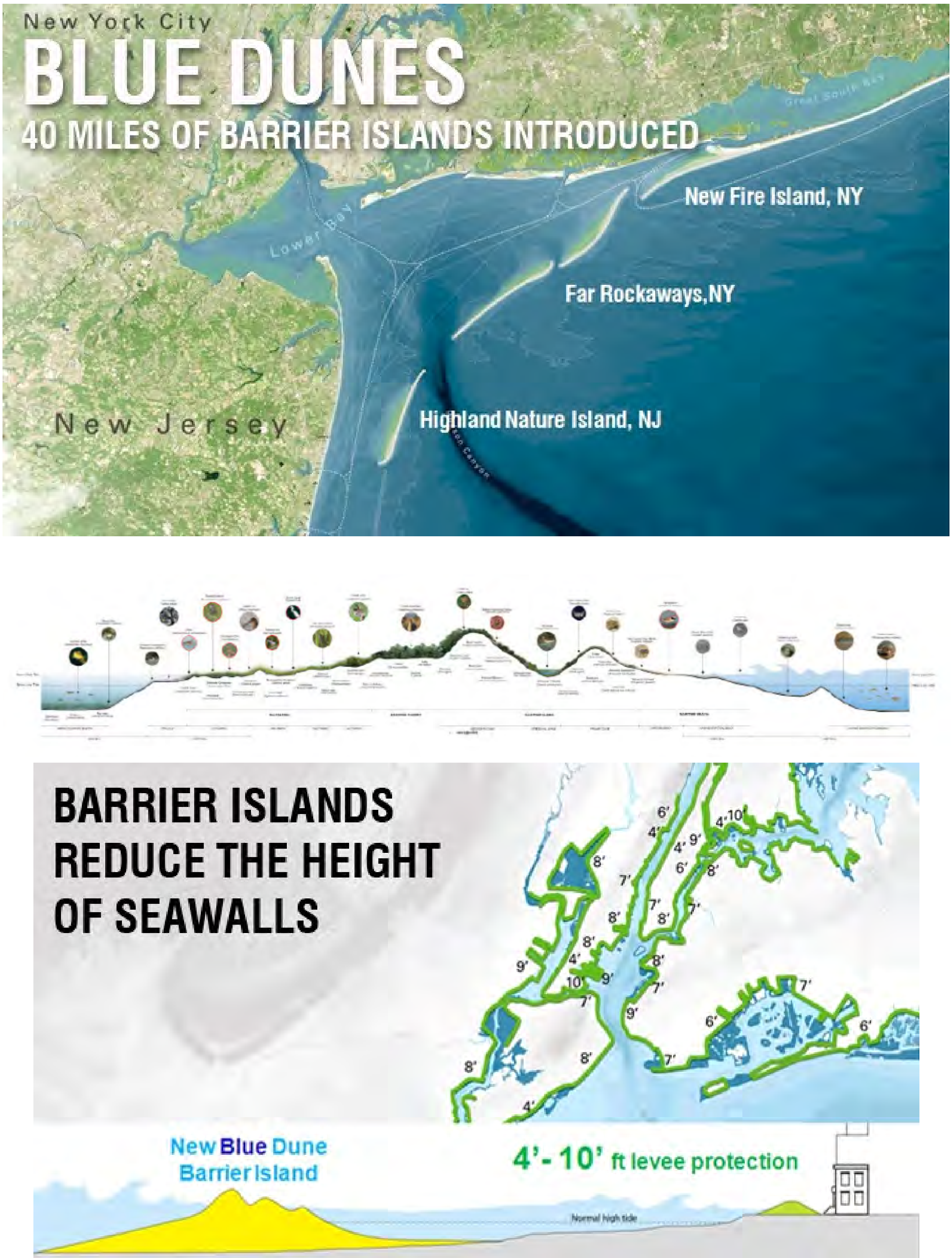

Figure 87. A hybrid approach where barrier islands out in the deeper waters are created to host dynamic ecologies to protect from storm surges in combination with levee protection inland. "Blue Dunes" by WXY Architecture + Urban Design and West 8 for NYC, USA (Keenan and Weisz, 2020). Image credit: Rebuild by Design (n.d.), WXY Architecture + Urban Design and West 8.
(Extracted from Kumu S-O-T-A map – Blue Dunes, NYC node).

Figure 88. A hybrid approach proposal by DLand Studios and ARO is called "A New Urban Ground." The proposals refurbish existing hard infrastructure systems, including perimeter wetlands, a raised edge, and absorptive sponge slips paired with new upland street infrastructure systems, protecting the island from flooding in the event of a large storm (DLand Studio and Sasaki, 2022). Image credit: Dland Studio.
(Extracted from Kumu S-O-T-A map – A New Urban Ground, NYC node).

According to Gendall, Bisker, Chester, & Eisenberg (2015), the hybrid approach is particularly relevant as the flood and coastal protection that keeps cities dry during extreme weather events will serve this purpose only for a certain percentage of the time. Therefore, it is essential that it be designed as an improvement to the city's coastline so that citizens can enjoy it on a daily basis. To make this work, flood protection features must become part of the life of the city. However, due to the increasing risks with water, coastal cities face increasing realities that leave them with two choices. Either continue to heavily armour the coastline while upgrading its infrastructure and/or plan a strategic retreat/relocation of critical risk areas in the long term while discouraging B-A-U development in low areas (Pilkey and Young, 2011).

Studies from Pilkey and Young (2011) advocate managed retreat/relocation/realignment as a key part of long-term coastal management strategies. They "recommend prohibiting the construction of high-rise buildings in areas vulnerable to future sea-level rise. Buildings placed in future hazardous zones should be small and movable or disposable... Relocation of buildings and infrastructure should be a guiding philosophy" (Pilkey and Young, 2011, p.179). They stress the importance of financially disincentivising waterfront developments, involving professions other than engineers and avoiding dualistic debates about buildings vs coastal ecosystems "because buildings will always win" (ibid.).

Although contentious (refer to section 3.1.3 on barriers to retreat), critical risk areas may need to be designated "no-build zones" in the future (or with the requirement that the buildings can be relocated and be able to withstand inundation), which leads to the question of what these risk areas should be in the future as the sea takes over these spaces. Important questions lie in being able to undergo an urban transformation of these risk areas in the future while maintaining a sense of community, culture and identity without being locked into a physical location or buildings that may no longer exist. Contrary to negative associations with retreat, there may be opportunities for new spatial types to emerge at the urban shorelines, especially driven by a crisis such as one posed by SLR and SS. These risk areas may be a blank slate for alternative future landscape-seascape (see Figure 84 and Figure 85 for examples) that can be more inclusive of the more-than-humans in this new hybrid meeting area.

Towards new forms of nature – "Urban Ecology"

Part of the hybrid approach is to conceive alternative conceptions of the current nature-culture dualities in urban contexts. It is part of an ongoing effort to rethink the relationship between people, infrastructure and ecology, which is built on a concern for public landscapes and its potential to facilitate relations in between. Intersections of these three are termed "urban ecology[172]", a paradigm in urban planning, architecture, landscape and environmental activism which has seen a significant increase in interest since the 1990s (Heise, 2019). Therefore, the urban landscape as a spatial medium is an ideal public setting for these hybrid experiments that combine "urbanism and ecology as mutually engendering and interdependent" (Orff, 2016). These

172 Urban Ecology has been influenced by actor network theory, ecological urbanism, landscape urbanism, biophilic design and climate urbanism to name a few (Heise, 2019).

approaches are further explored by Thaïsa Way (2016), in the book “Toward an Urban Ecology”, who suggests,

> “[u]rban ecological design defines a practice of landscape architecture grounded in the intersections and relationships of social and natural systems. As a design framework, it addresses the dynamic character of a city – its cultural and social networks – while simultaneously expanding the concept of urban nature and urban ecology... [It] seeks to envision a broader and more complex environment that is once of the past and the future. It enlarges our focus to engage a larger systematic thinking...” (Way, 2016, p.132).

In relation to the coastal cities’ context, the Urban Ecology design paradigm marks an attempt to acknowledge and foster new perspectives on the land-sea continuum. It seeks to construct an image of the ocean as a liquid space increasingly becoming an extension of cities in an entangled relation. Scholars Carola Hein and Nancy Couling explore the idea of seeing the sea as a critical part of the urban spatial condition in their book “The Urbanisation of the Sea” (Couling and Hein, 2020). Their approach is worth quoting in length, as this research adopts the same position in an attempt to,

> “...encourage understandings of shared land-sea spatial histories that go beyond the traditional exploration of development in the framework of nation-states or land-based entities. Employing a perspective from the sea, we aim to draw the sea-land continuum into discussions of urban and territorial development by investigating selected sites of critical interactions. These are sites that have been imagined, occupied, planned, and represented mostly by private actors, some of which have long operated autonomously, outside of classic land-based national and urban planning and policy frameworks that did not take the sea into account. Increasing in frequency and force, the effects of climate change have made the sea potentially more dangerous and unpredictable — conditions that neither directives nor technology are able to control. Our approach, therefore, promotes a three-dimensional understanding and calls for a trans-disciplinary investigation that is focused on space, society, and culture. The book argues that such an approach can help develop new directions in representation, design, and planning along the sea-land continuum and help dislodge inherited binary assumptions... This allows us to gain a better understanding of what a paradigm shift from a land-based logic with fixed spatial and legal delineations to a more fluid, integrated, sea-based approach can mean for research, representation, and ultimately policymaking, planning, and design... Such areas, including the world ocean and seas, serve vital functions for urban agglomerations, yet the direct links and interdependencies between them have mostly been neglected in the “city” focus of urban studies discussions” (Couling and Hein, 2020, p.8).

The two approaches by Orff (2016) and Couling and Hein (2020) are a testament to the emerging positions on Urban Ecology from both practice and research. They both seek to depart from current terrestrial biases and unproductive dualisms in the LUDP disciplines. And they contribute towards the foundational basis of Urban Seascaping as a critical proposition to explore the research question from a more equitable land-sea outlook. In extending these perspectives, I suggest exploring the notion of urban ecologies in these “sites of critical interactions”, focusing on how we might form a new public space for both humans and nonhumans.

3.2.4 The role of the blue urban commons

It is time to start valuing water as a shaping, connective force and designing space for regionally connected, robust water systems within our water fabric... by understanding how water actually moves through the landscape, deal with the reality of its degraded status, and reintegrate it into city streets and civic perception.

Kate Orff, SCAPE Studio, *Toward an Urban Ecology* (Orff, 2016, p.21).

The phenomenon of sea-level rise is often seen as an unfortunate crisis for coastal cities. However, it can also present new opportunities for urban transformation. From a long-term perspective, many vulnerable low-lying waterfront developments have dwindling justification for continuing to protect B-A-U buildings. In turn, this can lead to completely rethinking the waterfront areas increasingly inundated by the sea. The inevitability of relocating some of the most vulnerable low-lying waterfront areas in the future can provide a unique opportunity to experiment with a new form of urban "blue commons". However, what exactly might constitute "a commons" in coastal cities in the age of the Anthropocene?

The term "commons" represents shared material and immaterial resources (i.e. land) that belong to or affect the whole community in an urban setting (Hardt and Negri, 2009). It is founded on the guiding principle of equity that fundamentally re-conceptualises how we view entities and spaces as something that belongs to and affects all. "Urban commoning" is thus a collective socio-cultural practice of mutual sharing, collaboration and responsibility to look after urban spaces with qualities and resources necessary for liveability (Huron, 2017; Eynaud, Juan and Mourey, 2018). The concept of an urban commons has gained traction in the past decade[173] (Feinberg, Ghorbani and Herder, 2021), especially in its transformative power to utilise the collective will to implement initiatives that benefit all as a radical form of urban democracy. However, the traditional conceptions of a "commons for all" do not necessarily include nonhumans, as seen in the Blue Line project in Aarhus (see Figure 68). Therefore, there is an opportunity to investigate different ways coastal cities could broaden the concept of an urban commons to make space for marine life forms to be part of the resident and identity. For instance, Figure 89 illustrate a humble attempt at a form of blue commons designed for the meeting of human to nonhuman interaction in Wellington Harbour in New Zealand. People use this urban-designed public space for contemplation and interaction with the sea. The design of the structure incorporates the transient nature of the tides through the use of steps, rock reefs and intertidal pools, allowing people to see and touch the marine lifeforms. Despite the fact that it is essentially a simple concrete staircase to the water, according to the locals, the fact that they are flat "steps" allowed people to feel safe getting closer to the water.

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173 The 17th International Architecture Exhibition for Venice Biennale in 2021, called "How will we live together?" had a focus on inclusivity of other peoples, of other species, in the form of commons (La Biennale di Venezia, 2019).

Figure 89. A form of a blue commons called "Oriental Bay Enhancement" by Architecture Workshop in Wellington Harbour in New Zealand. People use this urban-designed public space for contemplation and interaction with the sea. Image credit: The top photos were taken by the author in December 2019. (Bottom left image) Photographer unidentified. (Bottom right image) Architecture Workshop (n.d.) (Extracted from Kumu S-O-T-A map – Oriental Bay Enhancement in Wellington, New Zealand node).

These forms of blue urban commons invite citizens to rethink the coastal urban edge conditions and to better respond to tides, periodic flooding, and long-term rise in sea levels. As such, the Wellington project exemplifies how the act of including the agency sea and its life forms in the coastal cities can inspire designs that reflect how the water weaves through the urban. Furthermore, such new urban commons can be a way of returning the vulnerable waterfront areas back to the sea and rethinking the traditional ways cities occupy the water's edge.

Moreover, the blue urban commons can be a space for more tactile and sensuous interaction and engagement through creative, artistic and educational means. For instance, a temporary large-scale art installation in Münster, Germany, allowed people to experience and feel the various qualities of water (i.e. temperature and viscosity) by walking through the submerged bridge (see Figure 90). The artist Ayşe Erkmen evoked a tactile and fun way to connect the residents to the water. This type of direct and close engagement with the water could be part of the blue urban commons rather than the current perceptions of water as segregated from the urban condition.

Figure 90. A temporary artistic installation called "On water" in a river in Münster, Germany, by Ayşe Erkmen. It is important to note that the installation is weather-dependent (i.e. summer) and is installed in water bodies with minimal currents and depth.
Image Credit: (Left image) Roman Mensing (Mensing, 2017). (Right image) Gregory Volk (Volk, 2017).
(Extracted from Kumu S-O-T-A map – "On water" in Münster, Germany node).

In the city of Vejle, many attempts have been made to educate the public through art and water. Using the water as a space for engagement, in 2018, Vejle Municipality hosted a Floating Art Festival with various themes on the Vejle Fjord, which meant that many of these floating art installations were only accessible via kayaks/canoes (see Figure 91). These attempts demonstrate the potential purpose and function of blue urban commons.

Figure 91. Various educational, recreational and artistic initiatives on and in the water could contribute towards forming a blue urban commons to engage the citizens on the issues of sea level rise and climate change. (First row of images) Photos of large-scale floating art installations with various themes and messages from the Floating Art Festival are accessible by kayaks/canoes. A notable art installation of Le Corbusier's infamous Villa Savoye has been partially submerged as a warning about the sea-level rise by artist Asmund Havsteen-Mikkelsen, called "Flooded modernity," 2018 (Vejle Municipality, 2020a).Image credit: (Left) Artist Swen Kählert (Kählert, 2022) and (Right) Artist Asmund Havsteen-Mikkelsen (Emmery, 2018). (Second row of images) An informative, educational installation on the impact of sea level rise and storm surge in Vejle at the harbourfront area of Fjordbyen in Vejle by Vejle Municipality (Johansen, 2020). Photos were taken by HS-Skilte (n.d.) on July 2020. (Extracted from Kumu S-O-T-A map – Floating Art Festival, Vejle, Denmark node).

The most appropriate design strategies to rethink the waterfront depend on several complex factors but most importantly, it requires a careful collaboration of the right actors in the decision-making process to conceive what these new blue urban commons could be. Social, ecological and physical resiliency are important aspects of coastal identity. Thus, the urban transformation of the current meeting area between the city and the water needs to provide a physical and perceptual link to the water, a space for enhanced awareness and stewardship through better exposure, while integrating various typologies of landscaping and seascaping elements as part of the blue commons.

Multispecies Urbanism[174]

> *Multispecies justice demands thinking in legal and political frameworks, but also in cultural ones, and especially in terms of narrative. What stories do particular communities tell about their own origins and futures, and about their relationship to other communities and species, is often a crucial means of establishing and perpetuating scenarios of justice and injustice.*
>
> Ursula Heise, *Mapping Urban Nature and Multispecies Storyworlds in Design with Nature Now* (Heise, 2019, p.79).

As anthropologist Anna Tsing writes: "Human nature is an interspecies relationship" (Kirksey, Schuetze and Helmreich, 2014, p.2). Yet, much of the recent surge of ecological movements and paradigms in the LUDP disciplines have yet to embrace this reality. Indeed, as Ursula Heise observes in her recent discussion of the precarious situation that nonhuman city-dwellers find themselves in:

174 Also refer to section 3.2.5 "A relational approach to water" as a complementary section to multispecies urbanism.

> "[M]ost urban developments remain anthropocentric in their focus, envisioning cities as spaces created by humans and *for* humans, and analysing their natural dimensions mostly as a function of human uses, benefits and harms, or of changing human perceptions of nature. But since the mid-1990s, some scholars and activists have also called for a reconsideration of cities as habitats for nonhuman species whose agency, exposure to human impacts and claims on human's ethical and legal consideration need to form part of urban theory" (Heise, 2019, p.77).

Within the field of urban theory, one of those emerging movements is called "Multispecies Urbanism". First coined by Debra Solomon, Multispecies Urbanism seeks to cultivate forms of urban development that can address the agency of nonhumans and recognize that humans are participants in multispecies assemblages with the so-called "natural world" (Neuhaus, 2019; Solomon and Nevejan, 2019; Solomon, 2020). The notion thus reflects an ethical argument about the importance of cohabiting with other species (i.e. plants and animals) in a more equitable and mutually beneficial manner (Heise, 2019).

However, as Solomon (2020) argues, Multispecies Urbanism as an urban design and development paradigm has yet to gain a stronghold in cities. Thus, she urges cities to rectify the current unequal exposure, focus and recipients of environmental risks and benefits that should also concern nonhuman wellbeing. Multispecies Urbanism is an inclusive spatial and social production of urban space for nonhumans as part of democratic collective living – a recognition that they are also rightful residents of urban environments (Solomon, 2020) (see Figure 92 of different nonhuman representatives of multispecies urbanism in different cities).

Figure 92. Image of all the different representative animal species that live in different cities worldwide (illustration from a French children's book called "Les animaux des villes" – The animals of the cities). For coastal cities, multispecies coexistence could include marine species, such as crabs, and oysters (i.e. New York City, as shown in Figure 85) and even seaweed. Image credit: Nadia Budde (2014).

From a pragmatic perspective, research in the natural sciences sheds light on ecologically sensitive design parameters of artificial structures and spatial planning that can contribute positively towards (re)creating habitats, which, in the case of this research, focuses specifically on marine life, as shown in research by Bishop et al. (2017) in Figure 93. Finally, this knowledge could aid practitioners and planners in proactively designing urban environments to be conducive to the well-being of marine life forms, as coastal cities are expected to be inundated more frequently and permanently by the sea, bringing in nonhumans that would inhabit these new spaces. In the following section, I review some of the S-O-T-A examples of how artists and designers have imagined such migrations and shifts in perspective to propose new modes of noticing and relating.

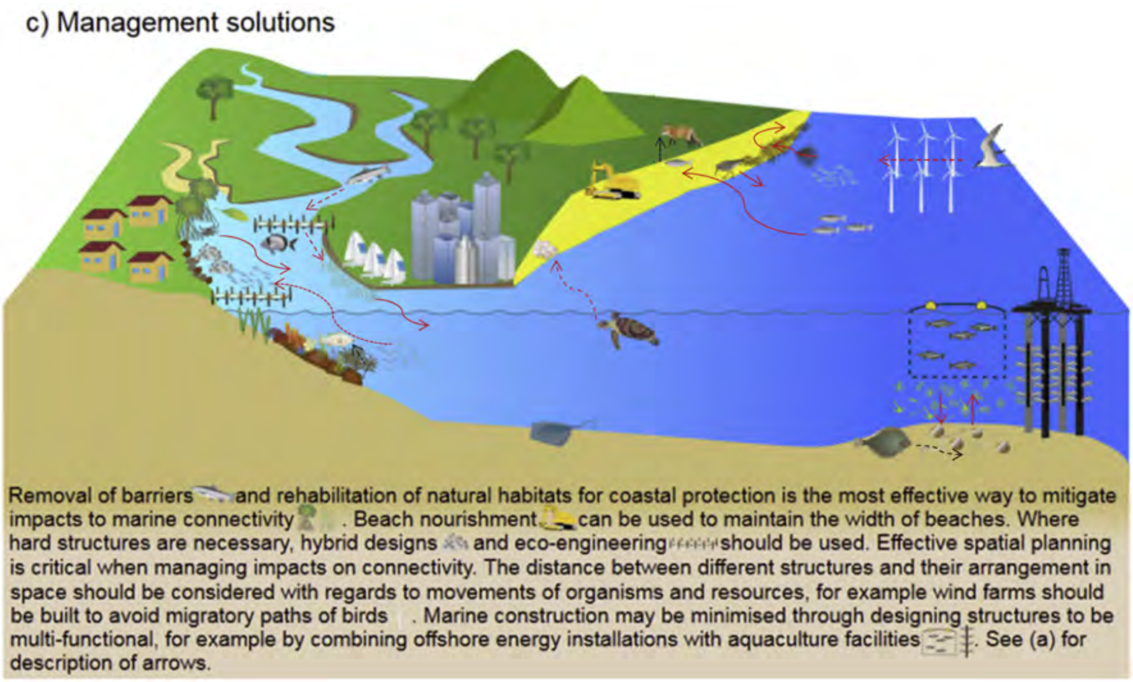

Figure 93. Artificial structures and better consideration of other species can minimise negative environmental impact and aid habitat creation for different types of marine life. Image credit: Bishop et al. (2017).

Art that facilitates multispecies coexistence by SUPERFLEX

Envisioning a new form of blue urban commons as a space for humans and nonhumans requires a paradigm shift to think from the perspective of marine life. In turn, this begs the question: How will the marine realm respond to what we created? This specific question has been explored by the Copenhagen artist group SUPERFLEX, who has been trying to think from the perspective of the marine realm in a few recent projects that illuminate imaginaries of the new urban commons envisaged by this project.

First, their animated film project "Vertical Migration" (2021c) tells the parallel story of vertical migration required by humans in our vertical ascent to the surface of the sea, shown from the perspective of a siphonophore (a relative of jellyfish). By relating the story of a siphonophore as our own, SUPERFLEX argues that "we can shift our perspective to recognise that we are connected, that our actions affect each other, and that we share a common fate" (SUPERFLEX 2021c). Vertical Migration is an appropriate term for the distant future, where a rise in sea level will bring marine life forms, such as seaweed, onto the coastal waterfront areas. It is also a story of a possible future where our coastal cities would eventually need to retreat vertically and leave the current waterfront spaces to be occupied by new inhabitants from the sea.

Second, the concept of re-occupying artificial structures by marine life due to sea-level rise is addressed in a project called the "Interspecies Assembly". It is a proposal for "a physical gathering site that aims to foster friendly relations among species and nurture interspecies living" (SUPERFLEX 2021b). It is a designated space where humans need to set aside their terrestrial biases to pay attention to the agency of the marine life below. The strength behind this project is the idea of a space for meeting humans and marine life, a new blue urban commons for all (see Figure 94) (SUPERFLEX 2021b).

Lastly, SUPERFLEX takes the stance that the buildings/and structures near the coast need to be designed for submersion[175], meaning that they should be designed to address the needs of marine life. The fish and seaweeds will be the new occupants of the waterfront areas in the future, and we can give them a helping hand by designing sculptures that function as art for humans while being habitats for fish and seaweed (see Figure 94). These porous and modular sculptural blocks designed for marine species can be installed as part of the current waterfront buildings or as stand-alone sculptures that form a "Super Reef", an artificial reef to reinstate and revive the lost stone reefs from waterfront/harbourfront expansion. The porous modules are made of lots of surface area that marine biodiversity thrives on with materials that can withstand marine conditions and are coloured in pink, a colour scientifically known to encourage coral polyp growth in the tropics (see Figure 94) (SUPERFLEX 2019; 2021a). The design decisions are made to cater for the occupation of underwater beings in the future and as a creative mechanism to tell the story of how they will shape the cities as the sea level rises.

These projects are all part of SUPERFLEX's research examining the relationship between humans and other species, proposing a new kind of multispecies coexistence that reimagines how we can all live together in a world with rising seas (SUPERFLEX 2021a). In formulating the principal propositions of USS (which will be outlined at the conclusion of this chapter), I have taken inspiration from the conceptual approaches by SUPERFLEX, who has offered examples of how to envision the creation of new blue urban commons.

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175 For instance, an unintended consequence of ship wrecks is that they have become hot spots for marine biodiversity. Coined "wreck biodiversity" (Mallefet et al., 2008) there are many examples of ship wrecks studied that shows how artificial structures can aid as marine habitat. Here lie opportunities for structures built in the waterfront/harbourfront areas to be specifically designed to be inundated to be inhabited by marine life.

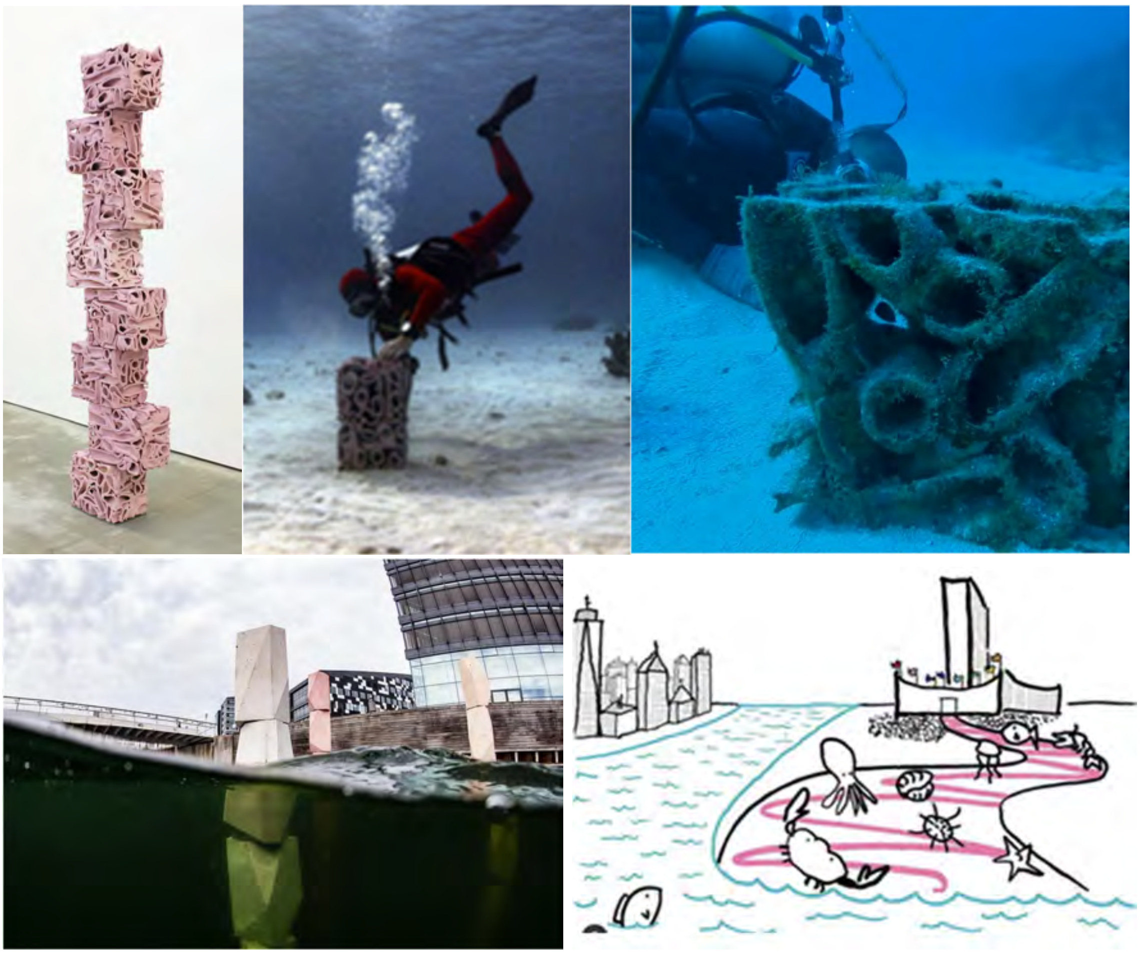


Figure 94. (Top Left): "Pink Elements" (no.6/Zig Zag Column) is part of the research project called "Deep Sea Minding" by SUPERFLEX. The pink sculpture is built with coral-friendly bricks for fish. Installed at Galería OMR, Mexico City, 2019. Photo credit: Enrique Macías Martínez (Superflex 2019).
(Top Middle): A diver installs the pink element to test if the fish would inhabit and interact with the sculpture (Superflex n.d.). Image credit: SUPERFLEX.
(Bottom left) An underwater sculpture in Copenhagen's Harbour. Entitled "As Close As We Get," the work is simultaneously an experiment, a home for marine organisms, and an artwork part of a super reef (SuperRev) (Tække, 2022). Image credit: SUPERFLEX.
(Bottom Right): "Interspecies Assembly" - A drawing of the first gathering of humans and other marine species on earth, a way to promote interspecies dialogue and cooperation (Superflex n.d.). Image credit: SUPERFLEX.
(Extracted from Kumu S-O-T-A map – Coast of Copenhagen node).

Marine restoration for biodiversity

Inviting the sea back to Gyldensteen Coastal Lagoon

While the nature-based solutions/soft approaches to coastal protection do not directly resolve the issue of sea level rise, one of the indisputable benefits of soft approaches centred on marine restoration is their positive impact on local biodiversity (Larsen et al., 2021). Thus, soft approaches can fulfil the biodiversity goals set out by the EU directive that requires coastal ecosystem restoration for coastal cities (European Commission, n.d.). One project in Denmark is rising to the challenge of mitigating the current biodiversity crisis through nature restoration while simultaneously providing resilient nature-based solutions to protect a coastal town in Denmark. The project is called “Gyldensteen Strand” (translated, Gyldensteen Beach), with the initial aim to restore habitats for birds and increase public awareness, led by marine biologists and funded by a private nature foundation (Aage V. Jensen Naturfond n.d.). Although this restoration project is not in an urban context, it is nevertheless a great example of a blue infrastructural strategy that allowed a planned conversion of the hard coastline via land reclamation[176] to intertidal and coastal lagoon marine reserve by breaching the dikes to flood the former farmland[177]. After 140 years of agricultural land use of 214 hectares, Gyldensteen’s dikes were breached in 2014 to allow the sea to come back. It was the first time in Denmark that such a large area was restored at once (Organo Quintana, 2020; Klimatilpasning, 2021) (see Figure 95). The restoration process was done through sand caps to limit suspended particles, reintroducing stone reefs, replanting eelgrass etc. (Organo Quintana, 2020). Moreover, the new lagoon provided a buffer zone in the event of a future storm surge to protect the nearby town of Bogense from flooding (Klimatilpasning n.d.; Aage V. Jensen Naturfond n.d.).

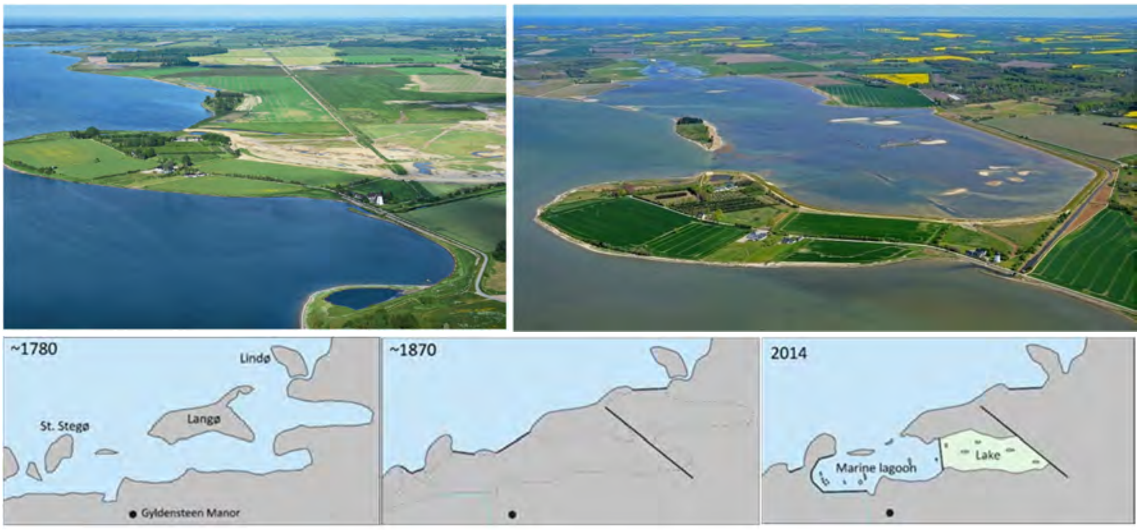


Figure 95. (Top row) Before and After photo of Gyldensteen beach (aerial photo credit: Viggo Lind). (Second row) Map of the transformation of Gyldensteen beach over the past 230 years from a coastal marine area to farmland to a marine nature reserve for research, recreation and a buffer zone to protect the town of Bogense behind. Image credit: Cintia Organo Quintana.
(Extracted from Kumu S-O-T-A map – Gyldensteen Strand, Fyn, Denmark node).

176 The construction of dikes was part of common practice in the 1800s to drain low-lying wetlands to gain arable land for agriculture and cattle grazing in Denmark (Stenak 2005).

177 These areas close to the sea often had problems with damages caused by storms (and accumulated rainwater) that breached the dikes that ruined crops in the pasture fields. Therefore, the re-flooding initiative was possible due to the increasing financial burden of upkeeping the dikes by the farmers and the low profitable yield of the fields (Organo Quintana, 2020; Klimatilpasning, 2021). The former site before lands reclamation in the late 1700s was a typical coastal marine area (see Figure 95). Understanding the former wet conditions of the area is critical in realising that in a wetter future, it is futile to constantly exert efforts to keep this area dry (Organo Quintana, 2020).

While the Gyldensteen Strand project is evidently not placed in an urban context, it showcases well how seaweed can play a key role in recognising the ecological restoration process[178] of the area. The presence of seaweed was one of the first indications that the lagoon was in an ecologically good condition for the fish to return, thus leading to an increase in the bird population as well (Organo Quintana, 2020). The observed results over six years showed the gradual colonisation of seaweeds and invertebrates in the lagoon, improving the overall biodiversity in the area (Valdemarsen et al. 2018) (see Figure 96). For instance, the diversity of seaweeds is twice as high in 2020 compared with 2014, after the flooding of the coastal lagoon, as shown in Figure 96.

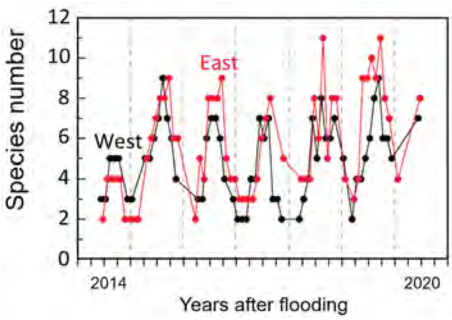


Figure 96. (Left image) The return of seaweed species in the Western and Eastern parts of Gyldensteen Coastal Lagoon six years after flooding in 2014. Kristensen et al. (unpublished data).
(Right image) The photo shows the growth of brown macroalgae growing in the Gyldensteen lagoon. Image credit: Cintia Organo Quintana took the photo in September 2021.
(Extracted from Kumu S-O-T-A map – Gyldensteen Strand, Fyn, Denmark node).

Furthermore, seaweed provided a framework for the dissemination of comprehensive monitoring and research on marine nature restoration and climate mitigation[179], bringing together various actors from schools, volunteers, tourists and authorities in collaboration. Gyldensteen Coastal Lagoon's increasing numbers of visitors and proactive participation of volunteers show societal engagement and participatory process in accepting this new form of blue commons (see Figure 97). The project thus indicates how recreational facilities may contribute to new perceptions, sense of place and identity. An outreach exhibition about the project, for instance, indicated in a survey (n = 433) that Gyldensteen Coastal Lagoon provided a learning opportunity for people aged between 15-30 years to be more conscious of marine diversity, the impact of climate change and understanding of the benefits of marine restoration (Frederiksen 2020).

178 The former farmland was heavily used for agriculture. It led to high concentration of nitrogen from excessive use of fertilisers that caused algal blooms in the first years of the restoration. Furthermore, the land was tilled which led to suspension of floating particles in the initial restoration period of the lagoon, causing murky water conditions that delayed the growth of coastal habitat forming seaweeds (Organo Quintana, 2020).
179 There is on-going research and monitoring at Gyldensteen Strand, to provide knowledge on possible consequences of rise in sea level breaching the diked farmland and strategies to support nature restoration in coastal areas with rising sea levels.

Figure 97. (Top Left to Right) A photo of the education centre for visitors showcasing information on the various land and marine-based species in the Gyldensteen nature reserve (called Naturrum) (Aage V. Jensen Naturfond. n.d.). A photo of seaweed in glass tanks for education purposes. Image credit: Cintia Organo Quintana took the photo in June 2019.
(Bottom Left to Right) A photo of birds occupying the Gyldensteen lagoon, a nature restoration area (VisitNordfyn n.d.). A photo of people visiting the area as a bird sanctuary. Image credit: May Holm Gramstrup-Nielsen (VisitNordfyn n.d.).
(Extracted from Kumu S-O-T-A map – Gyldensteen Strand, Fyn, Denmark node).

Gyldensteen Coastal Lagoon is recognised in Denmark as a successful nature-based solution to address the various challenges of climate change. Moreover, more importantly, it is an example of how the onset of sea-level rise and frequent coastal flood events can influence marine restoration projects in vulnerable areas by allowing the water to come back in, giving space for a new form of commons that benefits both humans and nonhumans. With time, the new commons transformed into a place with life as seaweeds returned, creating new opportunities for humans to connect better with the marine world. The Gyldensteen Strand project highlights the importance of understanding interconnected networks, such as the dynamic processes of constant synergy between the land and the water and the long-time spans required to consider marine nature restoration and sea-level rise. Furthermore, learnings from the Gyldensteen Strand project indicate the potential to adopt the restoration of coastal ecosystems as part of future planning of coastal cities to ensure a higher resilience to climate change and benefit from richer biodiversity.

Marine Reserves and Marine Protected Areas

In recent decades, restoration ecology has become critical in understanding threatened or degraded landscapes-seascapes. As outlined above, the sources of the threats are myriad: rising sea levels, frequent and stronger storm surges, continuing nutrient runoffs from agricultural activities, unregulated industrial fishing, the legacy of contamination from industrial processes, expansion of major urban areas through land reclamation, and limited municipal funds for restoration projects, to name a few. While ecological restoration practices have various limitations at a time of rapid climatic changes and increasing urbanisation, it nevertheless has been a significant way of tackling some of these issues and has increasingly influenced the policy and design of coastal cities (Gang et al., 2016).

The research supports the findings that marine reserves and marine protected areas[180] (MPA) coupled with a marine education centre (refer to Figure 20 in section 1.5.2) have seen successes both in the increase in marine biodiversity and improved ocean literacy (see definitions) of the residents and visitors (Francesca et al., 2017). However, these marine reserves are usually in places away from urban areas where nature has not been severely compromised. Nevertheless, lessons from these marine reserves could be transferrable to the urban context, where the protection of marine areas as part of the blue urban commons of the coastal city could have a role in reviving the compromised biodiversity and, thus, better exposing the citizens to life under the sea. MPAs are particularly relevant for coastal cities like Vejle, with its dire ecological conditions (of the fjord) and need for continual protection and restoration efforts, especially if the city is interested in engaging with nature underwater (i.e. nature-based solutions) as part of its coastal adaptation strategy.

There is also a global movement to increase the amount of "highly protected MPAs" (these MPAs also have varying degrees of protection, some less stringent than others), as they make up a very small proportion of overall nature-protected areas compared to land-based areas. The global goal is supported by various organisations, including the United Nations (2019) and IUCN (2016, n.d.), to increase MPAs of the world's oceans from approximately 5.3%-7.44% (Maestro et al., 2019; Marine Conservation Institute, n.d.) to 30% by 2030[181] (rectified in 2019) to safeguard marine ecosystems and biodiversity as well as the critical services these ecosystems provide (European Environment Agency., 2015).

180 See the definitions page in the Preface.

181 "The EU's 2030 Biodiversity strategy calls for better protection of European sea areas, by designating a minimum of 10 percent of the areas as untouched sea, and identifies this as one of the most important measures to take in order to curb the loss of biodiversity in the sea... According to research, areas designated as untouched sea are necessary in order to secure the marine biodiversity and to monitor changes in the marine environment" (The Fisheries Secretariat, 2021).

Learnings from the Goat Island (Te Hāwere-a-Maki in Māori) Marine Reserve in New Zealand

Goat Island (called Te Hāwere-a-Maki in Maori) is New Zealand's first marine reserve (Marine Protected Area - MPA), established in 1975 (Department of Conservation, 2015). The reserve consists of 547 hectares, five kilometres of coastline and an area extending 800m offshore (see Figure 98). Marine life flourishes in the reserve where fish populations were once scarce, but now the reserve has become an important breeding and nursery area for many different species (ibid.). Along with the reserve, the University of Auckland's marine laboratory was established in 1964, and the Marine Discovery Centre in 2008. The local Māori tribe called "Ngāti Manuhiri" are the traditional guardians[182] of Goat Island[183] that have customary rights ("Mana Whenua" and "Mana Moana" in Māori) over this area (ibid.).

An interview with the local marine biologist and a visit to the Goat Island marine reserve and the associated marine discovery centre in New Zealand led to several findings from Goat Island that could contribute to the notion of a blue urban commons. First, the importance of a marine reserve with a ban on commercial and recreational fishing with a legible boundary for the fishermen (Haggitt, 2021). However, the reserve allows recreational activities, such as snorkelling with local fish, walking trails around the shoreline, transparent kayaks for hire and a marine education centre which is well visited by the local schools and tourists as a popular destination (see Figure 98). Talking to the locals in the area is a source of pride and identity, with locals reporting higher ocean literacy (ibid.). The local Māori iwi (tribe) is closely involved in conserving this reserve, which has shown to be beneficial in helping to conserve the marine reserve (ibid.). There is a sociocultural and economic value of MPAs, especially for the local community, as shown with the Goat Island example (i.e. identity, tourism, ocean literacy etc.). For urban coastal areas, MPAs could be a vital part of a blue commons to demonstrate the importance of protecting marine areas from further exploitation.

182 Based on the guardianship and protection model of the Māori (indignous) people in New Zealand called "Kaitiakitanga". It is Māori world view of managing the environment, based on the Māori world view that humans are part of the natural world. A kaitiaki is a guardian who can be a group of people of individuals that are assigned to take care of entities such as a lake, river, or forest (etc.) (Te Ahukaramū Charles Royal, 2007).

183 However, there have been incidents of fisherman encroaching the area or extensively fishing near the boundary (Haggitt, 2021).

Figure 98. (Top left image) The variety of recreational activities, such as snorkelling and the possibility of hiring transparent kayaks, allows the visitors to see the marine life. Image credit: NZ Pocket Guide (Clear Kayaking at Goat Island in Auckland – New Zealand's Biggest Gap Year, 2018). (Top right image) Image credit: Darryl Torckler. (Middle-row left image) Map of the Goat Island Reserve and the Marine Education Centre and Marine Laboratory in New Zealand (otherwise known as Cape Rodney – Okakari Point) Marine Reserve. Image credit: Department of Conservation (n.d.). (Bottom right image) Public signage communicating the various benefits of a marine reserve. The photo was taken by the author on May 2021.
(Bottom left image) Inside the Goat Island Marine Discovery Centre. Image credit: Laura S (2018). (Bottom right image) There is a coast walkway around the Goat Island marine reserve, connecting the land to sea as a recreational experience for visitors. Image credit: Department of Conservation (n.d.).
(Extracted from Kumu S-O-T-A map – Goat Island, New Zealand node).

MPAs are a legal protection framework that begins to depart from a more utilitarian approach to nature that serves anthropocentric agendas to one that protects nature for its intrinsic value, i.e. a right to exist for its own sake. The next section explores three state-of-the-art cases that attempt to demonstrate a more relational approach to water bodies that could be relevant for coastal cities to forge new approaches with the water. Some of these solutions are not strictly related to urban settings but have the potential to be re-appropriated in aiding not only material and legal transformation but a paradigm shift for the way coastal cities are developed.

3.2.5 A relational approach to water

In this section, I explore three cases that are unified in their shared contribution to the emerging "Rights of Nature" movement[184], which has been influenced by indigenous people's relational worldviews as an ontological model that seeks to safeguard better and respect ecosystems (Dawson et al., 2021). The analytical aim of the section is to investigate how these alternative approaches can be re-adopted and reappropriated into contemporary urban settings. Moreover, I highlight that there is a research gap for exploring the potential of these worldviews in Danish urban planning as an alternative approach that might include local representatives with the more-than-human actors in the decision-making process. This means that for cases like Vejle, there is scope for the LUDP disciplines to investigate how designing blue urban commons might be accomplished from a relational perspective that takes into account the marine realm as a legitimate and rightful resident/actor.

1. Māori world view – The river as a living entity

The reason we [the Whanganui Māori tribe] have taken this approach is ... so that others can understand that from our perspective, treating the river as a living entity is the correct way to approach it, as an indivisible whole, instead of the traditional model for the last 100 years of treating it from a perspective of ownership and management... And therefore, rather than us being masters of the natural world, we are part of it. We want to live like that as our starting point. And that is not an anti-development or anti-economic use of the river but to begin with the view that it is a living being and then consider its future from that central belief.

Gerrard Albert, *the lead negotiator for the Whanganui iwi*
(Roy, 2017).

In 2017, the New Zealand government passed legislation (called "Te Awa Tupua" - Whanganui River Claims Settlement Act) declaring that the Whanganui river and all its physical and metaphysical elements represent "an indivisible, living whole, and henceforth possesses all the rights, powers, duties, and liabilities of a legal person" (Te Awa Tupua (Whanganui River Claims Settlement) Act 2017). This law reflects the Whanganui tribe's worldview, values and traditions

184 For instance, nature-based solutions have been utilised by Indigenous People and Local Communities (IPLCs) across the world for centuries to protect their local environments (Raygorodetsky, 2018). Despite comprising 6% of the world's population (ILO, 2019), IPLCs protect over 80% of biodiversity in areas that store at least 24% of the total carbon in global tropical forests (Rights and Resources Initiative, Woods Hole Research Center, and Landmark, 2016; Raygorodetsky, 2018; IUCN, 2019; Tauli-Corpuz et al., 2020).

that consider the water as a living entity, a person, and their ancestor. This is because the "tribe regard themselves as part of the universe" in a familial relationship with the forests, mountains, rivers and the sea (Roy, 2017). They believe all things are holistically integrated living entities, even those that are outside human perception and beyond our physical and material world. Therefore, "the new legal status of the river means that if someone abused or harmed the river, the law now sees no difference between harming the tribe or the river because they are the same" (Roy, 2017). This interconnected relational thinking was also extended to grant a nearby forest (national park) the same legal status as well as a mountain, which also be granted legal personhood, thus emphasising the connection between water and land entities (Macpherson, 2022).

Without a doubt, the move towards attributing legal status to nonhuman entities is contrary to the dominant instrumental way of engaging the water as a resource to own, degrade and exploit[185]. Although the Maori worldview is not a pure conservation approach (it also concerns human interests and rights), it departs from the premise that humans are inextricably enmeshed in nature, meaning that every compromise, negotiation and conflict stems from the effort to provide better ways to care for life-giving and life-sustaining properties of ecosystems (MacPherson 2021). Therefore, the "Rights of Nature" movement can be understood as an attempt to challenge the existing legal policy frameworks for more sustainable management of natural resources and the environment[186] (Morris and Ruru, 2010; Macpherson, 2022). Importantly, what mattered to the Wanganui tribe was not just the focus on legal rights. It also concerned the paradigm shift in the position of humans in the world based on responsibilities (Warne, n.d.). As such, the real benefits of this approach cannot be restricted to its litigious capacities (which do not solve the underlying source of the issues). Rather, the true potential of this trend lies in its capacity to enable communities to make decisions for the best interest of the river as guardians. It is the social impact and the resurgence of culture to connect people, place and nature in a relational way, which is applicable in other contexts (MacPherson, 2021).

MacPherson (2021) sees potential in this framework for its transferability to other countries/contexts with direct implications for urban planning and coastal management (ibid.). She argues that the rights of nature movement can make an impact on these areas by prioritising the health of natural ecosystems rather than solely considering these in terms of their instrumental production capacities. Ultimately, this is because the relational model reflects basic principles of ecology, which are arguably universally applicable (e.g. everything is connected to something, and everything comes from somewhere and goes somewhere). In turn, this means that the model may be relatable in other contexts, such as Denmark, while also showcasing the potential for fostering a heightened appreciation of the environment that envelops us (ibid.).

185 The Wanganui tribe cared for and depended on the Wanganui river for over 700 years. However, when the European settlers arrived in the mid-1800s, the Wanganui tribes' authority was undermined and relinquished. Since then, they have watched their river be degraded and exploited as a resource as the river was blown up by dynamites to create an easier passage for tourist boats, commercial fishing and the gravel on the river bed was extracted for constructing railways and roads, damaging the river bed and harming its marine life. The river's mouth became a drain for a city's wastewater and sewage. Furthermore, the river was diverted into a different catchment as part of a hydroelectric power initiative, depriving the river of its flow (Warne, n.d.).

186 Macpherson (2022, p. 168) here considers environmental degradation, biodiversity loss and climate change alongside associated economic and social injustices trifecta of challenges in the Anthropocene. She argues for a new legal paradigm shift that better addresses the aforementioned issues in the Anthropocene.

Furthermore, MacPherson (2021) argues that these concepts are even more needed in urban contexts like coastal waters, which continue to suffer from a lack of sensible use of traditional approaches to coastal management and marine spatial planning. Repeatedly, scientific findings have confirmed that it is difficult to draw a boundary around an ecosystem, as any ecosystem constitutes an interconnected whole in which humans are just one component of that system. In turn, this also sets this line of thinking aside from the one that is practised in normative nature protection areas, such as Natura2000. As MacPherson (2021) explains: "It is the urban coastal front, the areas of development where we need the better coexistence of people and ecosystems – to not 'trash' the areas we reside".

Lastly, recognising water bodies as living entities is a start of a new and innovative approach to coexisting with the environment, incorporating intrinsic values in a manner unknown in environmental law in most Western legal systems. While the relationships indigenous peoples have with the natural world and their views concerning its use often clash with the dominant capitalist worldviews, the importance here is that the act of giving rivers a legal status is beneficial not just for indigenous people but for everyone (including nonhumans) to create a mutually beneficial outcome for many generations to come. While it may seem difficult to implement these worldviews in places where such values of viewing nature as a family/person/living entity are absent (i.e. Denmark), the example of Whanganui may still inspire more creative and imaginative narratives to engage with the marine realm. Indeed, this has been shown to be the case in other countries such as Spain, where the legal personhood model of ecosystems was recently adopted in order to protect its saltwater coastal lagoon and its watershed, a first for Europe (Stokstad, 2022). Locals and scientists signed a petition for the lagoon's legal right to be restored from the current worsening eutrophication due to agricultural activities. Legal human guardians, including scientific experts, have been assigned to represent the lagoon's best interest (Stokstad, 2022). This is a case showing signs of potential to be integrated into European sociocultural contexts to protect ecologically poor areas and seems applicable to Denmark, where there are similar problems with eutrophication from farming. Furthermore, this model could also be relevant in inspiring new narratives of getting citizens to care/co-exist better with the water bodies they live with.

2. *Archipelagic thinking – Water as a connector*

> *Archipelagos are figures of connections and solidarity between peoples, places and non-humans.... Archipelagos are an intersectional site of liquid and solid, land and ocean with uncertain edges that are constantly changing according to the tides. Archipelagos are not only geographic but human and thus cultural.*
>
> Rob Shields, *Review: Contemporary Archipelagic Thinking* (Shields, 2020).

A major proponent of "Archipelagic Thinking" is the French Caribbean philosopher Édouard Glissant (1997a, 1997b, 2009) (Wiedorn, 2021). The term has a contextual reference to the Caribbean islands, an archipelago with many island-to-island relations and movements, and refers to a way to think differently about the often dualistic and static idea of borders, favouring a relational conception of water as a connector of the islands (Stephens and Miguel, 2020) instead. According to Pugh (2013, p. 10), "we live in a world of archipelagos, not static island forms" (see Figure 99 as an example). Simply put, to see the world through the eyes of the archipelago is to envision the water not as something that separates land from land but as a bridge that connects between parts, as a spatial interrelation in flux (Stratford et al., 2011). In many ways, this line of thinking reflects the current reality of a constantly changing world moving in an entanglement of dynamic assemblages and networks. Therefore, "[t]he concept of the archipelago deeply challenges how we think about the world and our relation to it" (Pugh, 2013, p.11). It de-territorialises static understandings of the land-to-sea divide to "such and such an assemblage", which can influence and reveal fluid practices, representations, experiences, and affects that produce the dynamic form of an archipelago (ibid.).

In the context of the climate crisis, Archipelagic Thinking offers a lens to engage the global repercussions that continuing SLR will cause. SLR will convert lands to islands, and current islands will go underwater in a continual process of re-territorialisation – a world in a process. Therefore, in the age of the Anthropocene, where change is complex and accelerated, the archipelagic model can help construct "archipelagic relations" that can avoid rhetorics of simplicity, searching instead for the "entanglement between and among" (Stratford et al., 2011, p. 124).

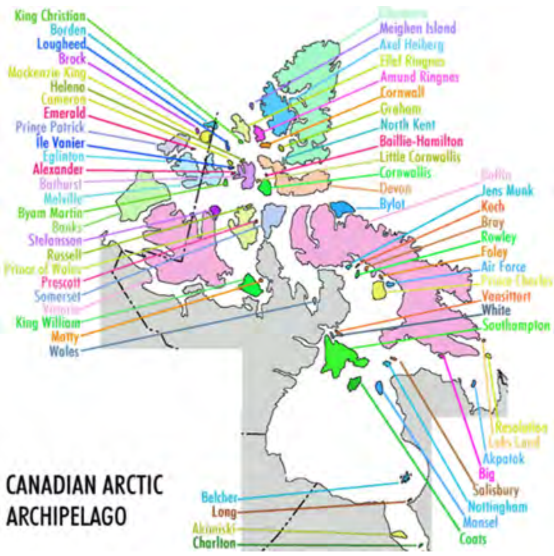


Figure 99. Examples of archipelagos that erode away the notion that the world consists of islands, nation-states and continents but a world as archipelagos (Pugh, 2013). For instance, Denmark and Canada are archipelagos composed of hundreds, if not thousands, of "island-to-island" assemblages. Canada has the largest number of islands in the world (i.e. 52,455) and should be understood "not as a unitary land mass but as a series of multiple assemblages of coastal, oceanic and insular identities" (Stratford et al., 2011, p. 121). Denmark is another example where it can be conceived of as an archipelago, not just within its own 400 islands but its inter-relation to the world of archipelagos. Image credit: Wikimedia Commons and Timvasquez (2006), Denmarkfacts.com (n.d.).

(Extracted from Kumu S-O-T-A map – Archipelagic Thinking, The Caribbean islands node).

In Berlin, Archipelagic Thinking was reappropriated as an urban design and planning concept by the dutch architect Rem Koolhas, who was rethinking the redevelopment of the city toward the end of the 1970s. Koolhas imagined the city as a network of distinct islands, each with an individual identity, floating within a green "ocean" instead of a densified city centre. He wanted to turn Berlin into a green archipelago by connecting all the interesting historical places with a collection of green parks (Hertweck and Marot, 2013; Khazaleh, 2014; Lohrmann, 2014). Thus, the concept was used to rethink the colonisation of the city by grey concrete and using the green spaces as the connecting binder that could enable new connections between already existing elements (Hertweck and Marot, 2013). While such practical uses may suggest the application of Archipelagic thinking as a kind of solution or an answer to a design issue, I argue that the true strength of this concept – as will be seen with the analysis below – lies in its ability inspire new forms of creation within the design disciplines. Much like the rights of nature movement addressed above, this framework offers a way to initate a paradigm shift that can help practitioners and researchers work with water in relational terms rather than as separate entities[187].

3. *The sixth borough – Water as the connective tissue of NYC*

Through this planning process, we have recognized that water has always, and will continue to shape our land. Our water is the connective tissue between our boroughs and is, in effect, our Sixth Borough.

Amanda M. Burden, Director, Department of City Planning Chair, New York City Planning Commission, *Vision 2020 - New York City Comprehensive Waterfront Plan* (NYC Planning, 2011).

Exemplifying both the Rights of Nature and the concept of Archipelagic Thinking in an urban context is "Vision 2020 – New York City Comprehensive Waterfront Plan", which was first introduced in 2011 to provide a framework[188] for waterfront development to transform the 840km of New York City (NYC) shoreline for the next ten years. It had a range of agendas and proposals, one of which was to name NYC's waterfront and its coastal waters the "sixth borough" (borough meaning district in the USA) as an addition to the existing five land-based boroughs (NYC Planning, 2011) (see Figure 100). The act of naming the water as the sixth borough functioned as a metaphor that sought to invite an alternative way of thinking about the water as a continuation of the city (Ameel, 2019a). The significance of attaining a borough status would entail acquiring

187 This is in reference to section 3.1 on the mechanical handling of water in the form of land reclamation and coastal protection and dualistic conception of nature in urban environments.

188 Vision 2020 had two major components. A three-year action agenda containing 130 funded projects, including more than 20 ha of new waterfront parks, the creation of 14 new waterfront esplanades, and a new ferry service providing a framework for the City's 840 km of shoreline for the next decade and beyond (NYC Planning, 2011).

legal human representation (i.e. a borough president) and would grant the water-based borough access to the same regulations, protections and management as the land-based boroughs (ibid.). Attaining this legal status thus recognises the distinct agency of the water (Ameel, 2019b). Moreover, in Vision 2020, water, tides, and wetlands are acknowledged as powerful actors that transform the land into the future and appear to be a valuable entity for the city, which perform vital ecosystem services (NYC Planning, 2011; Ameel, 2019a).

Figure 100. Vision 2020 New York City Comprehensive Waterfront Plan. The map of the five land-based boroughs (i.e. The Bronx, Manhatten, Queens, Brooklyn, Staten Island) and the proposal to make the coastal water body the sixth borough. Image credit: Skye Duncan (NYC Planning, 2011) and reappropriated image from Azoulay (2022). (Extracted from Kumu S-O-T-A map – The sixth borough, in New York City, USA node).

However, as promising and innovative as Vision 2020 might seem, it is necessary to acknowledge how the proposal ultimately succumbed to the logic of capital and extraction, as it also described the water as a resource to be exploited – an object and resource that "New York can *capitalize* on", as the proposal states (NYC Planning, 2011, p.86). As such, we here see how the water, again, is construed as a liquid space that can be subjected to an operation within the domain of production and control (Ameel, 2019a). Vision2020 views the water as "extraordinary physical assets that are 'possessed' by the city" (NYC Planning, 2011, p.6; Ameel, 2019a, p.7). What these descriptions signal is that the despite the efforts to innovate and alter our relationship with water, urban development models remain wedded to a particular vision of the water that needs to reflect the narrative of the growth of the city – i.e. as an "engine of economic growth for America and the world", to quote the Mayor Bloomberg of NYC at that time (NYC Planning, 2011, p.1). Thus, it draws on an enduring idea of "the city as feeding on its natural surroundings to fuel and produce growth" (Ameel, 2019a, p.8).

While Vision 2020 had sustainability and green transition themes embedded into the growth narrative, it unabashedly claimed that "the continued growth of New York City itself is a mitigation strategy for climate change" (NYC Planning, 2011, p.109) – a perspective which drew criticism from opponents (Ameel, 2019a).

Considering the story of The Sixth Borough in light of the studies and cases reviewed in this chapter, what is made visible is how the alternative perspectives and practices covered in the second half of this chapter struggles to overcome the current dominant overt instrumental relationships reviewed in the former half. Moreover, Vision 2020 is what a conventional planning document does: setting out how it will assign, manage, and develop the planning area for the benefit of its human citizens, albeit with a short-term outlook of profit maximisation, while the promise of ecological living, without the protection/restoration of the environment (Ameel, 2019a). Thus, it represents the catch-22 contemporary urban coastal development finds itself in.

That being said, Ameel (2019, p. 15) argues that there is still reason for optimism in such cases; even if the water of NYC is "relentlessly reclaimed, appropriated, redistributed, exploited and capitalised upon", it still retains a level of its transformative power. The transformative power of water and its catastrophes make space for a renewed sense of the commons, and through these instabilities, they can open up the room to accept new ways of thinking and doing, which can take shape. Furthermore, there are indications in the plan that addresses the unrealised potential to enhance the "Blue Network" that can "connect people with the waterways – physically, visually, and culturally – and to stitch the Blue Network into the city's urban fabric" (NYC Planning, 2011, p.86). As such, the important lesson here is to be wary of the dominant rhetorics and narratives and to be persistent in ensuring that nonhuman entities, such as the water, are represented properly and not side-lined to make way for other hidden agendas. Consequently, the different approaches explored in this section all speak to the importance surrounding representation, accessibility and ownership of the water (waterfront), and the intertidal as commons from which the citizen's/resident's conscious and proactive efforts can only shape a new order.

3.3 What is Urban Seascaping?

So far, this research has explored the complexities surrounding the need for coastal cities to move past entrenched ways of thinking and to adapt to the challenges posed by sea-level rise, storm surge, the biodiversity crisis, increasing urbanisation and pollution. The learnings from Part I, II and III have culminated in developing further the Urban Seascaping concept as an ethical and critical proposition (see Figure 101) that may catalyse urban waterfront transformation in the form of a new blue urban commons comprised of both humans and marine life, with seaweed as the key representative. Simply put, Urban Seascaping builds on the existing S-O-T-A approaches (both the soft and the hard) to formulate an approach capable of navigating what it might mean to truly live not just by the sea but *with* the sea. While Urban Seascaping is open to interpretation and further elaboration, the intention is to establish a common language and visual medium among various marine nature-based coastal adaptation approaches.

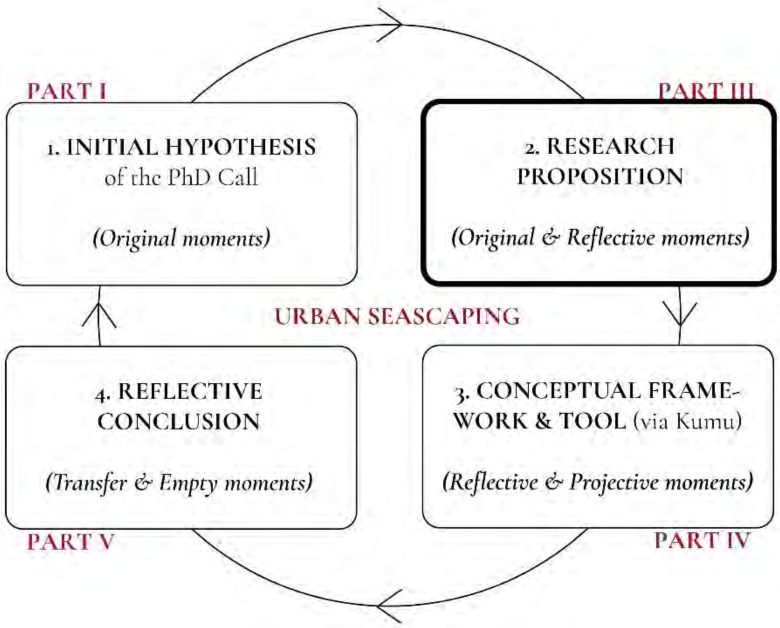


Figure 101. A flow chart describing the various moments of design research from Prominski (2019) (refer to section 2.2 for more information). Urban Seascaping evolves throughout the different moments in this research. In Part III of the monograph, Urban Seascaping is part of the Original and Reflective moments, mainly as a research proposition.

In this final section of Part III, I synthesize the existing research and S-O-T-A examples of soft and hard approaches into four main propositions that together make up Urban Seascaping (see Figure 102 for the key distinguishing aspects of each proposition). These propositions will act as a guardrail for the analysis of design proposals from Kanten/The Edge design competition that I explore in the following Part IV.

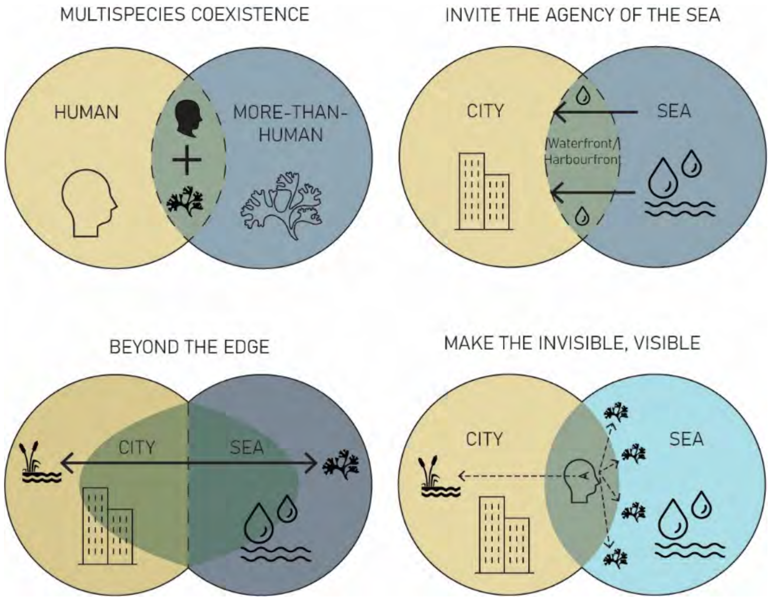


Figure 102. The four main Urban Seascaping propositions.

Proposition I: Multispecies coexistence (with seaweed)

The first principle of Urban Seascaping emphasizes the need for a paradigm shift in the current view of the sea as a threat. Instead, the first proposition suggests integrating the marine realms as a co-resident of coastal cities. Currently, the needs of humans and nonhumans seem to be in direct conflict with each other in urban environments. The first principle thus seeks to reorient the dualistic, anthropocentric, and capitalist worldview toward one that recognises that nonhumans[189] and humans are intimately linked and mutually interdependent. To this end, Urban Seascaping[190] draws on Multispecies Urbanism (see section 3.2.4) as a response to the main research question of seeking different ways to integrate nonhuman marine life forms into coastal cities, starting from a designed spatial meeting place at the boundary between land and sea. This means asking questions about how designers and planners can create coastal cities for both human and marine lifeforms. As the sea continues to rise in the future, Urban Seascaping questions how the inundated infrastructures and buildings could be designed for favourable habitation by marine life for better engagement with the urban realm (refer to Figure 94). Furthermore, a call for better protection and restoration of coastal ecosystems means addressing various anthropogenic pressures, such as water pollution, ocean sprawl and climate change. Without addressing these barriers to coastal ecosystems, they will have difficulty becoming co-residents in coastal cities.

189 This claim is rooted in the science of ecology and many ecological thinkers that focuses on intertwined interrelations and networks and that care should extend to other living species in order for a mutually beneficial future for all. See (Guattari, 2000; Haraway, 2007; Latour, 2007; Bennett, 2010; Morton, 2012; Alaimo, 2016).

190 It is important to note that the research on Urban Seascaping is not all about denouncing anthropocentrism completely or utilitarian approach as it has a place in aiding climate mitigation and ecological restoration. Rather, the focus on nonhuman and intrinsic value propositions should also have a place for an equitable coexistence.

Marine stewardship and ocean literacy

To coexist does not simply mean physically occupying a space. It would be naïve to suggest that urban design and coastal landscape architecture alone would resolve the current nature-culture divide at the coast. Marine biologists, researchers, climate activists and people who work with ocean advocacy emphasise the critical role of creating a community around ocean literacy (see definition) parallel to material initiatives (Hjerl, 2019; Mouritsen, 2019; Palmgren, 2019). These include marine education centres, community outreach programs, marine restoration projects, sea gardens and cultural initiatives surrounding marine food. Here, seaweed plays a strong representative role as marine vegetation to infiltrate sustainable food culture and educational opportunities. Local educational outreach programs for young students are essential as this generation will likely face the consequences of global warming and sea-level rise in this century. Therefore, the role of these initiatives is to help people develop "an ethical lens that extends beyond human self-interest" (Beatley, 2014). Hence, USS's first proposition of multispecies coexistence reflects the model of stewardship/guardianship, which advocates integrating educational, restorative and cultural initiatives with coastal urban seascape design interventions to help nurture and sustain the design interventions.

Proposition II: Invite the agency of the (rising) sea

Water as a connector, an actor, a living entity – An intrinsic value proposition

Humans have conceived the sea in many different ways, and these conceptions influence how we shape our urban coastal environment. For more than a century of human history, the industrialised nations exercised a superior position of ownership and management of the water by expanding coastal cities into the sea. The typical physical design of the urban shorelines reflects this sentiment, as it demarcates a clear delineation between land and sea through land reclamation and hard edges. However, there are alternative ways of regarding this dualistic relationship manifested in physical form. For instance, alternative notions such as "archipelagic thinking" dissolve the divisive hard boundary between the sea and land by conceiving the water as a connector (Pugh, 2013; Shields, 2020). By developing this type of interconnected thinking, the second proposition of Urban Seascaping highlights that there is scope for new urban shoreline spaces to use the agency of the water as a connector where human and nonhuman actors can interact and develop over time. Moreover, alternate worldviews that acknowledge the agency of water bodies, such as seeing the water as a living entity by the indigenous Māori people of New Zealand and NYC's proposal to include the coastal water bodies as a "sixth borough" with legal representation and frameworks (Ameel, 2019). Therefore, the second USS proposition questions the influence of the current dominant utilitarian worldviews of water and how it shapes the way we make decisions at the coast to one that also includes intrinsic value propositions.

Wet territory as the new blue commons

The second USS proposition departs from the view that the sea is a key actor and a spatial design driver to influence the meeting place between humans and nonhumans, city and sea in an increasingly wet reality. Therefore, we need to ask how much wetness we are willing to accept as the new reality of living in the Anthropocene. Many high-risk areas in coastal cities may need to be relocated to higher grounds by the end of the century. These vulnerable low-lying areas left behind after relocation provides a unique opportunity to experiment with – new blue urban commons (refer to section 3.2.4). Therefore, USS suggests radical opening up some of the urban shorelines to the sea to provide new connections and opportunities to create softer, more dynamic zones. These zones can better respond to tides, periodic flooding, and long-term rise in sea levels that could aid the citizens in understanding the ephemeral nature of coastlines and more fluid notions of boundaries beyond the concrete edge.

Proposition III: Beyond the edge (to a zone)

Seaweed as part of a marine nature-based solution

The third proposition of Urban Seascaping seeks to address the unexplored solution space (refer to Figure 83) by going beyond the dominant defence approach to one of adaptation. Going beyond the edge means thinking of it spatially as an interconnected zone. Marine nature-based solutions require a vast area to achieve a significant level of wave attenuation, carbon sequestration and water filtration. Therefore, coastal protection/adaptation should not be limited to the narrow boundaries of the urban shoreline edges but expand to a zone to address the interconnection between land and water. It means conceiving the site of intervention as a series of networks from a multi-scalar systems approach - everything from global to micro level (see Figure 168).

Seaweed has two main potentials as part of a marine nature-based solution (soft approach). First, to perform wave attenuating properties as the first line of defence for coastal cities. By the time the attenuated waves reach the coastal city, it reduces the need to implement harsher hard approaches to coastal protection, such as higher sea walls that sever the connection to the water. The wave attenuating capacity can only be performed by kelp forests that inhabit deeper, colder and saltier waters out of human sight (see Figure 168). Kelp can be grown on floating buoys and lines (refer to section 1.5.2 above, Figure 14 and section 1.5.3 aboveFigure 25) as a potential method to simulate a dense kelp forest for coastal protection that will correspond to a rise in sea level in the future due to its buoyancy.

Moreover, other smaller and more beautiful seaweeds that grow near the shallow coastal shorelines can be integrated as an urban design element, e.g. "sea gardens" to be the visual symbols of sea-level rise, a new resident of the critical coastal zone (the new blue urban commons). These sea gardens need to provide an opportunity for citizens to engage with the sea and its lifeforms to envision them as an active part of the physical, ecological and aesthetic coastal cityscape (refer to Figure 89). As we shall see in the following chapter, Kanten/The Edge design competition calls for a place of exposure, observation and interaction with marine nature, but also a place that challenges our everyday terrestrial experience of the sea – a call that several of the entrants responded to in creative ways.

Proposition IV: Making the invisible visible

Seaweed as the visual and ecological symbol of coastal urban transformation

The fourth and final proposition is to uncover the beauty of the invisible marine realm into the visible urban realm using seaweed as a symbol of waterfront transformation in coastal cities. In spatial terms, the lack of exposure/understanding, inaccessibility and dualistic separation make the marine realm perceivably invisible. Moreover, the continued anthropogenic activities such as the fertiliser runoffs from agriculture have made the world under the sea more invisible in a very literal sense. To communicate the continuing degradation of the marine realm in coastal cities, USS argues that seaweed can represent the importance of marine ecosystems in tackling global warming by providing various ecosystem services crucial to the city. Thus, the fourth proposition calls for coastal cities to "urban seascape" with seaweed by designing spaces that influence a future culture of living with the coastal ecosystems by recognising and fostering the links and constant flux between the environment, organisms, and land-use practices. It means identifying and bringing the complex processes that tie together different species and systems to the visible realm (this also applies to physical visibility and design and decision-making processes). True integration of the marine realm into the urban realm points to a much closer exposure to the sea and its life forms (as shown in Figure 168).

Moreover, USS advocates going beyond human tendencies for territorial favouritism to extend solidarity towards the marine lifeforms by making them a key visible part of the identity of coastal cities. Thus, by turning our gaze not just on land but also below the water, to start conceiving the invisible, visible. This is also applicable to departing from the conventional visual representations of the marine realm, which conventional maps are guilty of depicting the sea as largely dark, abstract, flat and devoid of the complex realities of life below the sea.

To conclude

Chapter III has discussed the potentials and limitations of both the hard and the soft approaches to coastal protection and the issues with ocean sprawl as a continuing urban development model as the climate crisis intensifies. The research emphasises re-envisioning B-A-U development, retreating some of the high-risk coastal areas, and planning for softer dynamic zones that can provide more accessible and equitable public space on the waterfront/harbourfront for the citizens in the form of blue urban commons.

However, unless there is a radical transformation in the way coastal cities are currently built, used and occupied, it seems likely that the land-reclaimed waterfront/harbourfront development model is here to stay in Denmark. Remaining critical to the current B-A-U land reclamation as an urban development model for coastal cities, the chapter explored more conducive ways for coastal cities to coexist with the sea. For instance, marine nature-based solutions (NbS) have been explored as an important addition to the hybrid approach (i.e. where hard approaches cannot be avoided) that require further investigation and attention. NbS has many other benefits that can mitigate decreasing biodiversity and climate change via carbon sequestration. Therefore, more efforts must be made to prioritise, integrate and renew the blue infrastructure as part of the hybrid approach to coastal adaptation and as a key part of the coastal city's waterfronts/harbourfronts identity.

Finally, the learnings from this chapter have been synthesized to develop Urban Seascaping further as a conceptual proposition. The next chapter unfolds the role of Urban Seascaping's four main critical propositions in the specific context of Vejle's Kanten/The Edge design competition entries. Thus, the aim will here be to give insights into future climate adaptation strategies as a designed public space, focusing on exploring the role of seaweed.

PART IV: URBAN SEASCAPING

Introduction to Part IV

Part IV consolidates the learnings from the previous chapters and seeks to mobilise these in an effort to assess Kanten/The Edge design competition brief and its entries. Using these entries as design data, the chapter further develops the propositions of Urban Seascaping by presenting a hybrid network mapping tool through which the entries may be analysed. As such, the learnings from Kanten/The Edge competition are here used to explore what it means to integrate marine life forms into urban development. In doing so, the chapter emphasises how this integration can address climate change-related impacts (RQ1), innovate the LUDP disciplines towards this green-blue transition (SRQ1) and formulate appropriate methodological visual tools that can help establish solutions for the future (SRQ2).

To assess and project Kanten/The Edge competition entries; two Kumu maps were developed. First, the Multiscalar map (MAP1) offers a deep site analysis that may assess the competition entries. Second, the Temporal-Projective map (MAP3) is based on the learnings from the multiscalar map to understand how past decisions on urban development affect Vejle's current situation with water. The learnings from both maps help to speculate a possible future scenario for Vejle's urban development based on the four main Urban Seascaping propositions. This means taking the Kanten/The Edge project further in scope, thereby projecting what it means to incorporate larger-scale marine nature-based solutions and waterfront development using seaweed as the main representative actor. The future timeline (MAP3) responds to the urgency of the IPCC deadlines and Vejle Municipality's storm surge strategy.

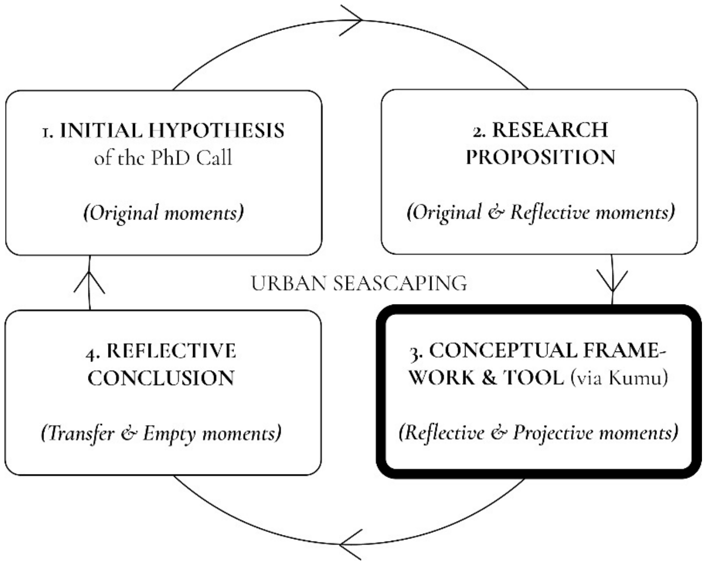


Figure 103. A flow chart describing the various moments of design research from Prominski (2019) (refer to section 2.2 for more information). Urban Seascaping evolves throughout the different moments in this research. In Part IV of the monograph, USS is part of the "Reflective and Projective" moments, mainly as a conceptual framework and as a mapping tool (via Kumu).

4.1 MAP 1: Multiscalar mapping as deep site analysis

The following analyses assess the case competition by exploring its contribution as a state-of-the-art case study for nature-based solutions in coastal protection/adaptation. This also involves taking notice of any shortfalls due to practical constraints (i.e. costs, ownership, resource, time limit and other practicalities). I will also explore key learnings from being involved throughout the competition process as an advisor, with the potential role of advisors in shaping outcomes. It is important to note that the purpose of the following analysis of the competition brief and the entries is not to denounce the efforts of Vejle Municipality and the participants but to explore further what it would take to implement these NbS coastal protection systems at a much larger scope.

The assessments are conducted via a research-through-design mapping framework developed by Kumu (refer to the Part II Methodology chapter, section 2.2 for more details) using the Multiscalar map. The multiscalar Kumu map starts at Kanten/The Edge scale, exploring the design competition brief, judging process and entries and zooms in and out to interconnected macro (global scale) and micro scalar (seaweed scale) contexts as shown in Figure 104 below. As such, the following sections will go through each scale of the map one by one, exploring the different actors, perspectives, stakeholders and issues made visible by the different levels of analysis.

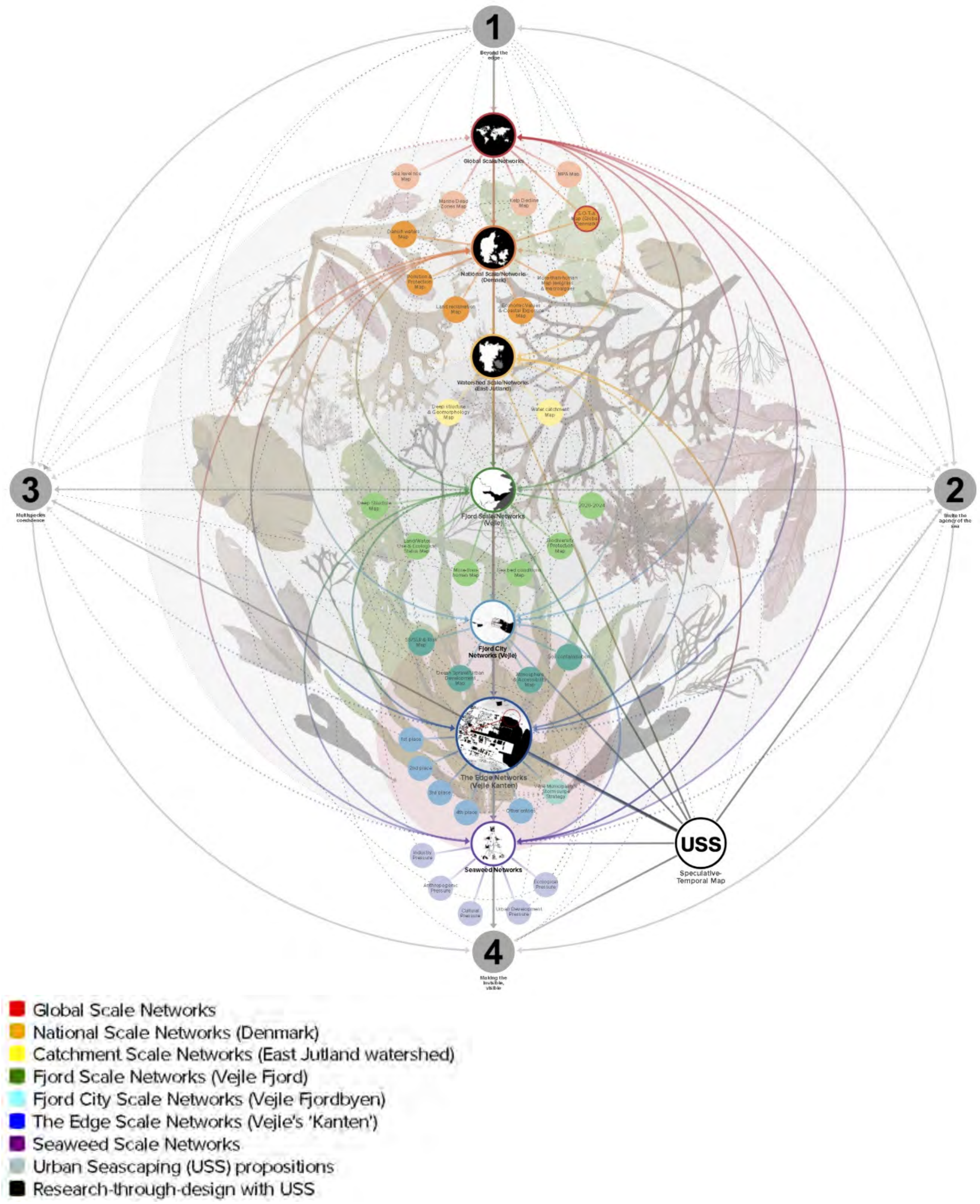


Figure 104. The master map is arranged in a multiscalar format in Kumu, developed and hosted online, which is interactive for the users (go to www.urbanseascaping.com for access) (Kumu, 2020). The numerous circular nodes are embedded with various types of analysis, which appear by clicking on them (a side window opens displaying images, videos, texts, animated GIFs and maps). The main scalar nodes are compiled in the centre linearly, ranging from the global scale to the seaweed scale from the water perspective. These seven major scales/networks are mapped and connected to mini nodes, representing sub-sections of each major scale. The nodes are connected with lines to indicate the network of interrelationships. A dashed line represents a more indirect relationship between nodes, while a solid line represents a more direct causal relationship between nodes. The multi-scalar nodes are enveloped by Urban Seascaping's four main propositions (main outer ring) that drive the overall direction and content of the mapping process.

Note: *Some of the contents (maps, diagrams, images) from the nodes of the Kumu maps have been used throughout the monograph as supporting materials. Moreover, not all the contents embedded into the Kumu maps have been described and used in the analysis in this chapter.*

4.1.1 Kanten/The Edge scale

> *Securing the edges will help establish new qualities in blue-green urban spaces, landscapes, art and architecture, which will increase the added value of the urban port areas, where nature and city become more integrated on both the macro and the micro scale.*
>
> Translated from *Vejle's Stormflodsstrategi* (Vejle's Storm surge strategy) (Vejle Municipality, 2020c).

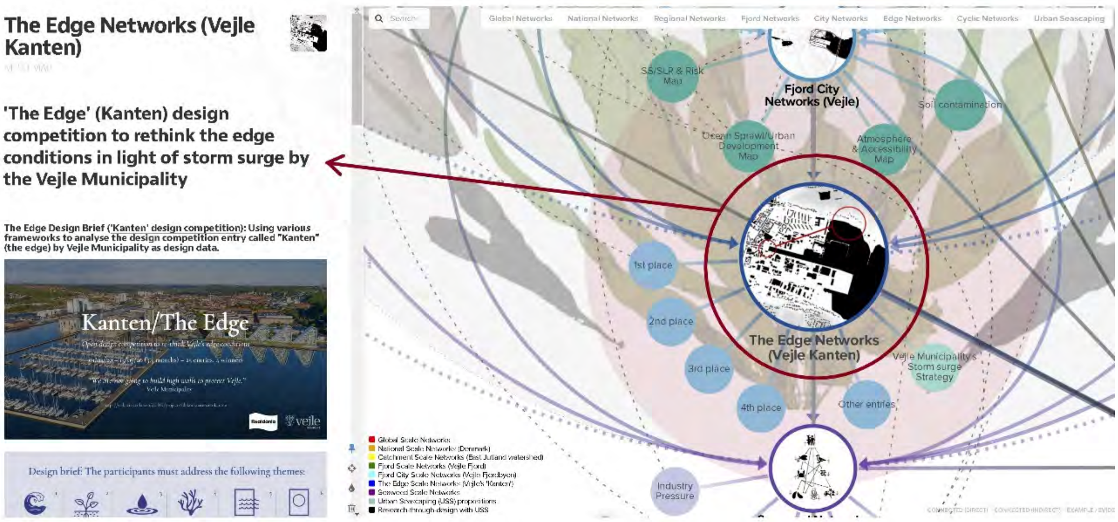


Figure 105. Screenshot of the Kumu map (Kumu, 2020). The Edge network/scale encompasses the analysis of the competition brief, the judging process, winning entries and other entries alongside the Vejle Municipality's Storm surge strategy that was ratified in December 2020 (Vejle Municipality, 2020c). By clicking on the node "The Edge Networks (Vejle Kanten)", one can access the information on the competition.

Introduction to Vejle Municipality's assessment criteria for Kanten/The Edge design competition

The assessment process started on 10 August 2020 to 16 September 2020, when the judging committee reviewed a total of 25 entries that were submitted and admitted for assessment. There were four deliberation meetings with nine judges[191] (seven from Vejle Municipality, one from the Aarhus Architecture School and one from Vejle Art Museum) and four advisers to the judges (one from Vejle Art Museum, one from the Department of Biology, University of Southern Denmark, an independent artist/researcher/art consultant and myself from the Aarhus Architecture School). The city architect of Vejle and a representative from the Aarhus School of Architecture acted as deliberators, with one member from Vejle Municipality as the competition secretary. The details of the participants in the judging process are included in Appendix 11. The deliberation meetings included short presentations from the advisors to the judges (two artists, a biologist and I) on their expertise (i.e. artistic merit, biological merit, spatial merit of the entries) in relation to the competition and which entries deserve merit from a particular point of view. The deliberators also presented to the judges a summary of all the entries, the main themes that arose from the entries, and the selection of the best proposals that satisfied the brief.

The competition required the participants to submit drawings, physical models and a written document[192]. An analysis of the context of the meeting between land and water in the two main zones (site) set out by the brief, the urban and the nature zone (see Figure 7 and Figure 106), as well as what role the proposal for Kanten/The Edge conditions in both zones will play. The analysis also had to describe how the proposal adhered to the following six main qualities (Vejle Municipality, 2020a, author's translation):

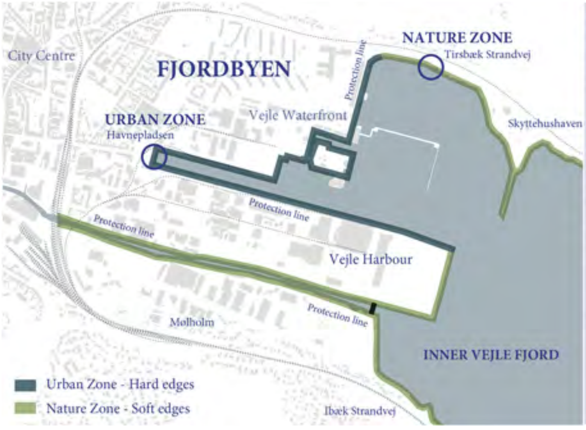
1. **A protection level** of 2.5m above the current sea level against storm surge events and flexible to be developed to an adaptation level of 3m in the future.
2. The proposal must be a **nature-based solution** (i.e. utilise its ecosystem services) with sustainable materials[193] and constructions with minimal CO_2 footprint where possible.
3. Explore **another perspective of the water** through aesthetic, sensory and spatial manner, conveying the transition and meeting between city, nature and water by using the water as an active design parameter in landscape design. Furthermore, Kanten/The Edge should strive to create a common reference, narrative and understanding of the water and its inherent challenges and qualities.
4. The proposal must **incorporate nature above and below the water** as part of the storm surge protection. The marine landscape design needs to feature qualities at varying water levels (i.e. both at normal and elevated water levels due to storm surges).

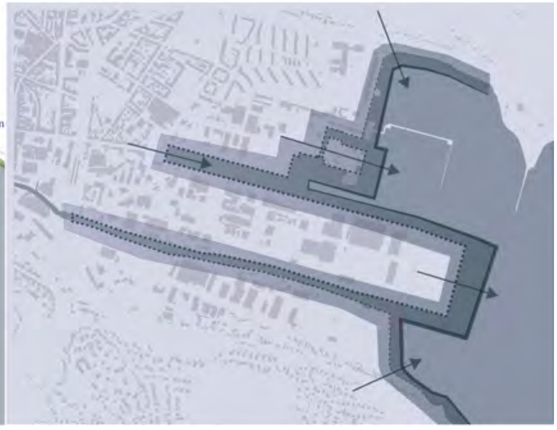
191 As this competition is funded by Realdania, the project manager of Realdania participated in one of the deliberation meetings with a presentation on the importance of going beyond the hard approaches to coastal protection, with the run down on the work Realdania has been supporting through its “Rising sea water” pilot projects, which had an influence on the judging process of reminding the focus on exploring alternative approaches.

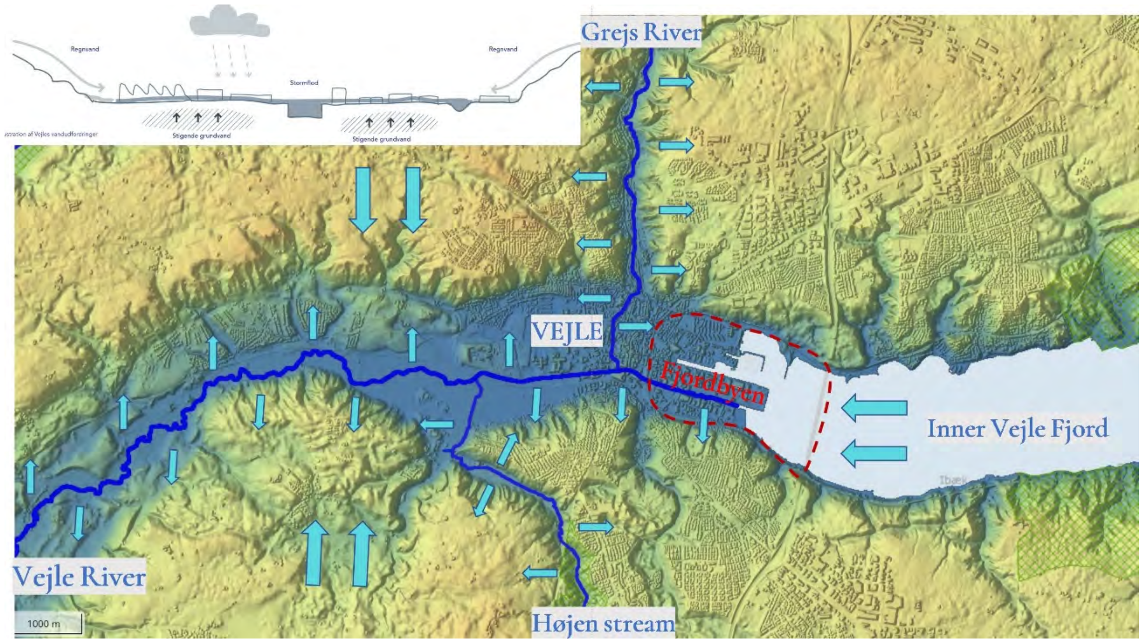
192 Competition submission requirements: x1 A0 poster (or x2 A1), A4 booklet and x2 physical models that describe the concept of the proposal. Physical models need to be in the scale 1:50 (15m x 15m in real life or 30cm x 30cm as a scaled model). The participants are required to submit the following drawings: x1 floor plans of each the urban zone and the nature zone in 1:100, x1 sections of each the urban zone and the nature zone in 1:50. The analysis can be done through drawing, illustration, diagram, ideogram, collage or other visual methods (Vejle Municipality, 2020a).

193 This can be achieved through upcycling, cradle-to-cradle principles, recycled building materials and other innovative approaches to architecture and the landscape (Vejle Municipality, 2020a).

5. The proposal must address Vejle Municipality's **Storm surge strategy**[194]
6. The proposal must address Vejle Municipality's **Resilient design criteria**[195]







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194 Kanten/The Edge must be designed to adhere to all three criteria of the storm surge strategy, in each of their proposals (Vejle Municipality, 2020a).
CRITERIA 1 - The water and Vejle Fjord are part of the city's identity and self-understanding. Vejle actively use art in urban spaces to communicate stories and create identity. Therefore, future storm-flood protection must enter into a common narrative of the city, the water and the arts. The edge's design must help strengthen Vejle's identity.
CRITERIA 2 - Fjordbyen must be developed into a resilient district where stormwater protection with added value and sustainable climate adaptation go hand in hand. The district should inspire how to create a future-proofed city by the water. The design of the border is to protect the city, promote urban nature and contribute to the urban and social capital.
CRITERIA 3 - Proposers must adhere to all three basic principles of each of their proposals:
PRINCIPLE 1: VALUE - Flood protection must ensure added value for the city as a whole. These can be, for example, urban spaces that are aesthetic and recreational, have blue-green qualities, promote physical movement, reduce insecurity and stress and have a positive environmental impact on the land as in water. PRINCIPLE 2: SECURE THE BACK - In storm surge protection, every measure must be considered in the security line that runs along the entire Fjordbyen.

Figure 106. (Top Left) The green lines indicate the security line to envelop Fjordbyen, with the two main zones as the representative site (the dark green line represents the current hard edge condition and the light green line a soft edge). Image credit: Vejle Municipality (2020a).
(Top Right) Vejle Municipality's idea of the edge as a zone. The edge should be considered as a zone extending off the concrete coastline. Image credit: Vejle Municipality (2020a).
(Middle) The way the water flows in Vejle is determined by its topography of the river valley, with the three streams/rivers meeting at the heart of the city centre of Vejle, while the water from the sea comes from the inner fjord. Image credit: SCALGO and Vejle Municipality (2020a).
(Bottom) An aerial photo of Fjordbyen and Vejle's city centre with the Fjord and the bridge. Image credit: Vejle Municipality Facebook page.
(Extracted from Kumu Multiscalar map – Fjordbyen scale node).

In addition to the six main qualities above, the following points further elaborate spatial and aesthetical aspects of Kanten/The Edge that Vejle Municipality would like the participants to consider (Vejle Municipality, 2020a, author's translation):

- **THE URBAN ZONE** is the Harbour Square called "Havnepladsen" (as shown in Figure 7, Figure 106 and Figure 107). Havnepladsen has great significance as a meeting place for the city, port and water. The site has parking facilities and a recreational area with trees and benches. The area is a public space with a stairwell that leads to the water with a concrete edge condition (bulkhead). This area is an obvious site for exploring an alternative urban design of Kanten/The Edge (Vejle Municipality, 2020a, author's translation).

PRINCIPLE 3: THE GOOD MEETING OF THE WATER - Storm flood protection must contribute to expanding contact with the water, visually as well as physically, in the future

195 Vejle's Resilience strategy (created on 2016) is based on the four focus areas: climate resilience, collaborating/co-creating city, social resilience and the digital city. Most of these four focus areas need to be incorporated into Kanten/The Edge development (see Vejle's Resilience Strategy for more details (Vejle Municipality, n.d.)).

- **THE NATURE ZONE** runs along part of "Tirsbæk Strandvej" (Tirsbæk beach road), which currently functions partly as a road, cycle and pedestrian path between Vejle city centre, Fjordbyen and its waterfront area, including the Skyttehushaven (see Figure 7, Figure 106 and Figure 107). This zone must partly be regarded as a recreational stretch, where pedestrians and cyclists are prioritised and are a central place for demonstrating Kanten/The Edge's nature-based design (Vejle Municipality, 2020a, author's translation).

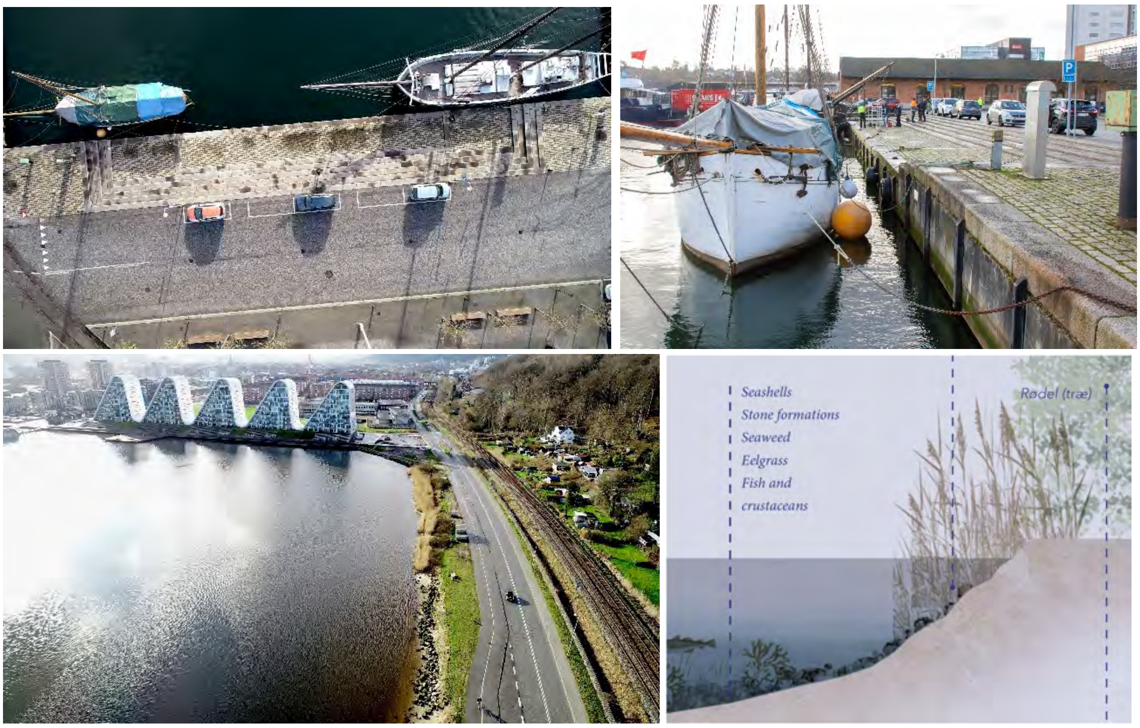

Figure 107. Images of the Kanten/The Edge zones: Urban and Nature Zone.
(Top images) The urban zone is a typical concrete bulkhead 1m-2m below the current water level. Image credit: Vejle Municipality (2020a) and photo of the hard concrete edge taken by the author on 17/09/21.
(Bottom images) The nature zone consists of reed beds and a small stone reef with grass alongside the road and bicycle path. Image credit: Vejle Municipality (2020a, n.d.).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

- **PROTECTION LINE AS A ZONE -** In the first phases of Vejle's storm surge strategy, the security line along the city's existing edge (shoreline) needs to be continuous so that by 2025 onwards, the edge will protect the city from future storm surges (refer to Figure 114). The security line runs along the harbour promenade, quayside, industrial port areas and along the beach (as shown in Figure 106 from Skyttehushaven to Ibæk Strandvej). The line consists of a different wide range of zones. However, a common feature is that they are all placed in spaces where the city meets the water. The security line must be experienced as a space (see Figure 106). This is why it is called a "zone" by the Kanten/The Edge competition brief (Vejle Municipality, 2020a, author's translation).

- **ADAPTIVE AND FLEXIBLE PROTECTION:** Future forecasts and predictions inform a certain height above the current sea level could protect the city from future storm surges (as shown in Figure 108 below). However, these forecasts are unpredictable and uncertain concerning how high the sea will rise by the end of the century. Therefore, the proposed storm surge protection must be an adaptive urban space that can evolve and host different possibilities and expressions in the future (Vejle Municipality, 2020a, author's translation).

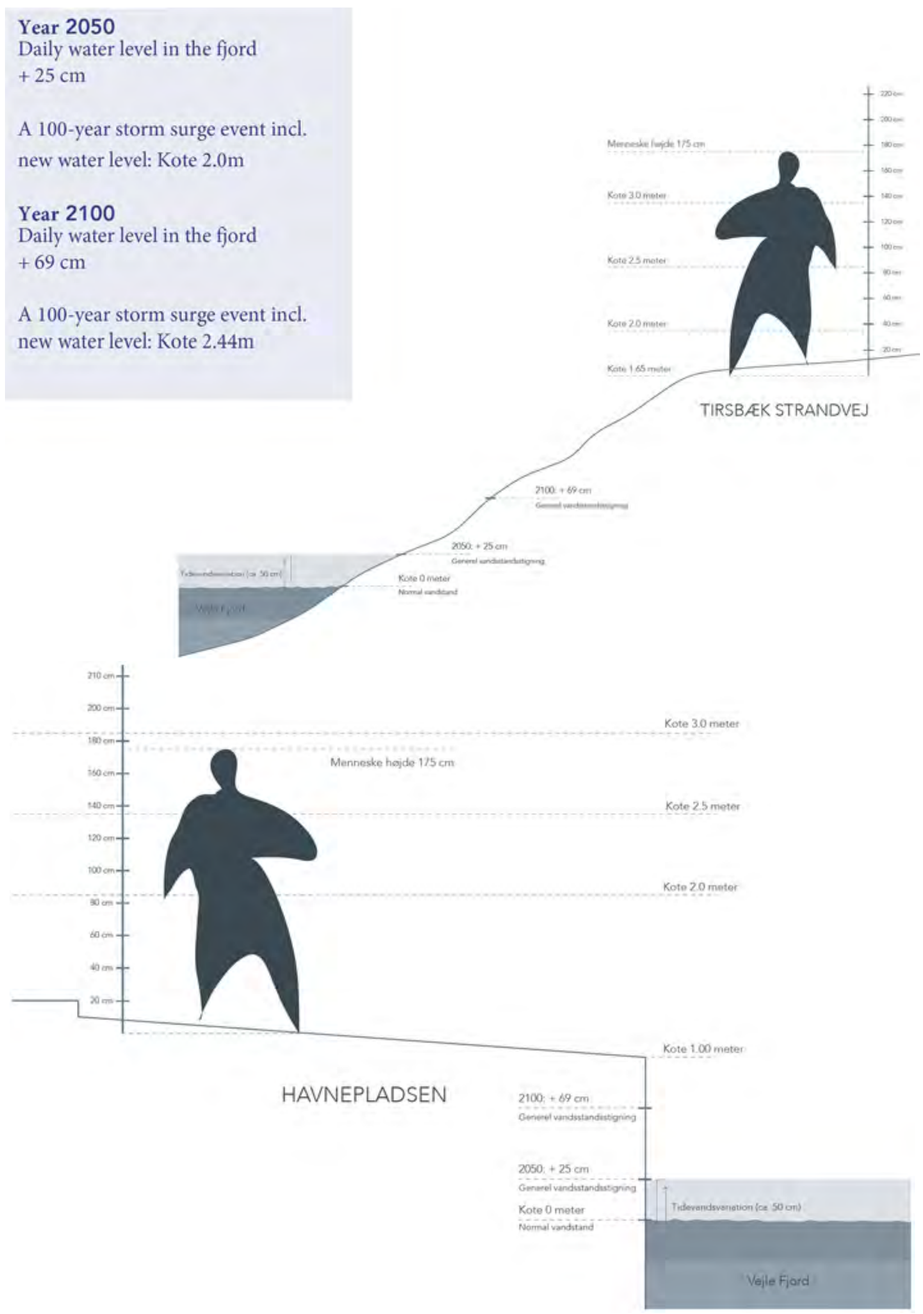

Figure 108. "Kote" (elevation) level 0 corresponds approximately to the current normal water level in the fjord (tidal variation of approximately 50cm). The Edge/Kanten protection levels are 2.5m for protection and 3.0m for adaptation (Vejle Municipality, 2020a). Image credit: Vejle Municipality (2020a, n.d.).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

- **NEW APPROACHES TO WATER:** These challenges facing Vejle are an opportunity for innovative solutions where water can be utilised as an asset in urban development. For Vejle, the municipality would like to see different ways of living with storm surges and rising seawater. This means water could create blue-green streets and squares, adding value to the urban spaces. These solutions need to help citizens gain insight into and understand the processes associated with water and landscape. Vejle Municipality welcomes new collaborations and alliances to start artistic processes and works that can envision the meeting between land and water and ensure good living conditions for all species (Vejle Municipality, 2020a, author's translation).

- **ROLE OF ART AND ARCHITECTURE:** Vejle has a long tradition of using architecture and art in ways that reinforce the narratives that form the basis for urban development. Art can show new perspectives and inspire new possibilities and ideas into the common understanding. Vejle is looking for art that contributes towards a solution with a certain perspective on the world with which we can engage in dialogue and experience new sensory land-water encounters (Vejle Municipality, 2020a, author's translation).

- **NEW VISION FOR FJORDBYEN:** Fjordbyen's vision is to be a climate-resilient, sustainable district where storm surge protection and urban development go hand in hand. The vision has ten key stances: 1. A sustainable and resilient neighbourhood. 2. A neighbourhood with the courage to try something new. 3. A neighbourhood where one is curious about the water. 4. A district with historical references. 5. A neighbourhood with room for everyone across the community. 6. A neighbourhood with space for nature. 7. An area where the urban spaces create recreational and socialising opportunities. 8. A neighbourhood that is a good place to live that connects the water and the arts. 9. A district with room for business development and port activities. 10. A neighbourhood that supports different communities (Vejle Municipality, 2020a, author's translation).

According to the brief, the design proposals would mainly be judged on the strength of the main idea and the conceptual solutions for a nature-based, recreational storm surge protection above and below the water in Vejle, with a particular focus on architectural, landscape and artistic innovation and quality.

Assessment of the Kanten/The Edge design competition brief

Kanten/The Edge competition design brief was pioneering in many respects. It emphasised the need for more nature-based solutions, especially incorporating nature *underwater* when considering coastal protection and adaptation strategies. It also highlighted the need for a different perspective on the water moving past B-A-U practices. Moreover, it is commendable that Kanten/The Edge competition was an open call to artists, landscape architects, architects, practitioners and students, which allowed small, unknown practitioners to enter and be judged anonymously. Interdisciplinary collaboration was encouraged[196], such as between marine biologists and artists (not surprisingly, all of the winning teams had a team member with both art and architecture backgrounds).

Nevertheless, this type of open design competition is disappearing in places like Denmark and Sweden, as noted by one of the winners, where design competitions often only invite big, well-known architectural firms, which can result in B-A-U proposals.

Furthermore, the design brief was limited in scope by focusing on the "edge" conditions (see Figure 106), which fails to capture and analyse the dynamic spatial networks of water that goes beyond the immediate site. The focus on the edge condition is due to the nature of design competitions, where it is difficult to assign a larger area of intervention due to budget[197] and other practicality issues, even though larger-scale interventions are often required for more effective marine nature-based solutions (refer to section 3.2.2).

In the following analysis, I briefly discuss the six main criteria in Kanten/The Edge competition from the perspective of the Urban Seascaping propositions, considering the potentials and limitations offered by each of the criteria offered to the entrants.

Kanten/The Edge design brief criteria 1: *2.5m protection by 2050, 3.0m adaptation by 2100* **→** ***Urban Seascaping proposition 3:*** *"Beyond the edge"*

While Vejle did not want to resort to sea walls, there was still the requirement of a protection level of 2.5m and 3m adaptation. This meant that some form of elevation was required to meet this criterion. Due to the limited area for intervention (i.e. allocated site), much of the competition entries ended up being some form of a stepped dike, albeit "nature-based" (see Figure 109). Many proposals displayed a solution to adaptation level to 3m by adding more materials and thereby increasing the dike's height (see Figure 109).

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196 However, as one of the winners pointed out, while inter-transdisciplinary collaborations are ideal, it may also be a time-consuming and labour-intensive endeavour, not least considering that the participants – at least in the case of those who did not win – had to do this work for free. Moreover, as one of the representatives of the winning team suggested that the lack of artists participating in the competition might indicate that without collaboration with landscape architects, it would be challenging to come up with a realisable pragmatic project. At the same time, it could be challenging for architects to be more artistically experimental if they were not trained to do so.

197 It is also difficult for these open competitions to ask practitioners to do extensive large-scale work for free.

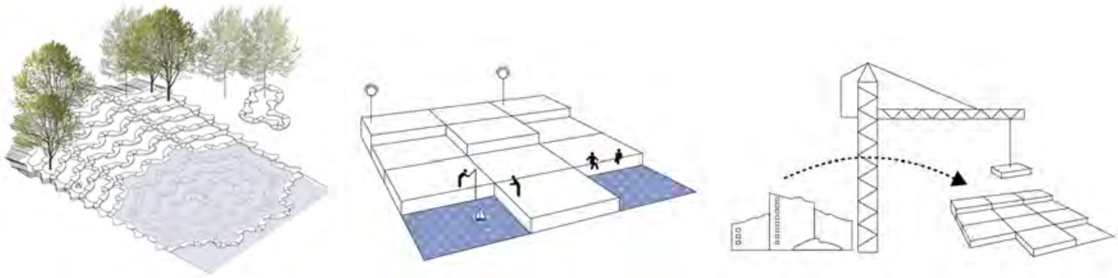
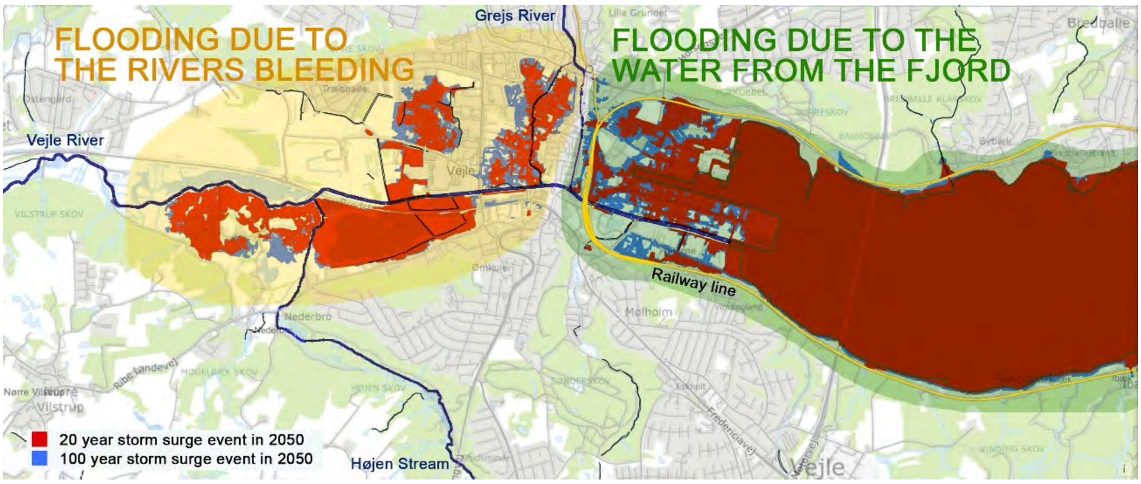


Figure 109. The most popular approach to meeting the 2.5m and 3m protection requirements. Image credit: Vejle Municipality (2020), SUPERFLEX and Baldios.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Thus, the protection systems do not have much room to be implemented further back from the edge (especially at the urban zone), taking advantage of the higher topography of the railway lines that border Fjordbyen (on a diked mound – see Figure 110). Fjordbyen could be a place that offers a larger transition zone from land to sea,[198] as it is also the most vulnerable area to the sea. The research questions the unexplored possibilities in expanding the site (Kanten/The Edge) further back into Fjordbyen to seek solutions other than the popular stepped dike approach in most proposals. Thus, the USS proposition of going "beyond the edge" highlights whether Kanten/The Edge has explored what it truly means to go beyond the "edge" condition to a zone. This aspect is explored further in the multiscalar analysis in the preceding sections, 4.1.2 to 4.1.7 and from the competition-winning entries.



198 This is referring to a future scenario where the current B-A-U high-rise residential and commercial buildings in Fjordbyen are either demolished or relocated to make way for a new use in Fjordbyen.

Figure 110. (Top image) A 20-year and 50-year storm surge event by 2050 (NetGIS, 2022) from Vejle Municipality. The area shaded in green is flooded due to water from the fjord, and the area shaded in yellow is flooded due to the river bleeding in the event of a storm surge. The extent of the water from the fjord does not go beyond the railway tracks on top of an existing dike, as shown in the photos. The water from the fjord can bleed through the tunnels further into the city centre. Images source: Net GIS (2022).
(Bottom row of images) Google street view of the elevated railway tracks that doubles as a dike. The water can only infiltrate through the tunnel bridge openings. Image source: Jernbanegade in Google Maps.
(Extracted from Kumu Multiscalar map – Fjordbyen scale node).

Kanten/The Edge design brief criteria 2 and 3: *Nature-based solution (NbS) above and underwater* **→** ***Urban Seascaping proposition 1&4:*** *"Multispecies coexistence" and "Making the invisible, visible"*

Kanten/The Edge competition has limited the site (area for intervention) to the inner fjords in Fjordbyen, which is a challenging area for marine nature but represents the meeting place where people have the most everyday opportunities for interaction with the water. However, the poor water clarity in the fjord impedes photosynthesis and the ability to view the marine vegetation under the water. Moreover, the sea bed is largely devoid of hard substrates and suffers from an unbalanced food web (see section 4.1.7 seaweed networks for more detail). Addressing these factors is crucial for the success of NbS with marine species[199]. Therefore, it is crucial to continue marine restoration projects like Sund Vejle Fjord until a healthier ecological condition of the fjord is achieved (see Figure 111 below). To coexist with marine life in coastal cities means ensuring the right conditions for marine habitats to thrive and ensuring that marine habitats are big enough to provide impactful ecosystem services[200] , as indicated in the research in section 3.2.2 (Mork, 1996; Orff, 2016; Boderskov, 2021).

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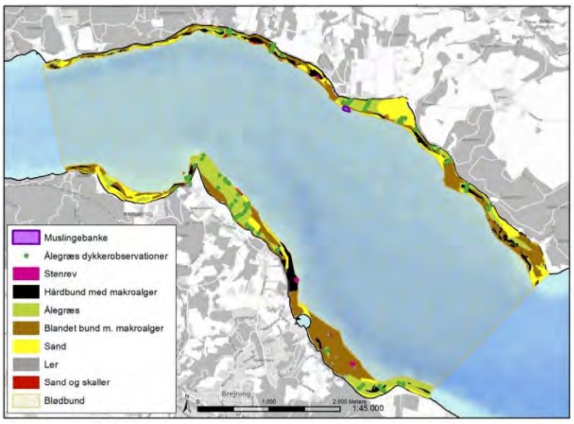
199 Nevertheless, many of these marine restoration initiatives have been implemented on the mid-outer fjord which currently has better conditions for reviving mussels beds and eelgrass plantations (due to salinity level, water flow, water clarity etc.) (Sund Vejle Fjord, 2022).

200 Such as, water purification, wave attenuation, improve biodiversity, coastal erosion mitigation, blue carbon etc. Refer to ecosystem services of seaweed in section 1.5.2.

Figure 111. Photo evidence of positive signs of marine life returning to the fjord due to the restoration efforts of eelgrass and mussels from the Sund Vejle Fjord marine restoration project. They are also fishing out the exploding crab population and establishing rock reefs back into the fjord in several locations (refer to Figure 10) where small fish can use as nurseries. The mussel beds and eelgrass plantations have settled in different parts of the mid-outer Vejle fjord. Image credit: Sund Vejle Fjord (n.d.).
(Extracted from Kumu S-O-T-A map – Sund Vejle Fjord, Denmark node).

Therefore, any interventions to reinstate nature below water (as NbS) must work with the current poor water visibility in the inner fjord, which requires shallow water depth for marine life to gain better access to sunlight. For instance, seaweed was found on the concrete staircase submerged from 10-30cm depth (as shown in Figure 112). The current visibility on a sunny day (from the naked human eye) is at a 3m depth maximum[201] due to the floating particles in the fjord (Boderskov, 2021). Moreover, Nielsen et al. (2015) reported that seaweed was only detectable to a water depth of up to 4m in the inner fjord (see Figure 112). These environmental conditions indicate that bringing the invisible nature underwater into the visible, accessible and tactile urban realm for the engagement with the human actors is a challenging design task that requires tackling much bigger issues of water quality, which is a concern beyond the edge conditions.

201 According to marine biologist working in Vejle Fjord, the visibility of the outer fjord reaches between 3-7m on a good sunny day (Hedrup, 2021).


Muslingebanke
Ålegræs dykkerobservationer
Stenrev
Hårdbund med makroalger
Ålegræs
Blandet bund m. makroalger
Sand
Ler
Sand og skaller
Blødbund
Brejning
0
1.000
2.000 Meters
1:45.000

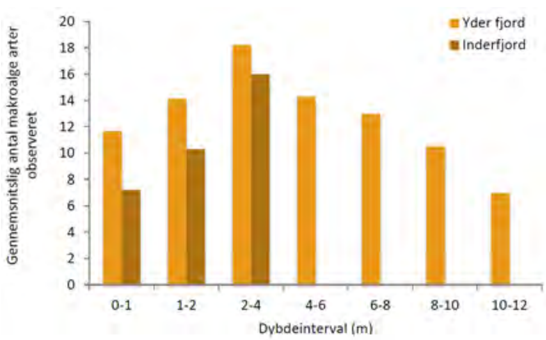

Gennemsnitslig antal makroalge arter observeret
20
18
16
14
12
10
8
6
4
2
0
Yder fjord
Inderfjord
0-1
1-2
2-4
4-6
6-8
8-10
10-12
Dybdeinterval (m)

Figure 112. (Top row) A concrete pedestrian platform borders the Vejle marina. At the end of the walkway, a concrete staircase leads into the water, where several different species of seaweed (and blue mussels) can be found due to the shallow water. Only a shallow water depth of around 10-30cm allows the seaweed to be seen by the human eye due to the fjord's poor water clarity. The photos were taken by the author on a site visit: on 07/06/22.
(Second row) Photos of green and red macroalgae growing on the submerged staircase. The underwater photo was taken with GoPro Camera by Niels Rysz Olsen on 07/06/22 (Rysz, 2022).
(Third row): Blæretang (Bladderwrack – brown macroalgae) was found attached to most of the concrete edges around the waterfront area. Crabs were also seen underwater. Seaweed is grown on lines in the Kayak Club in the waterfront area. The photos were taken by the author on a site visit on 29/07/20.
(Bottom left) Mapping the sea bed conditions and habitat types in the study area of mid-fjord. The figure is reproduced from Niras (2016).
(Bottom right) The average number of macroalgae species observed in Vejle's inner and outer fjord within the specified depth intervals in the time period 2009-2012 (Data from The Danish Nature Agency's monitoring program) (Nielsen et al., 2015). Also, refer to Appendix 13 on the list of seaweeds available in Vejle Fjord.
(Extracted from Kumu Multiscalar map – Seaweed scale node).

The need for better environmental conditions[202] at the inner fjord marks the importance of connecting the Kanten/The Edge initiatives with the water's networks – i.e. upstream to downstream. For instance, the wetland restoration projects upstream through the Vejle River (see Figure 113) and the Natura2000 protected forests along the coast of the fjord (as shown in Figure 79) play a role in filtering the agricultural runoffs before being flushed to the fjord (Chivian, 2003; Hedrup, 2021), while the Sund Vejle Fjord project clean the water from the mid-outer fjord. These nature restoration areas[203] serve an important role as a place for habitat, recreation and interaction between the human and the nonhuman world (e.g. visitors can engage in bird watching in the wetlands, as shown in Figure 113 (Naturstyrelsen, 2022)). The wetland restoration areas also double as a place to hold excess water in the event of a cloudburst (i.e. retention ponds). Consequently, it is important to highlight these stories of nature restoration as part of the water's network in parallel with Kanten/The Edge project if such projects are to contribute as vital blue-green infrastructures[204] in Vejle.

The competition brief misses an opportunity to scale up the NbS and expand the site from an edge to a zone in ways that might facilitate multispecies coexistence. Without 1:1 scale local testing, it is hard to know if these NbS will incur significant ecosystem services or even be big enough to provide decent habitat for marine life (i.e. wave attenuation, water filtration, carbon sequestration). Nevertheless, due to the limitations of the narrow width of the site in both urban and nature zone, the outcomes of most of the proposals ended up being a green dike or different sorts, limiting the number of possible solutions.

202 Unfortunately, limiting the amount of fertiliser use by the farmers in the water catchment area has been a long battle that has been going on in Denmark for the past 20 years (Organo Quintana, 2020; Fjeldsø Christensen, 2021; Hedrup, 2021). Vejle Municipality is proactively working with farmers to find ways in which the agricultural runoffs to the fjord can be limited, albeit with resistance (ibid.).

203 See the report "Fremtidens natur i Vejle Kommune" by Danmarks Naturfredningsforening (n.d.) for all the nature restoration initiative in Vejle.

204 See "Ecological infrastructure" in definitions.

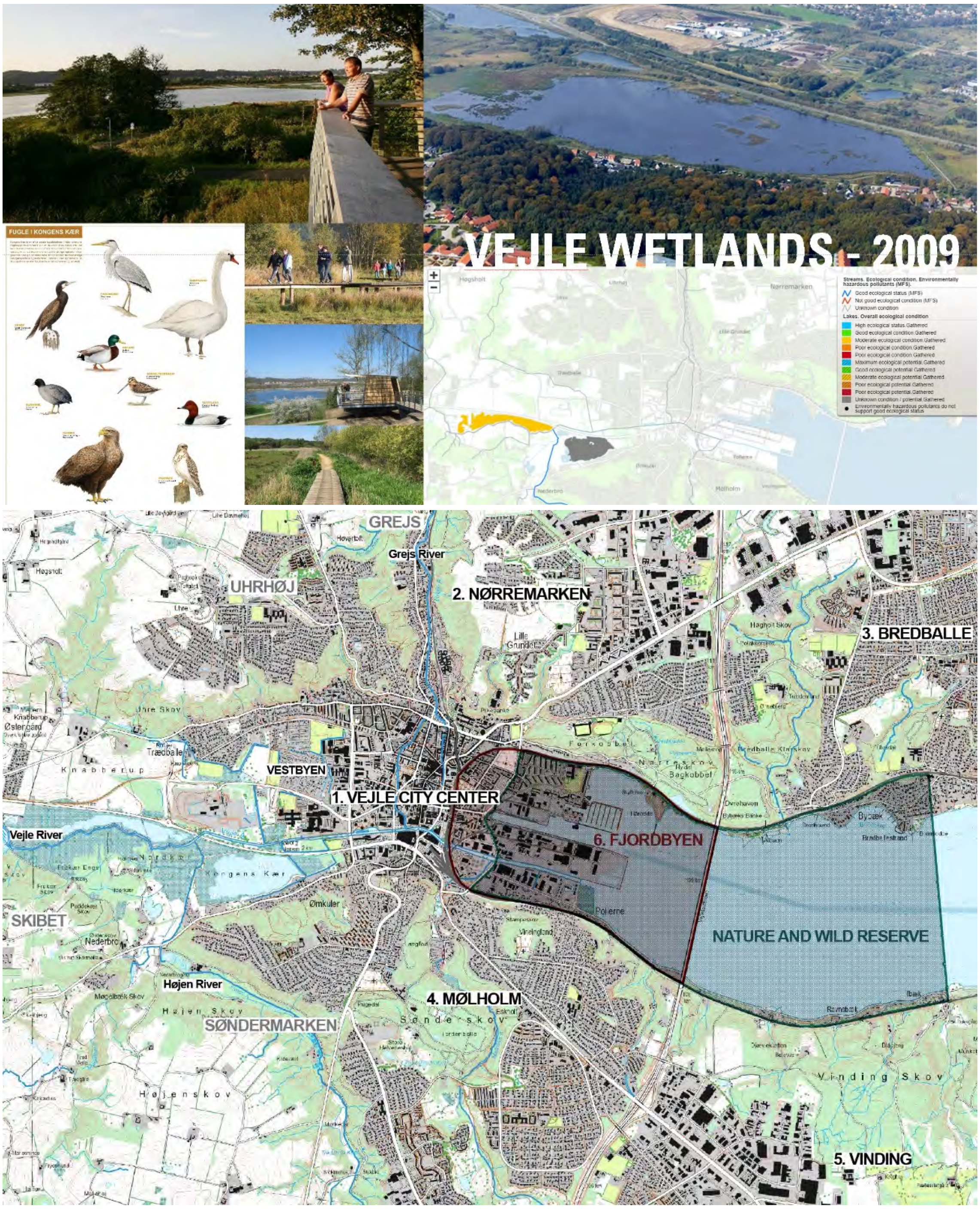


Figure 113. (Top image) "Kongens Kær" is an artificial wetland created to provide habitats for animals, and recreational activities, filter pollutants before being flushed to the fjord (Naturstyrelsen, 2022) and a place to hold excess water in cloudburst events. Wetlands are part of blue-green infrastructures in Vejle. Image credit: Vejle Municipality (2021), Visit Vejle (n.d.), Miljøstyrelsen (2016).
(Bottom image) Vejle River runs through Kongens Kær wetland to meet The Nature and Wild Reserve ("Natur og Vildt reservat" in blue). The reserve was established in 1940 to ban bird hunting in this area. The reserve (682 hectares) includes some of Fjordbyen and part of the Vejle river (Vejle Municipality, 2019b; Miljøministeriet Naturstyrelsen, n.d.; Bekendtgørelse om Vejle Inderfjord vildtreservat). Image credit: Miljø GIS by Miljøstyrelsen (2016).
(Extracted from Kumu Multiscalar map – Fjordbyen scale node and Kumu Temporal map 2004– 2009 node).

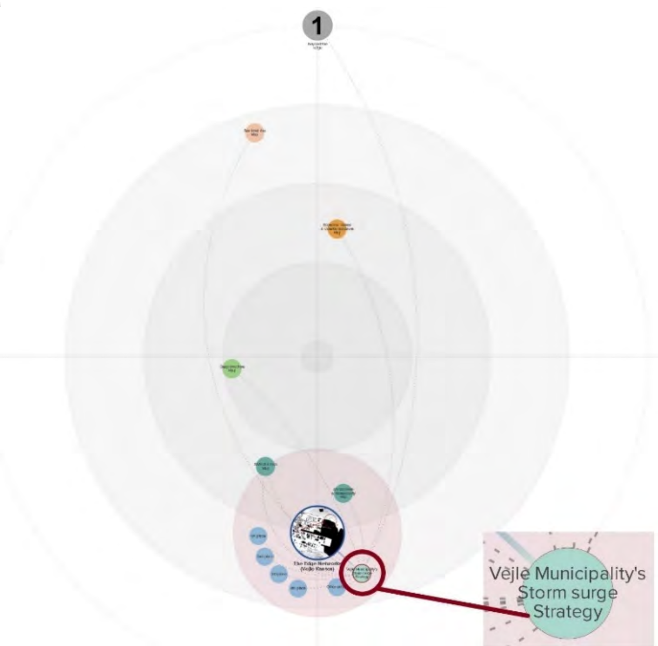
Design brief criteria four: Another perspective on the water

→ ***Urban Seascaping proposition 2:*** *Invite the agency of the water*

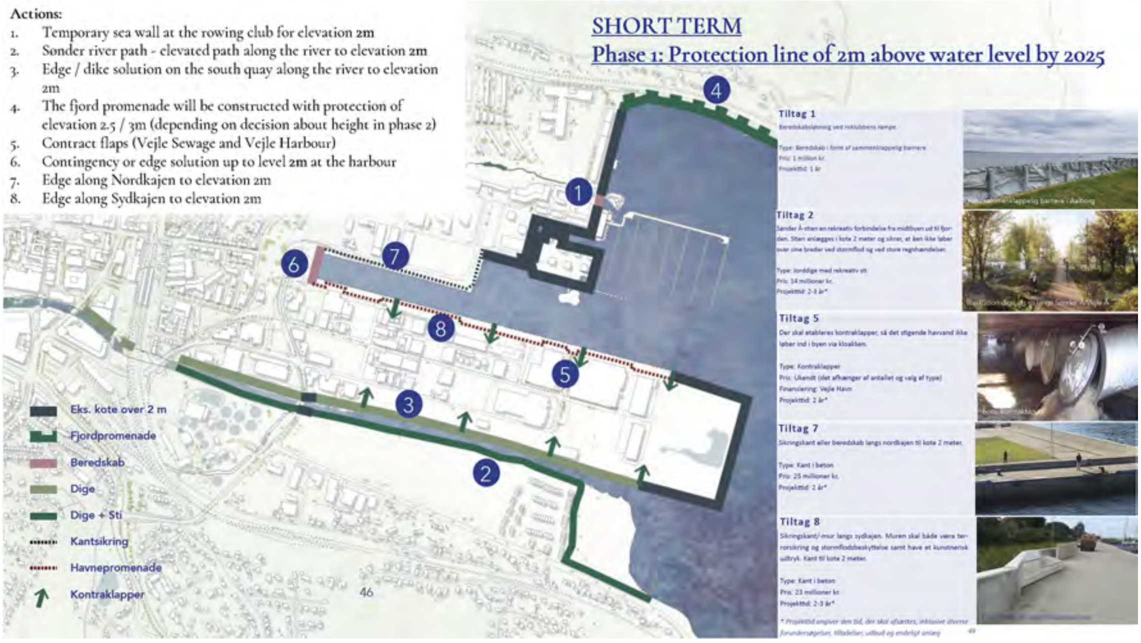
This brief criterion asks the participants to envision the “edge” not only as a spatial intervention but also as the way we think (perceptions) about how to live by and with the water, thereby making possible the cultivation of novel forms of ocean literacy. The criterion provoked philosophical approaches that advocated the need for a paradigm shift in how we view water (and its life forms). All the winning entrants responded strongly to this brief criterion (see the next sections for details). Moreover, the brief discusses the potential of how water could inspire new parameters in landscape design, albeit primarily from an instrumental point of view (e.g. as storm surge protection). Consequently, the brief fails to offer intrinsic value propositions of what the city can do for the fjord – to cater for its right to exist in its own right. Furthermore, the brief does not necessarily explore alternatives to existing with water other than the currently dominant approach to coastal protection to block the water from entering the city, as outlined in the competition brief.

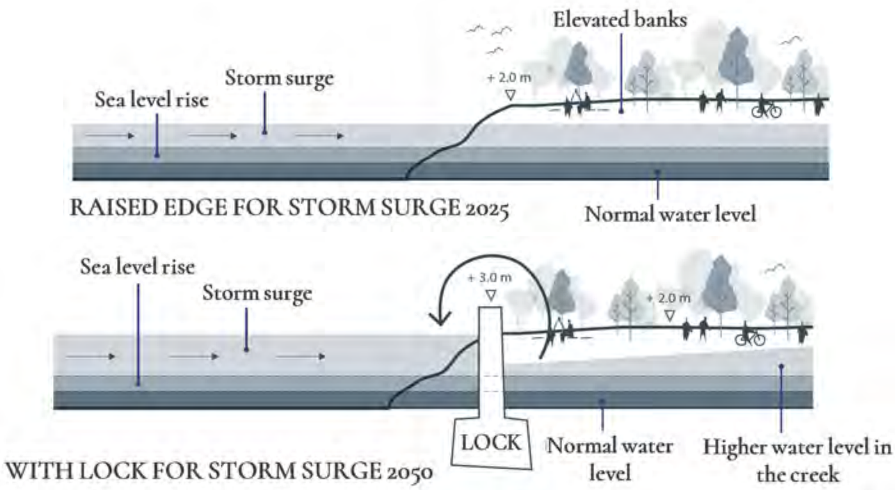
Design brief criteria five and six: Resilient Vejle and Vejle’s Storm surge strategy

Vejle Municipality’s storm surge strategy report was approved in December 2020, which includes Vejle’s action plan for its coastal protection and adaptation of Fjordbyen by 2025, 2050 and 2070 (Vejle Municipality, 2020c). As shown in Figure 114, the short-term phase 1 plan revolves around increasing the elevation (bulkhead and promenade) of the edge conditions by 2m, installing temporary sea walls and upgrading the infrastructure by 2025 (Vejle Municipality, 2020c). Medium-term phase 2 begins to include more recreational nature areas at the edge of the harbourfront (see number 6 in Phase 2 in Figure 114) with an elevated height of 2.5-3m (Vejle Municipality, 2020c). The long-term phase 3 for 2070 is vaguer in its plan and indicates a space further out in the fjord for some degree of nature-based barrier to protect to a level of 3m. There is no mention of a retreat or relocation plan for Fjordbyen in the report, nor a no-development area in the risk zones for the future (ibid).



Actions:
1. Temporary sea wall at the rowing club for elevation **2m**
2. Sønder river path - elevated path along the river to elevation **2m**
3. Edge / dike solution on the south quay along the river to elevation 2m
4. The fjord promenade will be constructed with protection of elevation 2.5 / 3m (depending on decision about height in phase 2)
5. Contract flaps (Vejle Sewage and Vejle Harbour)
6. Contingency or edge solution up to level **2m** at the harbour
7. Edge along Nordkajen to elevation 2m
8. Edge along Sydkajen to elevation 2m





Actions:
1. Edge / building blocks raised to elevation 2.5 / 3m
2. Permanent edge solution elevation 2.5 / 3m
3. The path connection at elevation 2 m is added to one edge / furniture of **+0.5 or +1m** along the path
4. Lock - dimensioned up to level **3m** + pump
5. Storm surge protection / art along the South Quay elevation 2.5 / 3 m
6. Recreational / nature area elevation 2.5 / 3m
7. A permanent security of the city at the harbour in connection with a harbour tunnel

Figure 114. Summaries of the main actions from Vejle Municipality's storm surge strategy. Short-term strategies include increasing the protection line by 2m by 2025, medium-term strategies include enhancing the protection line by 2.5-3m by 2050, and long-term strategies include increasing the elevation to 3m by 2070. Image credit: Vejle Municipality (2020b). (Extracted from Kumu Multiscalar map – Fjordbyen scale node and Kumu Temporal map – 2025, 2050 & 2070 node).

The storm surge strategy suggests using the predominant approach of elevating bulkheads. While it may not be a sea wall disconnecting the view and physical engagement with the water, the approach still repeats the business-as-usual practice of dualistic divide between city and water in many parts of the security line. Furthermore, it is unclear what the future intention is for Fjordbyen's existing buildings, whether they will be retrofitted, relocated or dismantled, not to mention what the urban development strategies will be in the future[205].

Moreover, as highlighted in the Resilient Vejle City plan, there is a clear emphasis on the green transition of Vejle, including the need for GHG reduction, mitigation and sequestration. There are many initiatives implemented in Vejle Municipality to uphold these sustainable visions and goals[206]. Kanten/The Edge as the initial catalyst for the green-blue transformation of the entire Fjordbyen district, especially with a stronger focus on the potential of nature underwater in aiding this change.

205 Potential future plans for Fjordbyen are not made public for various reasons. The workshop I had with key members of Vejle Municipality indicated that they are indeed thinking about the future role of Fjordbyen and accept a potential scenario in the future that this district may need to be very different from the way it is built currently.

206 Such as the Paris Agreement and the biodiversity goal by the EU directive (European Commission, n.d.). For Danish municipalites, they have plans to increase "nature and wetlands" (natur og vådeområder in Danish) from 12% coverage today to 25-30% by 2050 and forests (skov in Danish) from 15% to 20-25%, while farmland currently at 61% to either grow or shrink by 2050. However, it does not contain area requirements (arealbehov) for marine nature underwater but could be considered within the wetlands area as part of climate adaptation (Arler, Munk Sørensen and Søgaard Jørgensen, 2017).

The next section discusses the four winning entries from Kanten/The Edge, the judge's comments on why they were selected, how the entries satisfied the brief, shortfalls and new potential innovations that could be developed further. Like the case brief itself, the winning entries are also analysed from the four main Urban Seascaping propositions, emphasising how the proposals work from seaweed's perspective in each case. To substantiate this analysis further, I here supplement the design entries with information gathered from interviews with the participants.

Notable entries from Kanten/The Edge design competition

After three meetings of the judges, a unanimous decision on the winning proposals (first, second and third place) was eventually found. In addition, a fourth proposal was procured. The winners were announced on 5 October 2020. Currently, Vejle Municipality is in the initial phase of developing the award-winning proposals[207] into a built project by 2027.

My involvement in the three main phases of Kanten/The Edge competition is outlined in Figure 115 below: First, the pre-submission phase; second, the judging phase and third post-winning phase.

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207 None of the proposals can be realized in the form in which they are, but all the proposals will be able to be developed and processed into concrete solution proposals. Overall, the proposals provide a good picture of what possible paths the municipality can take to develop a storm surge protection with added value (Vejle Municipality, 2020b). Realdania has chosen to support the Membrane winning entry with 24.7 million kroner (DKK) to realise the Nature Zone (Tirsbæk Strandvej) part of the project. Vejle Municipality is currently initiating a process in two phases, a development phase and a realisation phase, where the goal is to have the project completed by 2027.

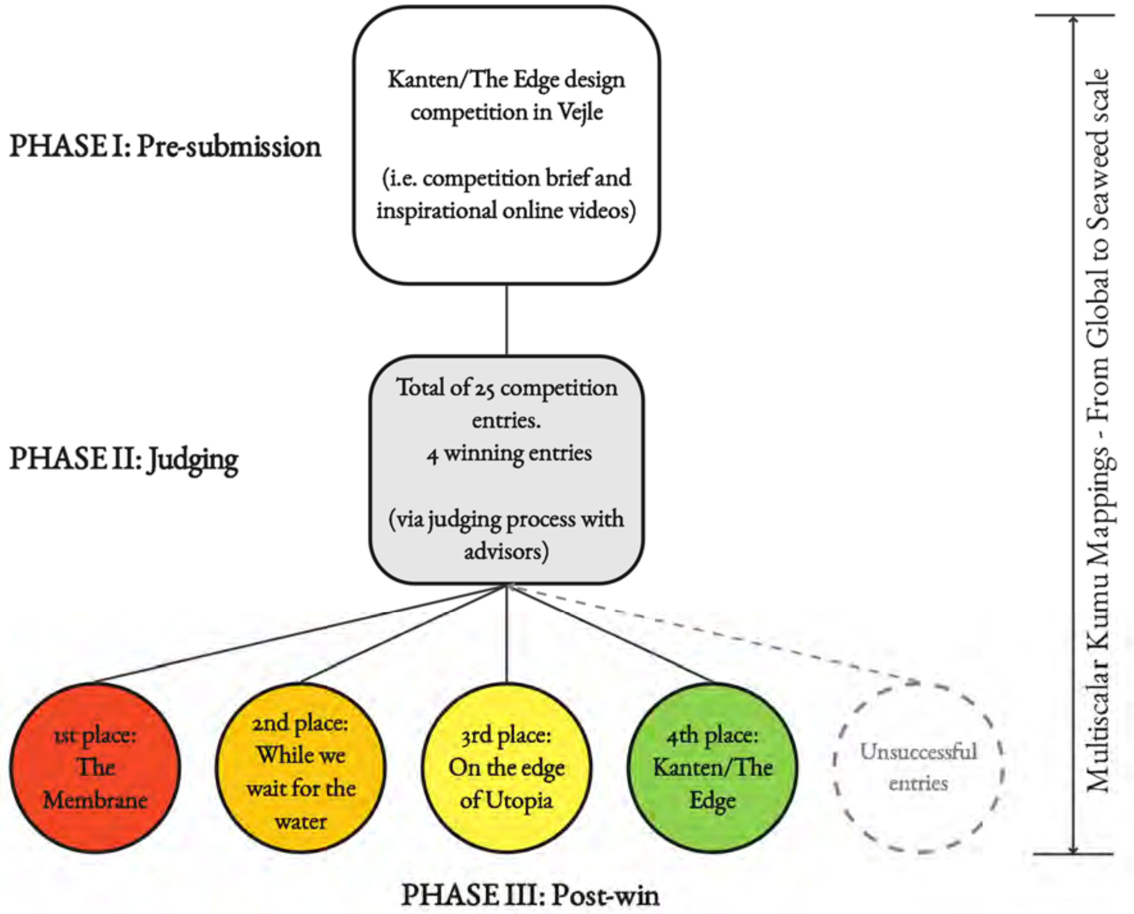


Figure 115. A diagram of my involvement in the different processes in Kanten/The Edge competition. The four winning proposals are the main data to be analysed in this chapter (with brief mentions of the unsuccessful entries).
**It is important to note that the multiscalar Kumu mappings have been done throughout the whole process of engaging with Kanten/The Edge's three phases. Therefore, the analysis of the winning proposals throughout this section 4.1.1 has also been informed by the learnings Kumu mapping process (see sections 4.1.2 to 4.1.7) running in parallel.*

1st place: The Membrane (Membranen)

The first place was awarded to a project called "The Membrane" (Membranen) by Josephine Philipsen, a landscape architect from Malmo, Sweden, Luisa Brando, an artist and an architect from Madrid, Spain and Andres Hernandez, an architect from Bogota, Colombia. They collaborated online on the project for several months with a brief consultation from a marine biologist. This winning entry, in the end, was unanimously voted as the winner by the judges (see Figure 116 below of the submission).


Membranen
1.Havnepladsen

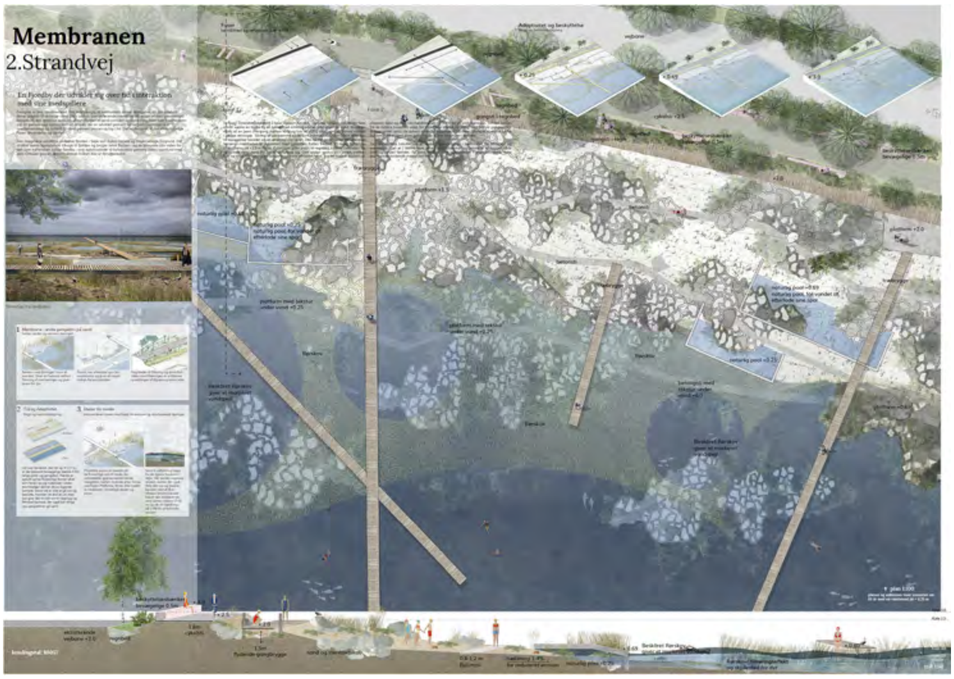
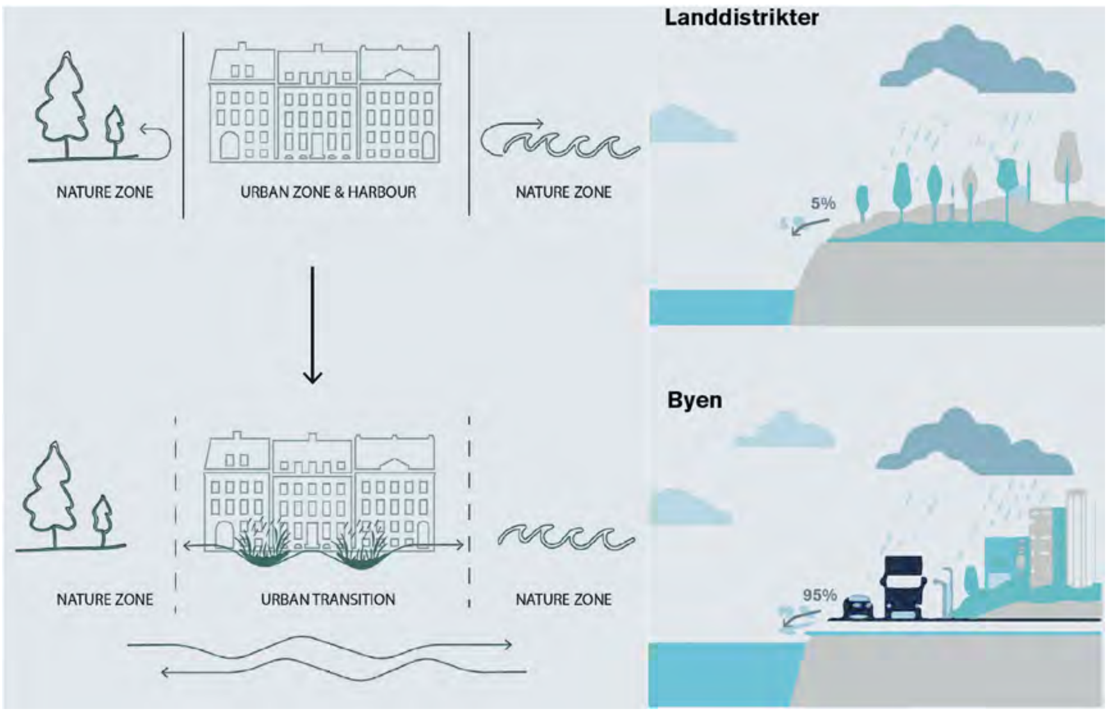

Membranen
2.Strandvej

Figure 116. The winning entry's submission of x2 A1 boards of the two main zones (the urban zone and the nature zone) and x2 physical models as per requirement (they also need to submit a booklet of their ideas in writing). Image credit: Vejle Municipality, Josephine Philipsen, Luisa Brando, and Andres Hernandez (photos of the physical models taken by the author on 13/08/20).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Judges' comment on the winning entry

The main concept

The winning proposal's main idea is an innovative project containing a strategic design for the future development of Fjordbyen and storm surge protection that, like a cell membrane, opens and closes depending on the impact (see Figure 117). The focus of the proposal is to allow the water to come in and out regardless of direction and create an "aquatic" terrain in the entire Fjordbyen area (master plan for Fjordbyen's future urban development, as shown in Figure 120). The proposal presents a way to depart from the norm of creating a sharp division between land and water, usually informed by a perception of the water as a threat. Instead, the proposal suggests inviting the water into the district and letting it become part of the urban design. As the proposal states: "The problem is not that a city floods; the problem is that we have not known how to live and design with the water". The security line consists of a membrane that functions as a floodplain that opens and closes according to the impact. The hard edge that separates water and land today changes over time into a membrane that generates new types of nature that can contribute to purifying the water through nature-based solutions. It also generates encounters between species, humans and more-than-humans (Vejle Municipality, 2020c, author's translation).



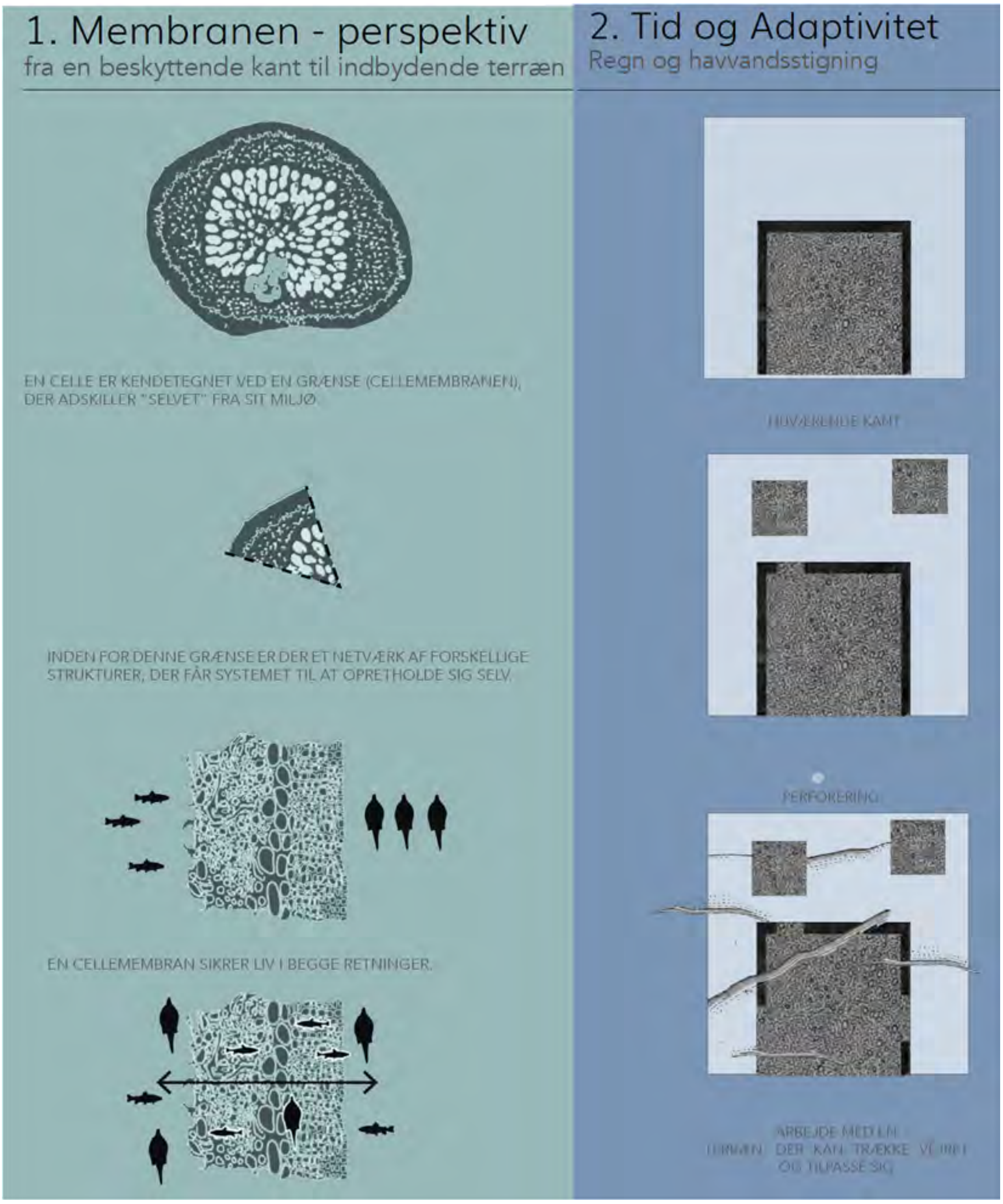


Figure 117. The main overarching concept is the idea of a membrane that allows the flow between nature above the water to the city and nature under the water. The membrane also signifies a connection between marine life (i.e. fish) and human residents of Vejle. Image credit: Vejle Municipality, Josephine Philipsen, Luisa Brando and Andres Hernandez. (Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Urban zone – Havnepladsen

The proposal suggests establishing the membrane over time as a stone landscape (consisting of both stones and recycled concrete) with different "grain sizes" - i.e. small and large elements in different places. The landscape is established both above and below water. On the water, platforms are created with textures to attract underwater plants (see Figure 118) (Vejle Municipality, 2020c, author's translation).

Figure 118. Visualisations for the Urban Zone. The intention of the design is that as the water level rises, the stone landscape out into the water also grows with time. Various platforms, benches and staircases allow the meeting between human and nonhuman subjects. Image credit: Vejle Municipality, Josephine Philipsen, Luisa Brando, and Andres Hernandez. (Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature zone – Tirsbæk Strandvej

In the proposal, the existing cycle path along Tirsbæk Strandvej is moved one meter further out, and a membrane landscape similar to Havnepladsen is created. The nature zone is characterised by reed forest, eelgrass and seaweed with rock pools and rainbeds (see Figure 120). The wooden walkways are added across the water to give access and a varied experience of different types of landscape in this transition zone (see Figure 119) (Vejle Municipality, 2020c, author's translation).

Figure 119. Visualisations for the Nature Zone. The design intends to accommodate more water as the sea level rises. Various rock pools and timber walkways allow engagement with the water and marine life. Image credit: Vejle Municipality, Josephine Philipsen, Luisa Brando, and Andres Hernandez.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature-based considerations

The proposal points out that nature is Vejle's strength and that the city must build on it. Vejle must find its development model for Fjordbyen and not end up as a copy of other European coastal cities but develop dynamically with the water as a design parameter. The Membrane seeks to remedy the impermeability in the harbourfront area due to concrete surfaces (Vejle Municipality, 2020c, author's translation).

Another perspective on water

Furthermore, the Membrane seeks to help transform the shoreline as the water bodies emerge in the future. Thus, the perspective changes from "edge" to "zone" for the entire Fjordbyen. The idea is to make the water visible and present to create opportunities for reflection for the residents of Vejle (see Figure 120) (Vejle Municipality, 2020c, author's translation).

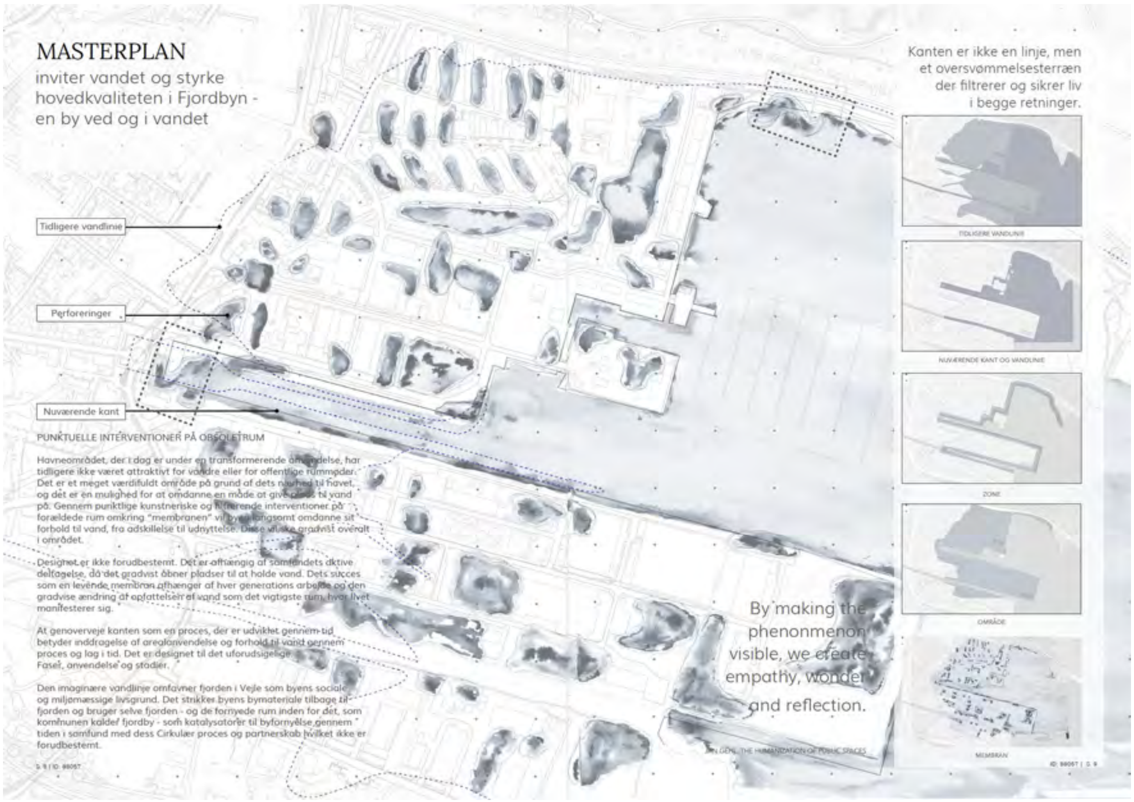


Figure 120. (Top image) "Membrane - Another perspective on the water. Invite the water and nature's solutions" (translate). Proposal for the Urban and Nature zone.
(Bottom image) A conceptual illustration of the entire master plan of Fjordbyen as a wet district able to accommodate the increase in water in the future.
Image credit: Vejle Municipality, Josephine Philipsen, Luisa Brando, and Andres Hernandez.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Protection and adaptive measures

For many residents of Vejle, looking towards the horizon through Vejle fjord is an essential part of the city's identity and self-understanding. This aspect needs to be strengthened through future storm surge protection. The winning proposal secures the edge in the Harbour zone through a raised stone terrain up to elevation 2.5m, while the securing up to elevation 3.0m is done using manually movable furniture (i.e. bench) into a protective wall so that the view of the fjord can be maintained when there is no storm surge (see Figure 121). The bench system also applies to the Nature zone to reach the protection level of 3.0m (see Figure 121). The new cycle path will be established at an elevation of 2.5m, with protective movable benches scattered along the stretch of the road. This is a case where gradual adaptation to increased risk by adding more material to increase the dike's height (however, it is doubtful whether the manual positioning of the benches will be able to create flood protection) (Vejle Municipality, 2020c, author's translation).

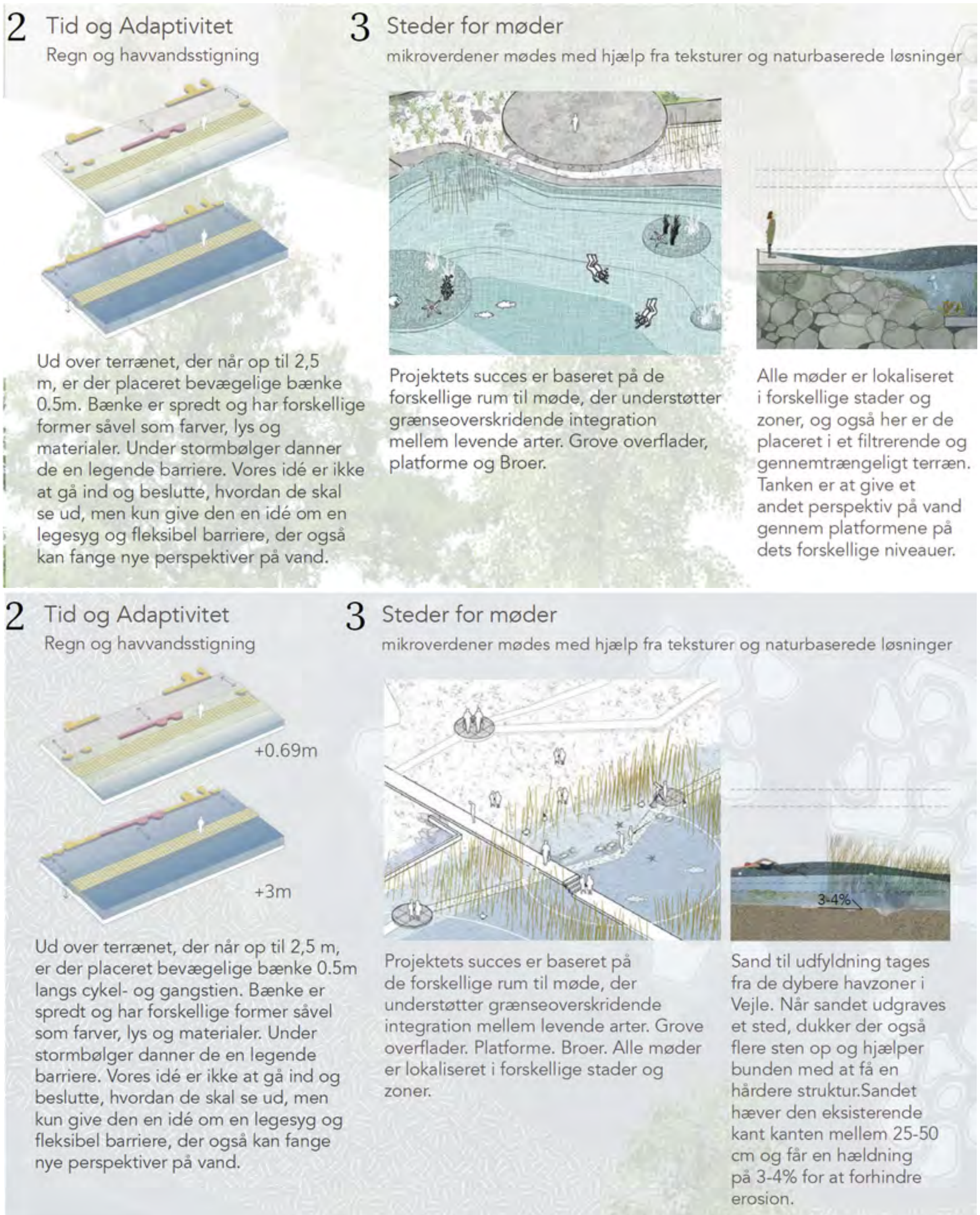


Figure 121. Strategies for meeting the brief's requirement both in the Urban and the Nature Zone. Translated: Point 2. Time and Adaptivity (rain and sea level rise). 3. Meeting place (microworlds come together with the help of textures and nature-based solutions).
Image credit: Vejle Municipality, Josephine Philipsen, Luisa Brando, and Andres Hernandez.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Professional assessment of The Membrane proposal

The proposal goes beyond the security line to include a master plan for the entire Fjordbyen and how it can be designed with water instead of against it. It is a strong concept that creates a direction for further urban development beyond the two zones. However, its storm surge protection is less ambitious. A combination of permanent and temporary protective elements requires manual operation via moveable benches but, at the same time, clears the view for better access to the water. This is a solid proposal with one of the most detailed analyses with a clear vision of an adaptive and flexible zone that overlaps the current edge both inwards towards the harbour and outwards to the water while retaining experiential and landscape architectural qualities. However, the artistic aspect of the proposal seems harder to determine (Vejle Municipality, 2020c, author's translation).

Assessment of the proposal based on Urban Seascaping propositions and Kumu mappings

Overall work process and values

My analysis of the Membrane proposal and the interview suggests that the proposal's values, propositions and goals aligned strongest with two of the Urban Seascaping propositions; "Beyond the edge" and "Inviting the agency of the sea". This is one of the projects with a strong landscape architectural approach, and it demonstrated potential design outcomes to tackle all the requirements of the brief.

Team Membrane's approach of scaling up from Kanten/The edge conditions to include a master plan of Fjordbyen demonstrated their understanding of what it meant to go beyond the edge conditions to a zone (albeit within the confines of the competition). Nevertheless, the team expressed that they experienced several obstacles working across scales during the creation process. For instance, they found it difficult to work with the given scale (1:100 edge conditions) and ended up scaling up to include a conceptual master plan of Fjordbyen. While they were uncertain how much to go into detail with the master plan, they felt it was necessary to zoom in and out to resolve the requirements of the brief. They realised later on (after winning) that their proposal was different from other submissions, especially in terms of their interpretation of scale. In much of their previous work, the team had dealt with a scope that is the size of a courtyard, not a harbourfront. Even the physical models, which were required to be a scale of 1:50 (i.e. 30cm x 30cm as a scaled model (15m x 15m in real life), left them pondering as to what would be appropriate to show, as it became very detailed orientated almost like an industrial design (Philipsen et al., 2020).

Their main idea of a membrane came one month before submission, after months of research and explorations. It was particularly difficult to create a holistic vision for two sites requiring different implementations, indicating how this kind of design project may take time, especially given the degree of complexity involved. After months of research trying to analyse a site they had never been to, the actual designing of the proposal then took place in the last month, in which they relied heavily on the comprehensive brief, which enabled them to understand Vejle as a context. Ultimately, this suggests the importance of a competition brief in producing good outcomes for a project like this (Philipsen et al., 2020).

The Membrane's approach acknowledged the immense complexities and interconnections when dealing with issues such as climate adaptation. Therefore, their focus has been on the role of landscape architecture in helping change the mentality and perception behind the way we relate to nature and water. They wanted to work with nature and not against it. These principles have been applied in their proposal by creating spaces that allow people to reflect on the current B-A-U relationship to water. However, it was not easy for them to find a balance between an ideal vision that adhered to their theoretical approach with something more tangible and realistic that could be implemented. Moreover, to be sensitive to the complex issues of working with nature underwater, they recognised the importance of consulting experts [208] (in this case, a marine biologist), thereby breaking the siloed disciplinary boundaries between design practice and natural science (Philipsen et al., 2020).

1. USS: Multispecies co-existence (with seaweed)

The current reality of Fjordbyen is one of strict segregation and inaccessible boundaries between humans and marine life, with priority given to terrestrial causes. Considering the Membrane from this perspective, it is clear that the proposal seeks to foster multispecies coexistence by providing better conditions for marine life (especially seaweed) through rock landscaping and allowing the water to come deeper into the cities, provoking a much closer spatial engagement. The new proposal for Fjordbyen alludes to a concept of a "blue" commons, a meeting place between land and sea, human and nonhuman. The idea of a meeting place or a commons is also an issue of scale, as multispecies coexistence means acknowledging the former extractivist urban development model (i.e. ocean sprawl and extracting stones and rocks from the sea bed) and re-envisioning these formerly reclaimed land as a new form of equitable interspecies space (as shown in Figure 120).

However, the proposal does not engage more specifically with resolving the current ecological imbalance in the fjord[209], such as providing more proactive forms of artificial structures (other than stone reefs) that might provide a nursery for small fish or protection of young eelgrass plantations from predators (i.e. crabs) and help withstand storms as demonstrated in other entries (i.e. see 3rd place and 4th place).

208 The interviews with the winners later revealed that the information provided by the videos contributed to developing their project (Philipsen et al., 2020) (refer to Appendix 11 of the transcript of the videos). They had limited contacts with marine biologists as these interdisciplinary networks are hard to come by, revealing the need for better platforms for these cross-disciplinary collaborations outside the silos of their field.

209 As addressed by the marine biologist in the inspiration videos of the competition brief (Vejle Municipality 2020).

2. USS: Making the invisible visible

The Membrane project tackles issues around accessibility and proximity through a landscape/seascape approach. Large areas of Fjordbyen are currently inaccessible to the public and are sharply severed from the water. As part of a new urban ecology, the Membrane is a small attempt to provide different levels of spaces which can be inhabited by different species, with paths for people to get closer to them. The proposal showcases the transition from land-based to water-based lifeforms (i.e. via rain beds and rock pools, providing an opportunity to see and experience up close). The proximity allows visibility and tactile access to water, creating a different kind of atmosphere in Fjordbyen.

The issue of water clarity in Vejle fjord prevents the invisible marine landscape (i.e. urban seascaping efforts) from being seen. While this is an issue that goes beyond the scope of this proposal, there could have been stronger educational/pedagogical narrative and ways to host or engage the citizens in the process of improving the conditions in the fjord (such as involving the citizens in the eelgrass planting process outlined by the winners of 3rd place).

3. USS: Beyond the edge

The membrane project demonstrated "beyond-the-edge" thinking in their conceptual master plan for Fjordbyen over a long period, conceiving the membrane as a floodplain (see Figure 120). Moreover, working with nature-based solutions entails thinking about temporality and flexibility, especially in light of the unpredictability of climate change. Therefore, they approached this unpredictability with a value-driven concept that allows room for the proposal's (i.e. urban and nature zone) growth and change, with the final design yet to be determined by the agency of the water in the future (see Figure 118 and Figure 119). They learned that due to their limitation of being physically distant from the project site, their approach was to be more time-specific so that these proposals could be adapted to the local context as conditions change with time, thus, flexible enough to be implemented anywhere. This approach is a departure from the current status quo of coastal protection/adaptation.

4. USS: Invite the agency of water

The membrane was one of the few exemplary projects that planned for the sea to come into Fjordbyen as an aquatic terrain, an alternative practice to coastal protection. It allowed the water to infiltrate through a membrane concept that mediates the land-water continuum (see Figure 117). Water is conceived as a designer in its own right that inhabits and transforms Fjordbyen over time. However, the scope of the brief did not allow a more detailed investigation into how this sponge-like membrane concept would work in practice for Fjordbyen district. For instance, what would be the new function of these membranes during dry periods, especially if they are not connected to the Fjord? How would the membrane influence the new function, activities [210] and spatial experiences beyond Kanten/The Edge for the entire Fjordbyen?

210 What happens to the existing buildings and use of the waterfront and harbourfront areas? Are they relocated or retrofitted? Do their current functions completely change? These are questions outside the scope of the competition

Their long-term approach to transforming Kanten/The Edge demonstrates how urban landscape-seascape elements accommodate the rise of sea level through constantly evolving Urban Zone (see Havneplads/Harbour Square in Figure 118). For the Nature Zone, the proposed timber walkways present an opportunity to adapt to the change in sea level (allowing the water to enact change in the design), but where do these platforms lead? Do these experiences enhance or show a particular narrative of water?

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but nevertheless, important questions to think about from an urban development point of view of the future of Fjordbyen.

2nd place: While we wait for the water (Mens vi venter på vandet)

The second place was awarded to a project called "While we wait for the water" by Jonathan Houser, a Danish artist/architect, and Jonas Lambert, a Danish landscape architect. Due to COVID-19 halting other works, they were able to dedicate longer time to this competition on and off for approximately 3.5 months.

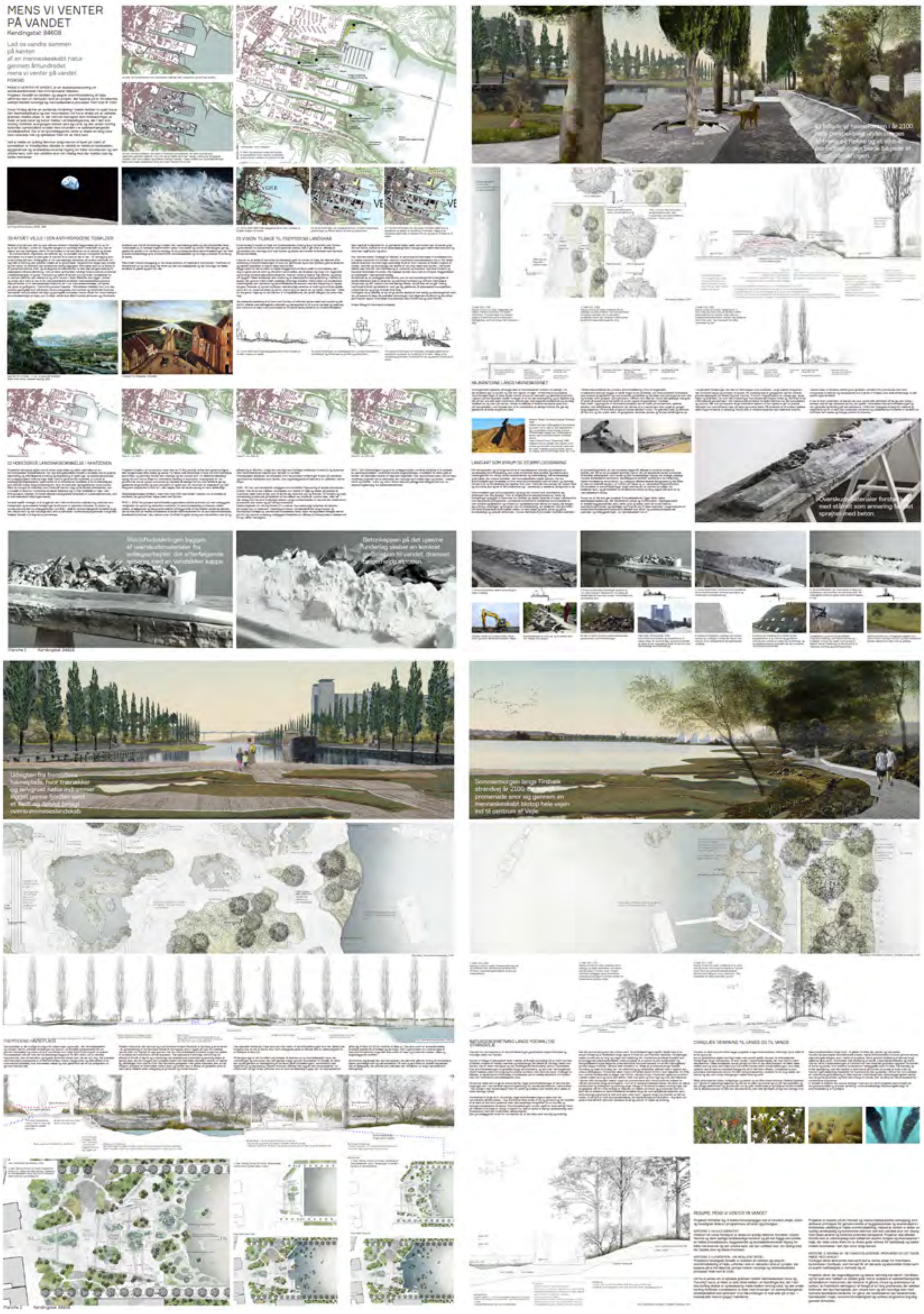

Figure 122. The winning entry's submission of x2 A1 boards of the two main zones (the urban zone and the nature zone) and x2 physical models as per requirement (they also need to submit a booklet of their ideas in writing). Image credit: Vejle Municipality, Jonathan Houser and Jonas Lambert.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Judges' comment on the winning entry

The main concept:
The second prize proposal also displayed efforts to design *with* the water. The proposal's main idea is to create a new hybrid landscape that might protect Vejle against storm surges. The landscape is created from surplus materials from construction work and the breaking up of the existing asphalt into long strips, which are covered with waterproof concrete. After this, plants and trees are grown across, on and around this constructed landscape. Storm surge protection will eventually become a new type of landscape that continuously develops and grows as an interaction between natural and man-made processes. The proposal shows an evolution of development towards the year 2100. In this way, the edge becomes a mixed zone where culture and nature meet and the flood protection process unfolds as a large landscape project inspired by the "Land Art"[211] movement. Thus, the outcome is an artistic landscape element in the city's development, experienced as a soft and nuanced meeting with the water with a green edge along the edge of the city (Vejle Municipality, 2020c, author's translation).

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211 Land art is a visual artistic direction that developed in the USA in the latter half of the 1960s based on minimalism and installation art (Den Store Danske).

01. Fortid 1850-1900: Vejle beliggende på en holm i bunden af å-dalen omgivet af marker

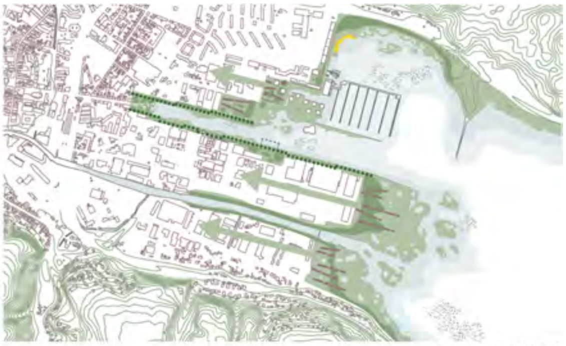
02. Nutid 2019: Vejle i sin nuveærende form. En hård industrihavn, opfyldninger og Marina danner en hård og præcis kant mod fjorden.

03. Fremtid 2100: Vision for fremtiden. Fortidens bløde kant er reetableret og skaber en forankring til fortiden i tillæg til det rekreative poetentiale. Et levested for dyr og planter til lands og til vands.

Eksisterende forhold

Fase 01 - ca. 2025

Fase 02 - ca. 2035-45



Fase 03 - ca. 2075-100

Helhedsplan, fuldt udbygget

Et blødt og nuanceret møde med vandet er genetableret mens naturen og fjordens grønne kanter trækkes ind i hjertet af vejle

Figure 123. (Top image) The history of Vejle's urban development, transitioning from a meadow and salt marsh (soft-edge condition) to the present land reclaimed and hard-edged waterfront/ harbourfront. They explore the future edge conditions, which is a mixture of recuperating the past coastal landscape and the present man-made urban landscape. (Second-row image) The master plan for the future Kanten/The Edge that develops and grows with time as nature-based solutions take over the whole shoreline of Kanten/The Edge and infiltrate into Fjordbyen as part of the green transition of Vejle by the end of the century. The proposal includes many recreational opportunities, walkways, re-establishing rock reefs, etc. Image credit: Vejle Municipality, Jonathan Houser and Jonas Lambert.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Urban zone – Havnepladsen

The harbour square is designed so that you get a monumental spatial experience (see Figure 124). The proposal emphasises the view toward the fjord, in the design of Havnepladsen, especially through planting trees on each side of the harbour channel to maintain a view of the horizon through the fjord. The aim is to draw inspiration from the atmosphere that both drew on the Golden Age 19th-century oil painting of Vejle before industrialisation (see Figure 62), where there is an open experience and more direct contact with the fjord while also departing from this perspective by integrating industrial structures (Vejle Municipality, 2020c, author's translation).

Figure 124. A plan of the Urban Zone that grows as the sea level rise over time. The visualisation is an ode to 19th-century Golden Age paintings depicting romanticised landscapes of Denmark. Image credit: Vejle Municipality, Jonathan Houser and Jonas Lambert.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

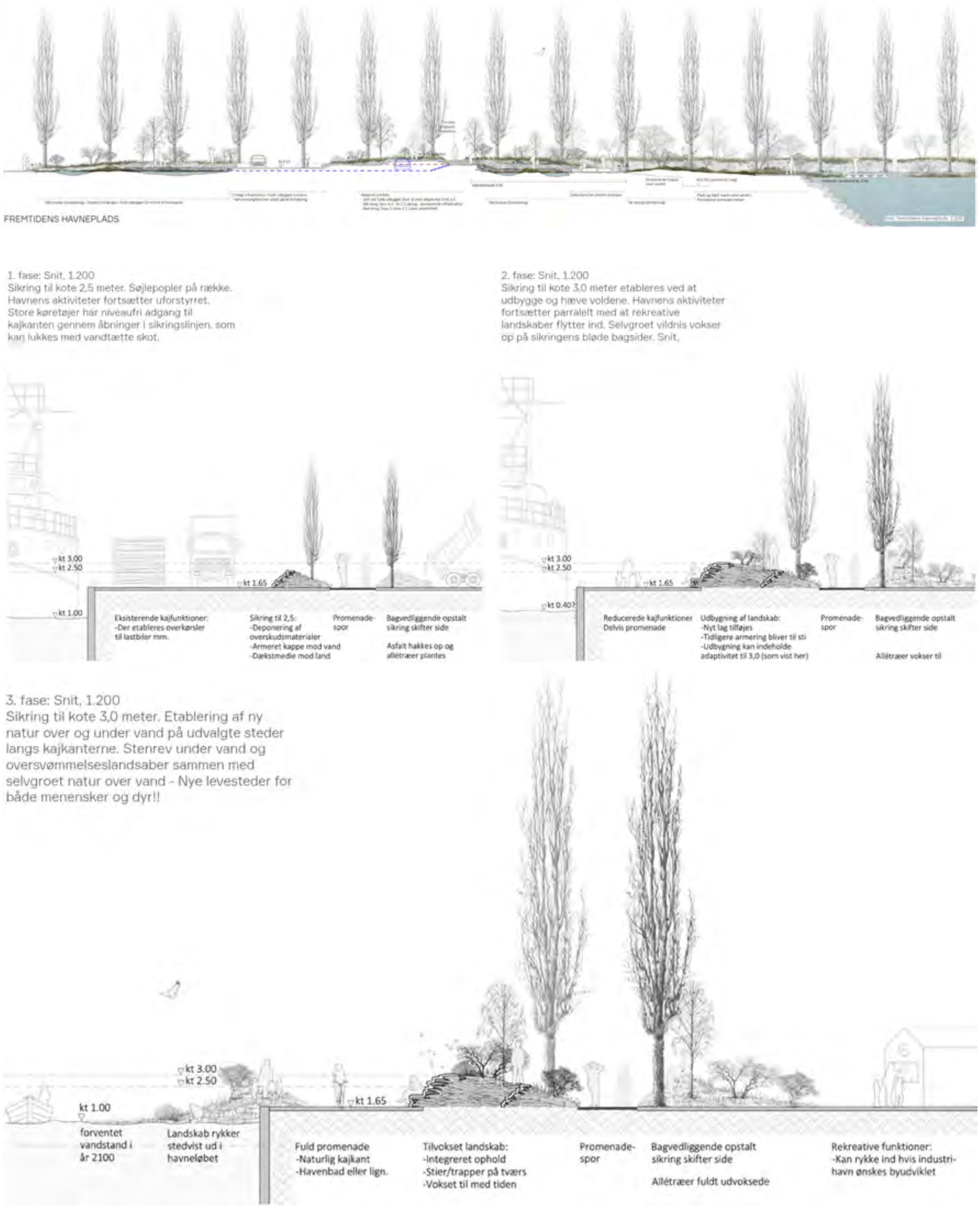


Figure 125. The section of the Urban Zone, where the landscaped embankments made of surplus construction materials provide coastal protection by growing with time while landscaping also envelops these concrete mounds. Image credit: Vejle Municipality, Jonathan Houser and Jonas Lambert.

(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature zone – Tirsbæk strandvej

In the same way, storm surge protection in the natural zone is based on creating a landscape with surplus materials, primarily surplus soil, that makes up a dike up to elevation 3.0m with a timber promenade for those walking along the fjord. The idea of wooden floating bridges and pathways across the nature area is repeated in many other proposals. These pathways and bridges make it possible to walk through these natural areas without direct contact with the water. Furthermore, the promenade creates a natural expression with tall trees planted along Tirsbæk Strandvej along with the salt marshes bordering the walkway (Vejle Municipality, 2020c, author's translation).

Figure 126. While the urban zone emphasises land-based planting (such as the row of trees), the nature zone has more sea-based planting, such as salt marshes and reeds. The marine biologist has commended the visualisation of the nature zone as an accurate depiction of what is likely to grow in these areas. The concrete landscaped embankments grow larger horizontally, hosting more trees and planting while protecting up to 2.5-3m. Image credit: Vejle Municipality, Jonathan Houser and Jonas Lambert.

(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature-based considerations

Vejle was conceived at the bottom of the river valley, surrounded by fields, meadows and salt marshes, which created a more natural encounter with the fjord than it is today. It is these former natural landscapes that the proposal wants to recreate along the entire edge and the security line. Thus, the central vision of the proposal is to strengthen the city's connection to the landscape by drawing elements from the past into the man-made nature of the future. Many other proposals revolved around the same stance of restoring the former landscape before industrialisation (i.e. extensive land reclamation process) by re-establishing salt marshes and vegetation that will purify the water. For this project, extending the protection edge to a zone means creating an opportunity to allow nature to create a "buffer" that can absorb the strength of storm surges before it hits the city. This was done by taking inspiration to re-compensate the nature lost from the land reclamation process by referring to the former shoreline (see Figure 123) (Vejle Municipality, 2020c, author's translation).

Another perspective on water

This proposal took the form of a large "Land-Art" project, where the artificial landscape that forms the storm surge protection could contribute toward an artistic dimension of the city. The beautiful physical model photographs (see Figure 127 below) show an aesthetic dimension to the design of the landscape, where there is a juxtaposition between something almost formless with precisely shaped edges to create contrast and variety. The creation of storm surge protection is considered an artistic design process, in which nature's processes over time will also play a role as a creator/designer. However, the visualisations raise doubts about whether the artistic quality will be present in the final project (Vejle Municipality, 2020c, author's translation).

Figure 127. An extra physical model submission as a photo from gravel sprayed with plaster. The idea of this approach is that the mound forms its shape with material that is underneath and is expected to grow and change with time. Image credit: Vejle Municipality, Jonathan Houser and Jonas Lambert.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Protective and adaptive measures

The storm surge adaptation aspect of the proposal is the most innovative. It beautifully expresses how the sites will grow and adapt as the risk increases over time. The landscape is reinterpreted and reconstructed out of surplus materials, which are reinforced and sprayed with concrete which over time develops into overgrown ramparts. In this way, an interesting, adaptive aesthetic is achieved that transforms storm surge protection to a new level by creating the future landscape of today's materials. For instance, at Havnepladsen (urban zone), the proposal secures an elevation of 3.0m by processing the square in a fan-shaped spatial course designed as a wide landscape staircase (dike) and along Tirsbæk strandvej (nature zone) as an embankment that can be increased up to elevation 3.0m (Vejle Municipality, 2020c, author's translation).

Professional assessment

The proposal is very thorough, with good analysis and a clear artistic approach to working with the edge. While it appears to be a well-thought-out proposal for landscape architecture, there can be doubts about the large quantities of plaster that have to cover surplus materials, even though it looks exciting on the sectional physical models. It is a query that can be worked on further with a variation on the possibilities over the entire protection line (Vejle Municipality, 2020c, author's translation).

Assessment of the proposal based on Urban Seascaping propositions and Kumu mappings

Overall work process

My analysis of the "While we wait for the water" proposal and the interview (only with Jonas Lambert) suggested that their values, propositions and goals aligned well with two of the Urban

Seascaping propositions; “Beyond the edge” and “Invite the agency of the sea”. This is one of the projects that demonstrated a process-orientated approach to designing while also displaying sensitivity to the local context.

The duo has a background in architecture and landscape architecture and has engaged with everything from urban planning to buildings to small landscape projects and art installations. They have always been very interested in large-scale landscape interventions with a drive to address sea level rise and storm surge as one of the most important issues to engage in this century as landscape architects. They explicitly engage with Anthropocene as a way to think about the current relationship between “nature” and humans to inform a more entangled relation into the future. For them, Kanten/The Edge presented a rare opportunity to engage with these wicked problems from a spatial, landscape and artistic approach influenced by themes of breaking down the dualism between the traditional, romantic notions of landscape (i.e. Danish Golden Age era[212]) to incorporate the current presence of artificial and production landscapes. Thus, the point of departure was to integrate these industrial landscapes (i.e. Vejle’s harbourscape) as part of a nature-based solution for Kanten/The Edge. The challenge for the duo was to tackle these various issues holistically and think of design solutions as a process rather than a product. Therefore, they approached Kanten/The Edge from the process of making and shaping the landscape formation (i.e. “you could never just sit down and draw” like a conventional architectural design, as one of the entrants put it). The shape of the coastal protection was formed by the process of piling the leftover materials from the industry in Vejle. These materials have their own shape, mixing concrete, asphalt, and gravel together and letting the natural processes transform the mound over time. Thus, they also use long-term time scales as a form (design) driver. Through this “making” and “shaping” design process, they started to view their proposal as a “land art” expression. Moreover, they felt it was important to design the masterplan of the whole Fjordbyen and show some levels of nuance to a different location but also as a holistic sculptural artistic “line” that would preserve the form of what is underneath (i.e. the gravel concrete leftovers from industry). They used the master plan as a design tool and often referred back to the master plan to understand their project from a holistic point of view as a large-scale sculptural landscape project (Lambert et al., 2020).

Nevertheless, they struggled with depicting nature underwater because they did not know what was underneath and had limited knowledge of marine ecology (they also ran out of time). Ideally, they would have liked to have followed a similar design process by making, via 1:1 mock-up studies, to see how architecture could aid marine life (Lambert et al., 2020).

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212 According the interview with Jonas Lambert, their point of departure was to engage in a holistic project that integrates what people in Denmark commonly perceive as being “natural” landscape and the unavoidable manmade landscape. While, they claim that the Danish perception of what constitutes a landscape is what you see in the Golden Age paintings as pastoral landscapes, it has not caught up to date with the current reality of landscape being also largely industrial which is considered an eyesore. For instance, one can see the topographies of the raw materials like a constructed ruin of the modern landscapes in Vejle harbour today. However, even though these are “rough” landscapes, they also have some kind of appeal in their topography and shape that Jonas and Jonathan find beautiful and poetic and have been a source of inspiration as a large-scale landscape in Denmark today. But then their idea is to take this industrial landscape and leaving it to allow natural processes to reclaim these materials, as an overgrown ruin of an industrial landscape. (Lambert et al., 2020).

1. USS: Multispecies co-existence (with seaweed)

In the master plan, there is a presence of stone reefs scattered throughout the inner fjord, which will help with marine restoration in the area. However, some of the placement of these stone reefs could have been more strategic, i.e. along with the timber pathways for a better human-to-nonhuman engagement. Their use of hard substrates (the concrete gravels for the sculptural mounds) that provide coastal protection bordering Fjordbyen will eventually be inundated when the water rises, providing a substrate for marine life like seaweed and mussels to attach onto. However, their narrative is based more on the artistic-landscape approach with a focus on materials and form, missing a more nuanced discussion on how to live with life underwater. Furthermore, there seems to be difficulty in departing from the romantic landscape notion of the Golden Age era in the urban zone, where there is a stronger emphasis on land-based plantings, like trees bordering the current concrete edge as a promenade. Some of these trees will be inundated by saltwater in the future and thus die. If they had prioritised seascapes as part of their vision of the future landscape, they would have avoided the common pitfalls of terrestrial bias. Nevertheless, this is the most extensive and sophisticated project to bridge the current dualistic nature-culture divide from a spatial-material point of view (if nature can be considered a "material") and how industrial production landscape could potentially aid the marine coastal seascape in the future. While not explicit and nuanced in their proposal, especially of the marine realm, this proposal does have the grounds for multispecies coexistence.

2. USS: Making the invisible visible

The depiction of the nature zone references salt marshes that are most likely to grow in these areas (as noted by the marine biologist). Salt marshes are good for retaining fine particles that cloud the water, paving the way for improved water clarity, thus, contributing to making the invisible marine realm more visible. While their lack of visualisation of nature underwater is their weakest link, the presence of rock pools that will form due to sea level rise (as long as they are within the tidal elevation to ensure a constant exchange of water) will be able to reveal different marine life that could potentially occupy in these spaces.

3. USS: Beyond the edge

The proposal extends the edge to a zone by thinking of Fjordbyen as a nature-based sculptural line that envelops the whole district with a reasonably detailed master plan. This was one of the few projects from the 25 entries that provided a holistic vision for Kanten/The Edge with a master plan. The proposed nature-based protection gradually expands into the fjord to restore the former coastline (albeit in a new way) lost from land reclamation and also expands into the city over time. Moreover, even their seemingly "hard" coastal protection in the form of the gravel and concrete sculpted mounds is softened as the natural landscape takes over and reclaims it over time. These leftover materials from industry are "returned" to the fjord in the form of stone reefs, extending the edge conditions into a larger zone. However, it is unclear whether these initiatives will make a significant impact as wave attenuators unless they are tested (or simulated).

4. USS: Invite the agency of the water

Similar to the Membrane project, this proposal allowed water to infiltrate the urban zone, albeit in a more restricted and smaller area (as shown in Figure 124), with the intention of transforming this very zone. The team mentioned working with nature over time as a process that enables nature itself to act as a "designer". Furthermore, the proposal alludes to an "untapped potential" in these large urban areas next to the water (such as Fjordbyen), where it will become increasingly difficult to attain various "value" (be it economic, social or cultural) associated with the area that warrants constant investment to secure buildings and infrastructures from rising and raging waters. Thus, they envision a future where these areas could create a new type of coastal landscape in which the harbourfront areas can develop *with* the rising sea rather than constructing a dike with water on one side and the city on the other. As such, the proposal suggests approaching the areas of intervention as fluid zones, where water can cohabit better with the artificial landscape as part of an entangled process.

3rd place: On the edge of Utopia (På Kanten af Utopia)

The third place was awarded to a project called "On the edge of Utopia – An underwater botanical garden" by Karen Gamborg Knudsen and Kasper Magnussen, who works together as a small Danish interdisciplinary architecture and art practice called, Gamborg/Magnussen.

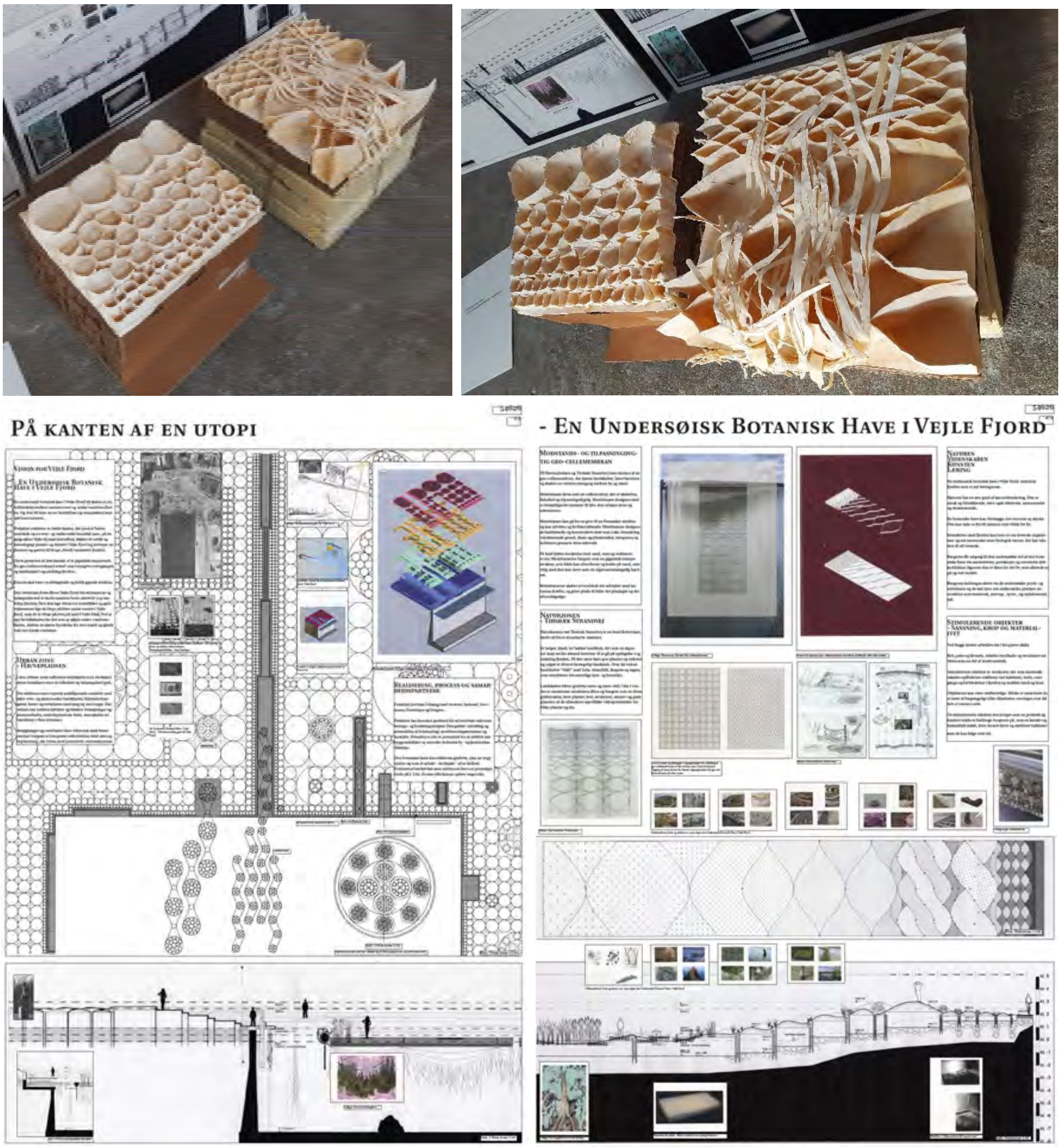


Figure 128. The winning entry's submission of x2 A1 boards of the two main zones (the urban zone and the nature zone) and x2 physical models as per requirement (they also need to submit a booklet of their ideas in writing). Image credit: Vejle Municipality and Gamborg/Magnussen (photos of the physical models taken by the author on 13/08/20). (Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Judges' comment on the winning entry

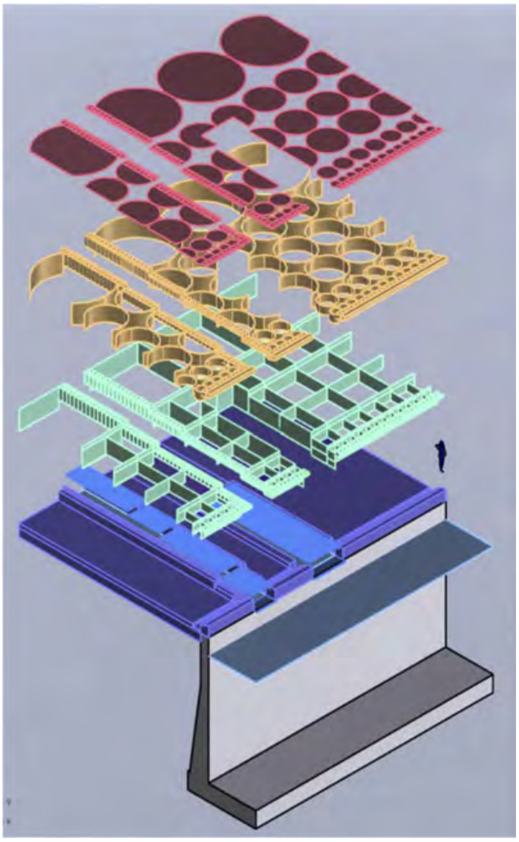
The main concept

The main idea of this project is to create an artistic underwater botanical garden in Vejle fjord and transform nature above and below the water into an experience and a learning space. It gives physical and tactile access to the underwater botanical garden via snorkelling routes, periscopes and inverted diving bells to become a tourist attraction and a learning space for citizens. Furthermore, this proposal is the most extensive of the nature-based solutions. Here, nature builds its storm surge protection. Moreover, a degradable braided geocell membrane creates a resistant and adaptable marsh landscape, forming the future storm surge protection zone. The wide edge gradually makes the landscape wetter with time, while on the dry edge, plants grow and transform the landscape (Vejle Municipality, 2020c, author's translation).

Urban zone - Havnepladsen

The landscape is designed as a baroque garden over a circular and rectangular grid. The proposal appears as a concept that must be further processed and detailed in relation to existing conditions at Havnepladsen (see Figure 129) (Vejle Municipality, 2020c, author's translation).

Grid af cirkler og rektangler. Udgangspunktet for udvikling af geo-cellemembranen til den urbane zone. Havnepladsen. Koncetuel collage.



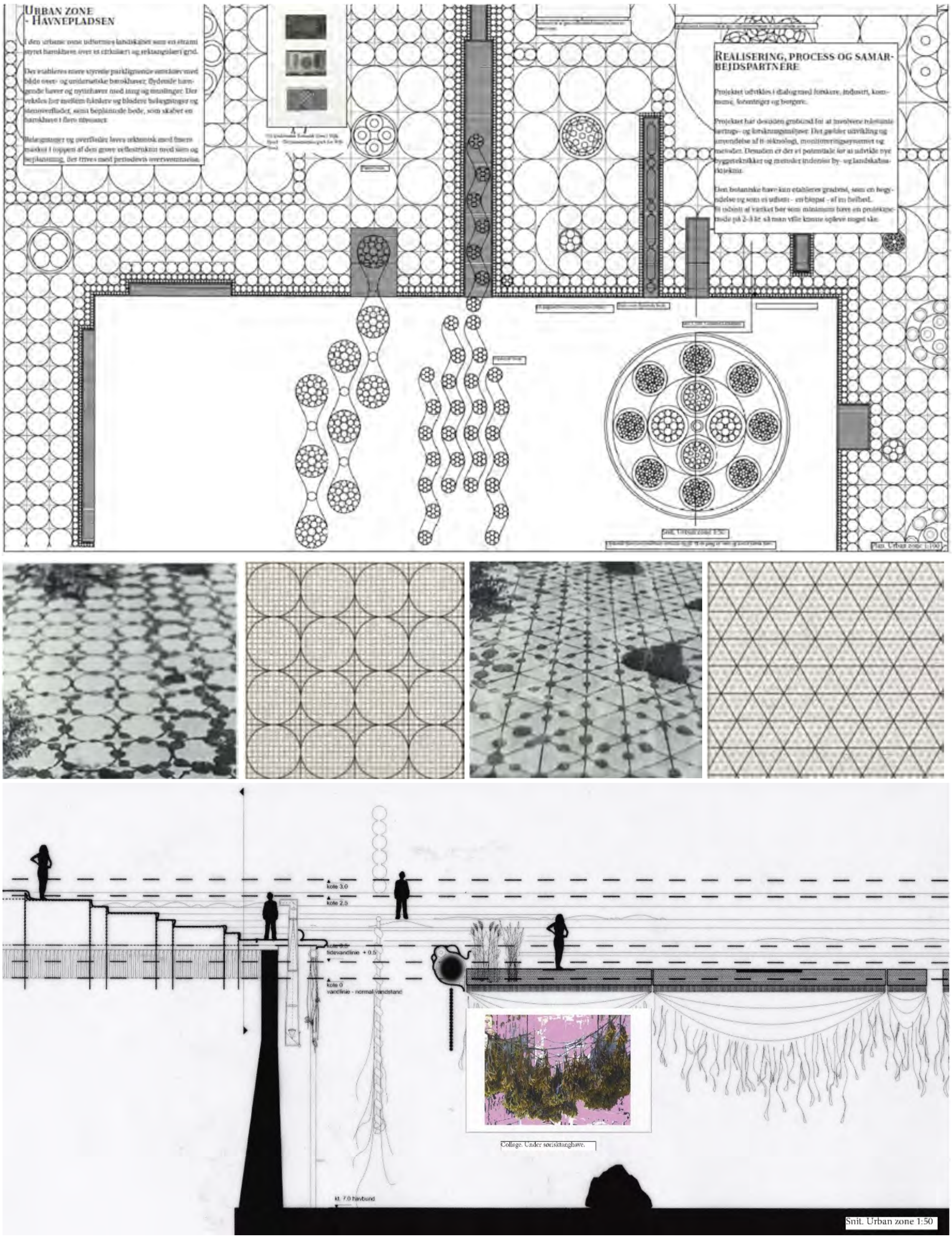
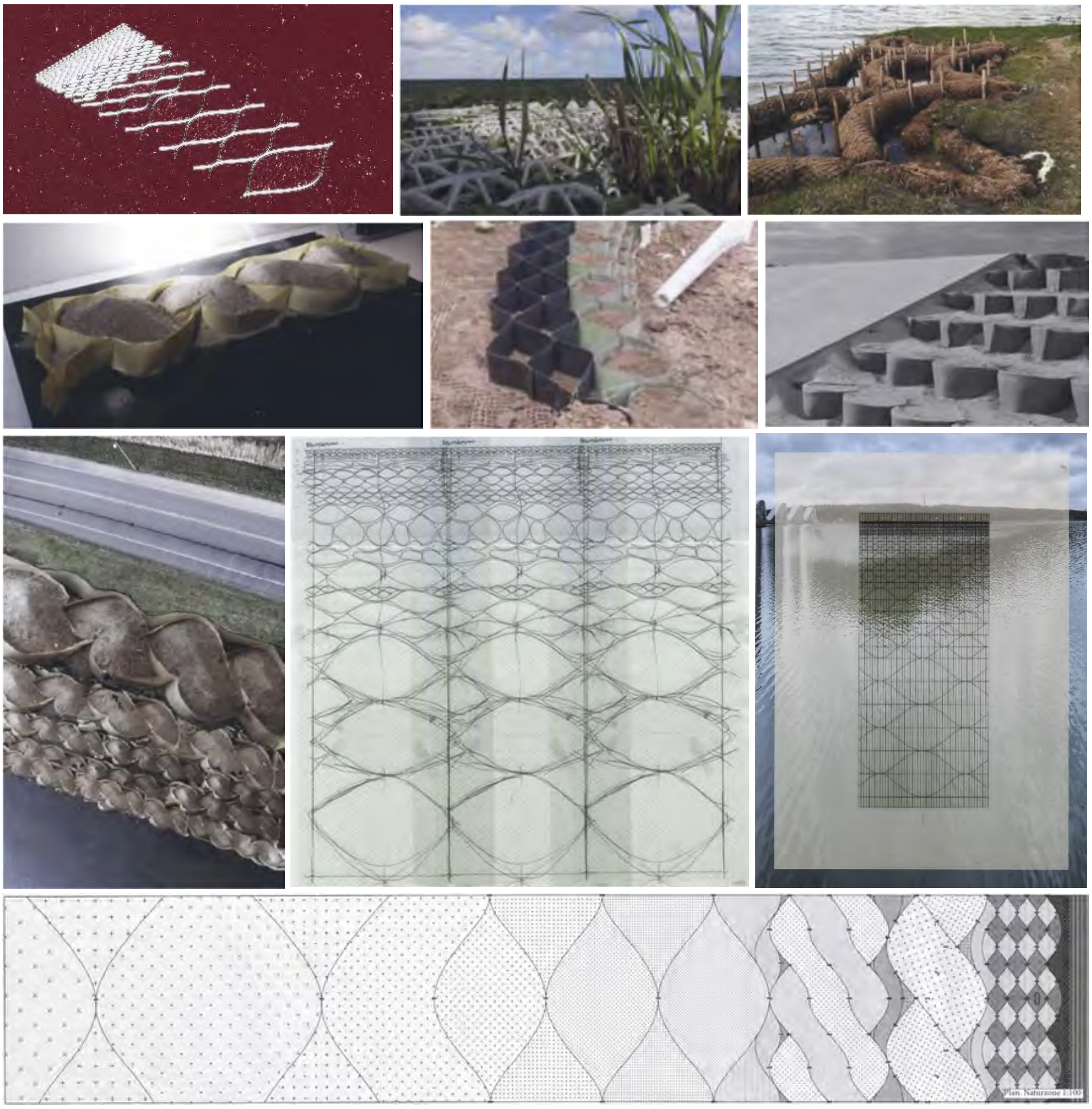


Figure 129. A geometric hard membrane inspired by baroque gardens in the harbour zone. The floating membrane is designed to host gardens underwater, like the hanging seaweed. Image credit: Vejle Municipality and Gamborg/Magnussen.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature zone – Tirsbæk Strandvej

The proposal is a wide, braided edge inspired by a sine curve pattern (as shown in Figure 130). Plants grow on the current dry edge, and the landscape grows wilder with beach cabbage and reed over time. The wild edge gradually makes the landscape wetter (Vejle Municipality, 2020b). Understanding the water and nature in a material-based artistic outcome is the strength of this approach (Vejle Municipality, 2020c, author's translation).



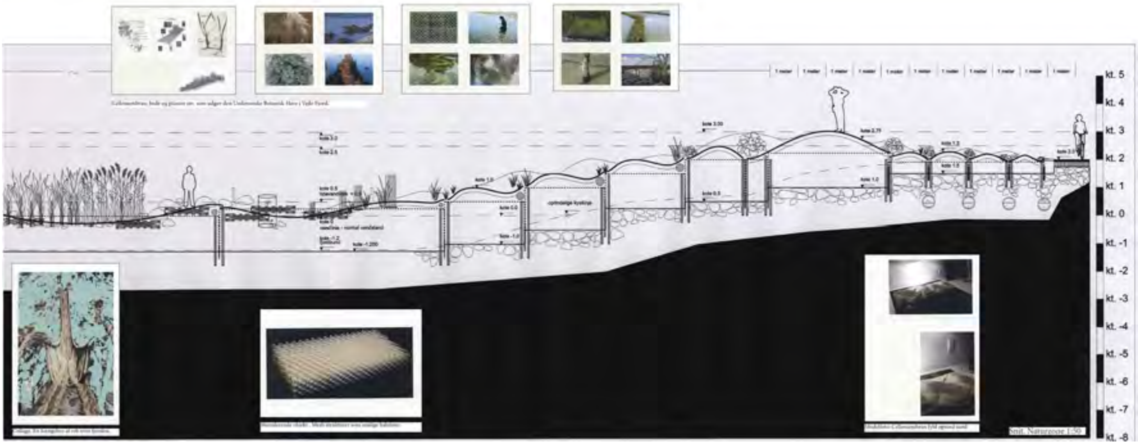


Figure 130. An artistic organic formed geo-cell membrane that weaves and envelops the nature zone's edge condition. The material is made of organic matter that disintegrates in the water with time, allowing the eelgrass protection and support while it grows and disappears with time. Image credit: Vejle Municipality and Gamborg/Magnussen.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature-based considerations

Storm surge protection consists of a resistant and adaptable geo-cell membrane, in which planted plants can absorb the water. The idea here is that nature builds storm surge protection over time. While it grows, at the same time, it contributes to better nature and a healthier fjord due to the ecosystem services of plants that clean the water (i.e. biofiltration) (Vejle Municipality, 2020c, author's translation).

Another perspective on water

Ropes, poles and braided textile surfaces and structures are developed as part of the site's aesthetics that stimulate sensation through its materiality. The objects can be temporary, so they disappear over time. These objects are used as a practical way of involving citizens in artistic work along the edge (Vejle Municipality, 2020c, author's translation).

Protective and adaptive measures

The geocell membrane goes up to an elevation of 3.0m and differentiates in height according to the size of the meshes. These are filled with stones, gravel, soil and plants as needed and develop over time. The adaptive approach is very prominent in the proposal, which does not designate either a precise starting point or an endpoint of the proposal (Vejle Municipality, 2020c, author's translation).

Professional assessment

The proposal has a very strong artistic touch. The sensual and subtle edge, where water and land are woven together in a poetic braid with textiles, rope and seaweed as weaving threads, forms a distinctive and unique landscape (see Figure 130). The citizens are involved in a long-term artistic project that contributes to understanding the edge's potential and challenges through landscape interventions. The proposal is not easily recognisable in its final drawings but contains beautiful and inspiring material that describes the ideas: i.e. photographs, drawings, sketches, conceptual collages and models. However, the artistic and conceptual qualities lack a foundation in a clear analysis and more specific design considerations for the realisation at a more practical level. It is very difficult to read how the "baroque gardens" will actually be realised and how they will work as space and experience. The proposal is praised for its artistic vision of an underwater botanical garden, and the nature-based solution holds great potential. It could become a fantastic attraction in Vejle (Vejle Municipality, 2020c, author's translation).

Assessment of the proposal based on Urban Seascaping propositions and Kumu mappings

Overall work process and values

My analysis of the "On the Edge of Utopia" proposal and the interview suggested that their values, propositions and goals aligned well with two of the Urban Seascaping propositions; "Beyond the edge" and "Making the invisible visible." This is one of the projects that demonstrated what design outcomes could come from designing with these two USS propositions.

Because of their more interdisciplinary practice with a strong focus on art, they have engaged in more experimental projects that depart from the usual commercial architectural practices. They have worked with various media, such as sculpture, drawings, photography, and films, but always working with creative ways to represent their ideas and visions through the act of making objects, using different materials to experiment with form and placement (Magnussen, Gamborg Knudsen and Organo Quintana, 2020).

For Kanten/The Edge, they departed from the notion of making a stimulating "object" fit for Vejle. They first understood the fjord as a "hyper object[213]". To make the fjord more perceptually and visually graspable for humans, they extracted aspects of the fjord that they found interesting and explored through the creative process of making models, photographs and drawings. They wanted their intervention to help change and deepen people's understanding of the fjord by staging and representing them in a way that allows people to engage with the Fjord in a specific way. They found it challenging to find spatial design solutions to get people to relate and locate themselves in the world in a sustainable way, beyond the narrative of the climate crisis only as a fearful disaster. They wanted to create a place where people could learn about the fjord and form memories to refer back to through more proactive engagement. For instance, they referred to the

213 Scholar Timothy Morton in his books, Hyperobject (Morton, 2013) and in The Ecological Thought (Morton, 2012), employs the term "Hyperobjects" to describe objects that are vastly distributed in time and space as to transcend spatiotemporal specificity and beyond comprehension such as climate change, microplastics, and radioactive waste. There are scholars who argue that the sea is not a landscape or facilitator of human activity but an entity of massive geographical and temporal scale that inhabits agency, and thus an understanding the sea as a hyperobject (Campbell, 2020).

citizen engagement initiatives by Vejle Municipality to engage people such as kids, students and other volunteers to help transplant large areas of eelgrass by putting them into frames to help prepare them for planting later on via scuba diving (Magnussen, Gamborg Knudsen and Organo Quintana, 2020).

Ultimately, they also stress the importance of going beyond the overt focus of how humans occupy the edge and toward questions of how to inhabit the fjord as an edge. By flipping the question, they could explore alternative solutions in a relational manner and not only from a form-based aesthetic investigation (Magnussen, Gamborg Knudsen and Organo Quintana, 2020).

1. USS: Multispecies co-existence (with seaweed)

The proposal presents an artistic way of showcasing the seascape-landscape continuum. The team designed the undulating membrane to inhabit the edge conditions in the nature zone and as a supporting frame to provide young eelgrass beds with stability, increasing their chance of survival (performing like a "sculptural infrastructure[214]"). Providing space that can function as a support system for eelgrass displays the proposal's effort to further multispecies urbanism. But more importantly, the geocell membrane is established through the participation of the citizens in the planting and installation process, which encourages ocean literacy by spreading awareness of the multispecies reality of the fjord, with its human and more-than-human inhabitants. Thus, the geocell membrane is a unifying element to conceive the edge development and the fjord as one holistic (eco)system. For the urban zone, this is the only project (out of four winning projects) that explicitly designed a floating structure/system for seaweed that is not a rock reef, where they would have better access to light in the inner fjord. It clearly demonstrates designing the edge conditions from a human engagement and a nonhuman perspective as a design client for multispecies living.

2. USS: Making the invisible visible

The use of the geocell membrane is a way to highlight natural elements over and underwater, which might otherwise have gone unnoticed. It is an innovative way of making invisible marine life visible through designing new structures that span over the edge emerging from the bottom of the sea bed to the current dry elevation. The approach from this team has been to direct the gaze under the surface, the invisible aspect of the fjord (to humans), by making a stimulating "object" that could help to "get to know the fjord a bit better" by looking under the surface (Magnussen, Gamborg Knudsen and Organo Quintana, 2020). This is clearly illustrated in the urban zone, where the perforated patterned floating system would allow the seaweed (a submerged botanic garden) hanging underneath to be seen from above. Ultimately, the project intended to reveal the neglected underwater seascape and, in the process, unite people, landscape, and marine life through artistic and scientific explorations. However, these "simulating objects" remain rather unresolved and, at times, abstract and conceptual.

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214 Term coined by SUPERFLEX in Landskab magazine (Bisgaard, 2022).

3. USS: Beyond the edge

The idea of a membrane-like structure as part of the nature-based solution that ripples out into the fjord (in the form of a sine curve) was inspired by the history of protecting cathedrals during world war two in Germany. People used to deploy temporary sandbags in front of the local cathedrals by stacking them beautifully, forming a membrane-like landscape. They applied this idea of a patterned protective membrane in forming their concept for Kanten/The Edge (Magnussen, Gamborg Knudsen and Organo Quintana, 2020). The nature zone proposed a large-scale flexible material structure forming an underwater undulating carpet membrane. This membrane can form into different patterns to support and be inhabited by plants, which become part of the material over time. The project intends for "nature" to build a protective barrier that forms a resilient landscape over time while contributing to a healthier fjord (through water filtration). For the urban zone, the multi-layered floating structures with perforations that extended out into the water hosted underwater (botanic) sea gardens such as seaweed.

4. USS: Invite the agency of the water

The water has agency as a designer in this project, as the terrains are created by the geocell membrane. In this project, the water has agency as a designer. The terrains created by the geocell membrane become wetter and wetter, and the vegetations (i.e. eelgrass) grow wilder and wilder, transforming the site gradually into a blue-green zone. The water also slowly dissipates the organic textile structure over time, using the water's agency as an agent of change. The temporal dimension of the geocell membrane is strong as another factor that drives the transformation of the edge.

4th place (special mention): Kanten by SUPERFLEX

The fourth place was awarded to a team consisting of two groups, an art collective called SUPERFLEX (represented by Rasmus Rosengren Nielsen) and a Portuguese landscape architecture firm Baldios. They are the only winning entry to have an interdisciplinary team of artists and landscape architects (including close collaborations with marine biologists). SUPERFLEX is a well-known art collective founded in 1993 based in Copenhagen. Their entry for Kanten/The Edge design competition is an extension of the work they have been doing for several years in collaboration with marine biologists. Notably, projects like: "Pink Elements", "As Close As We Get" (artificial super reef), "Interspecies Assembly", and "Deep Sea Minding" (as shown in Figure 94).

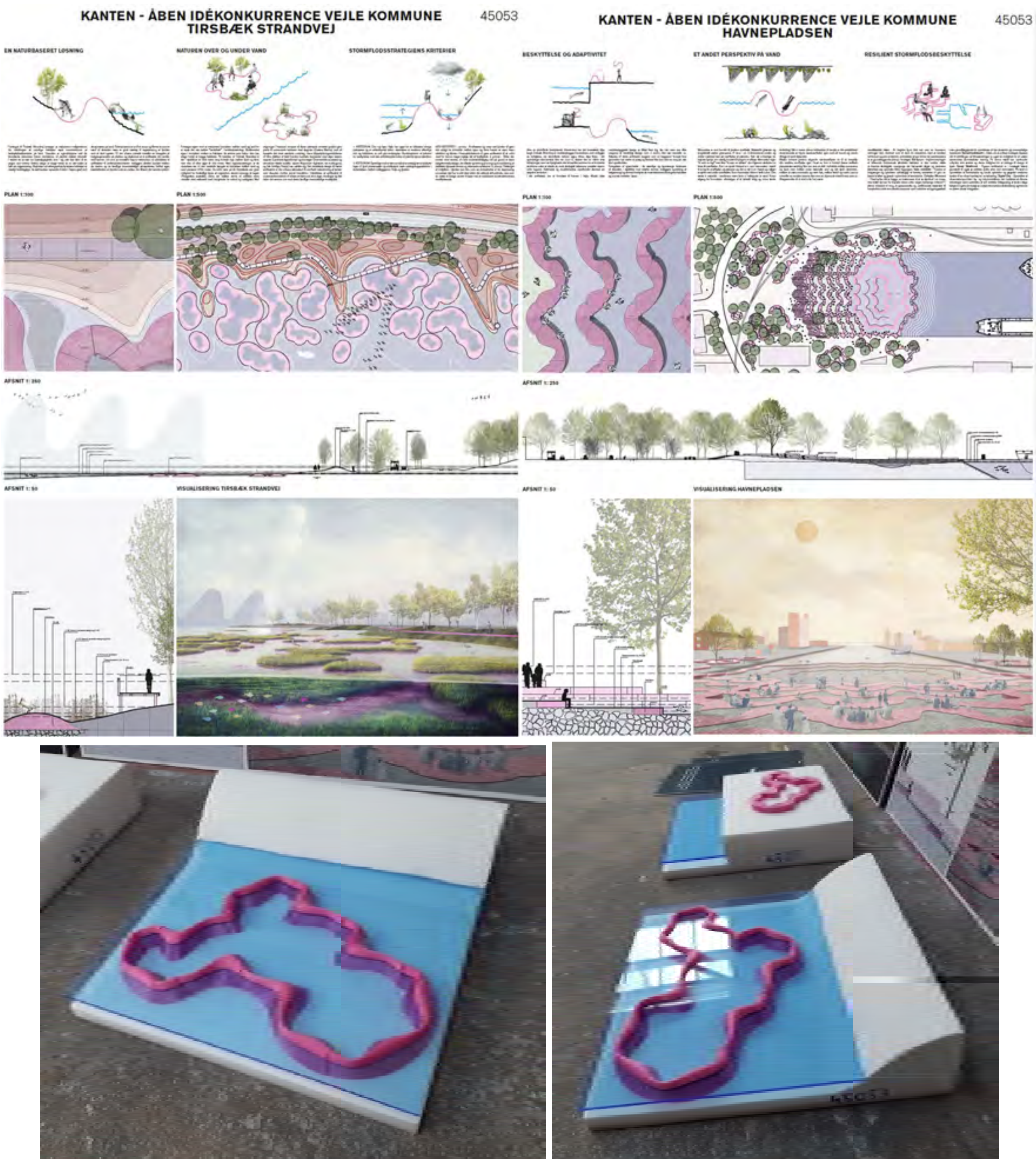


Figure 131. Images of the final A1 panels for each zone and the physical models of their entry. The undulating pink surfaces are for marine life to attach to in the water. Image credit: Vejle Municipality and SUPERFLEX/Baldios. (photos of the physical models taken by the author on 13/08/20).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Judges' comment on the winning entry

The main concept

The proposal is the most artistic expression seen in the competition, which shifts the view upside down from the fjord's perspective. It rethinks the discussion on climate change and seeks to understand the storm surge threat in a new way. Its distinctive colour and eye-catching organic, undulating pink expression draw the focus of the project. One of the potentials is that it seeks to engage with and create connections between the different actors, both human and non-human. The proposal is clearly the best of the competition in bringing the more universal themes around storm surge protection into play (see Figure 133). They did this by creating five universal themes or approaches to drive their project of living with the sea on a rapidly changing planet while enhancing biodiversity (Vejle Municipality, 2020c, author's translation).

1. **Turning the perspective upside down** – Looking at Vejle from the bottom of the Vejle fjord as if we were underwater creatures
2. **Surfaces are Interfaces** – Designing for the marine realm means maximising hard surface areas and introducing porousness and gaps for marine life to inhabit (see Figure 132)
3. **Magic Materialism** – The ability of the material to be intelligent for change, mutate and adapt over time as the climate changes
4. **Aquatic Acoustics** – Being sensitive to how sound travels in water and impacts marine life like fish. Therefore, building with an acoustic consideration, like an opera house
5. **Artistic agency of fish** – Recognising the expanding collective notion to include fish as designers (see Figure 132)

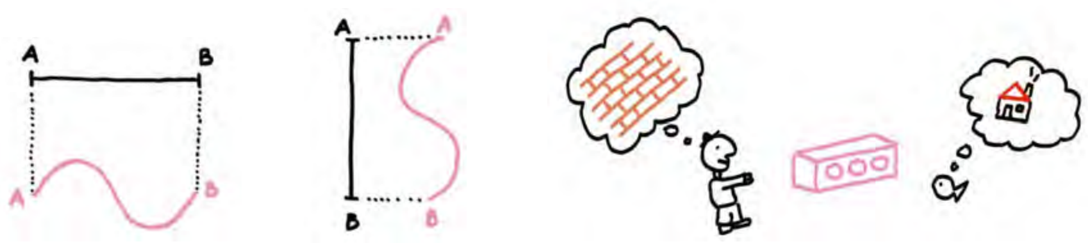


Figure 132. Based on the research on shipwrecks ("wreck biodiversity") as a host for biodiversity, the images show different ways to increase surface area, porosity and hard substrates to accommodate the marine realm – as a house for fish. Image credit: Vejle Municipality and SUPERFLEX/Baldios.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

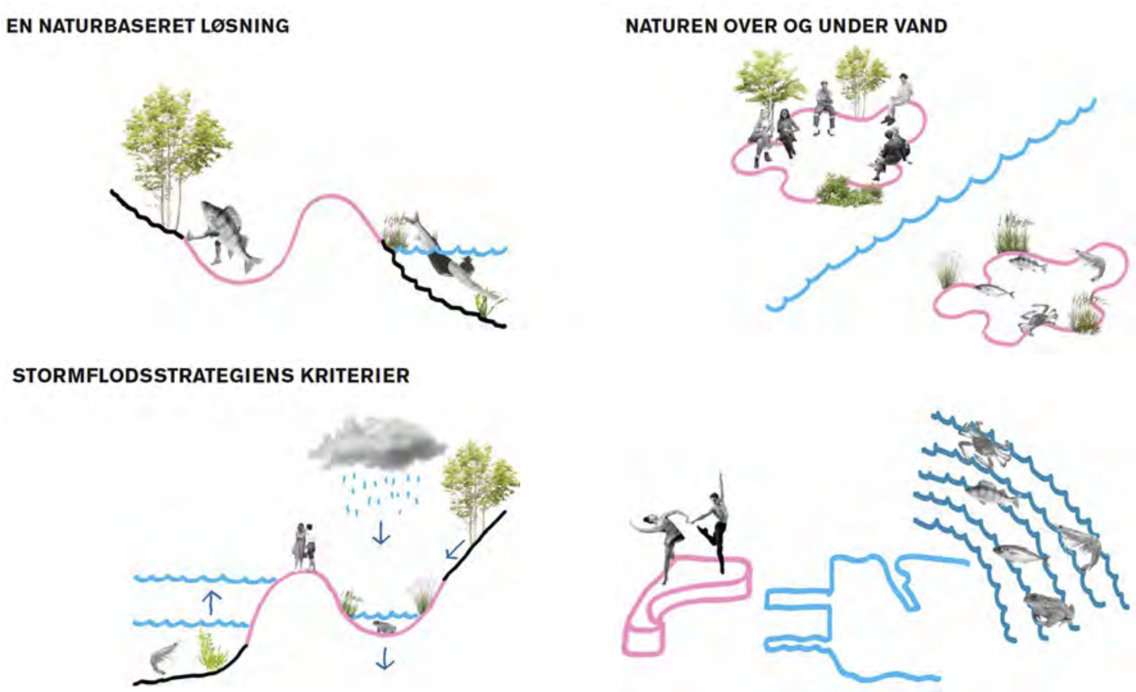
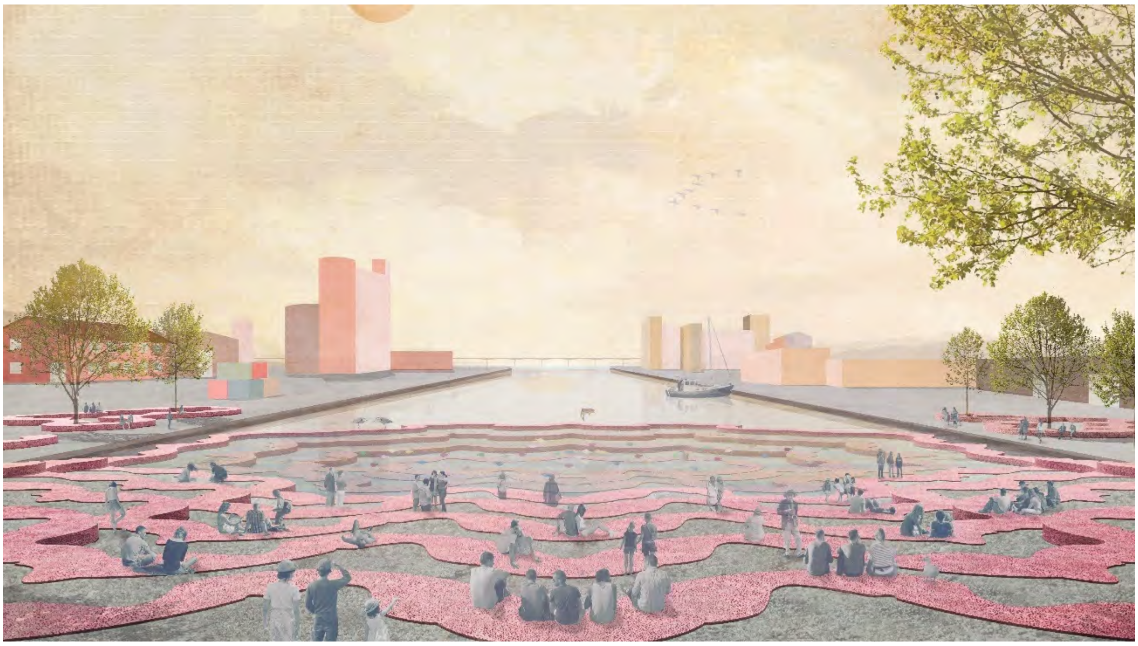
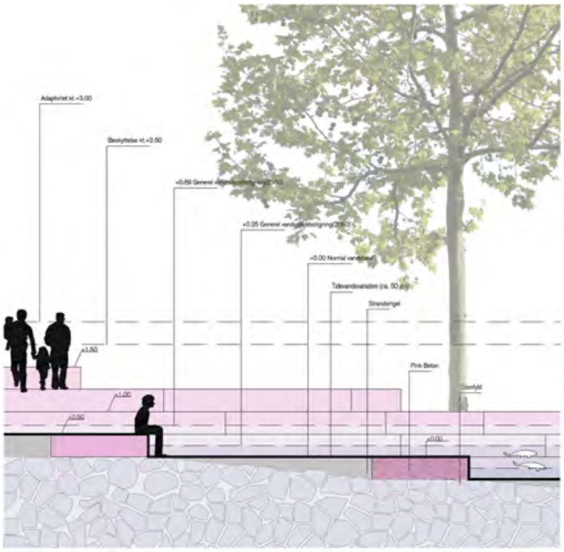


Figure 133. Illustration showcasing how this entry satisfies the major criteria set by Kanten/The Edge (i.e. A nature-based solution, nature over and underwater, Vejle's storm surge strategy and another perspective of the water). Image credit: Vejle Municipality and SUPERFLEX/Baldios.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Nature-based considerations at the Urban zone and Nature zone

In the urban zone, the main spatial approach is a democratic amphitheatre that stretches from land to water, where fish and people can come together in a single concept (as shown in Figure 133 and Figure 134). Along Tirsbæk Strandvej, a walkway weaves through islands of wetlands where plants and fish live (as shown in Figure 135). The amphitheatre and the wetland islands both consist of pink, porous modules with optimal opportunities for mussels and seaweed to develop and contribute to a better environmental balance by filtering the water and providing habitats for fish (Vejle Municipality, 2020c, author's translation).

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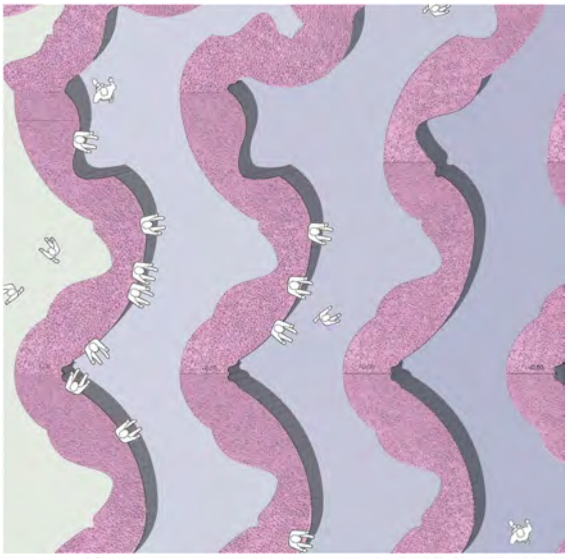


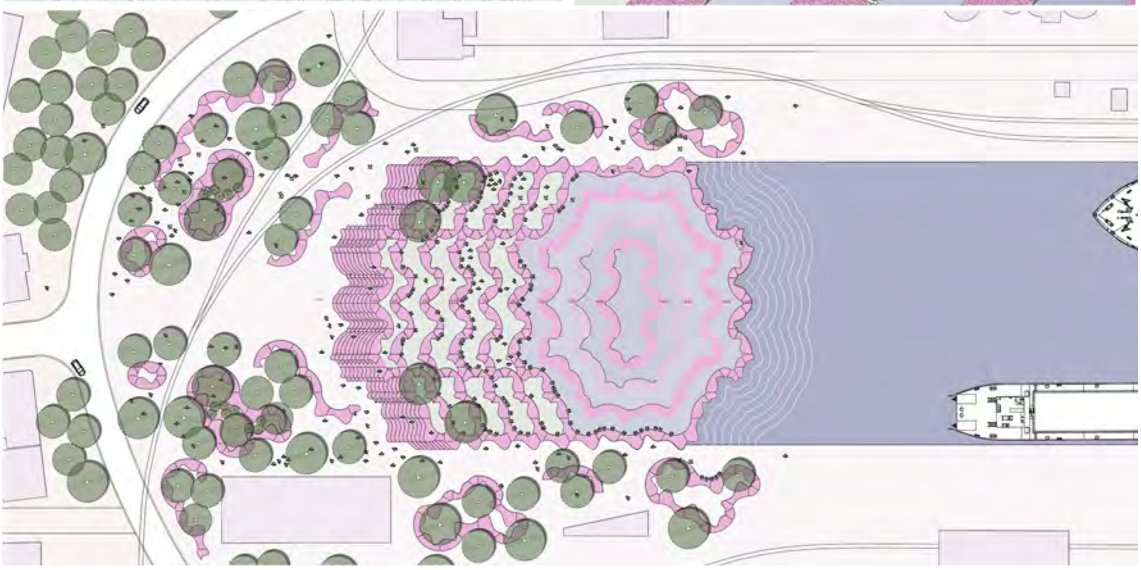
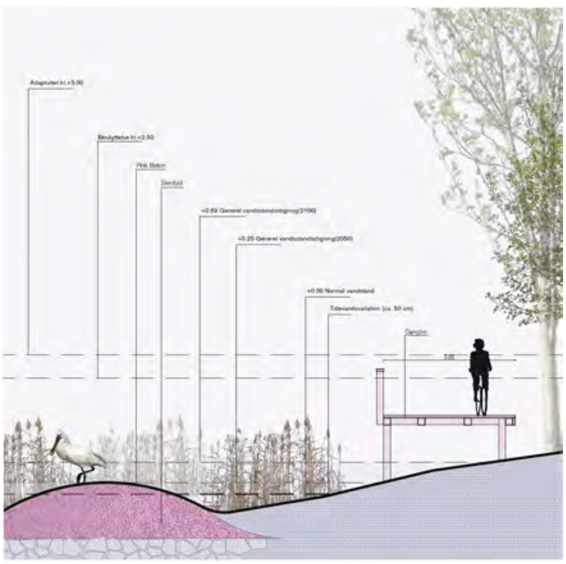
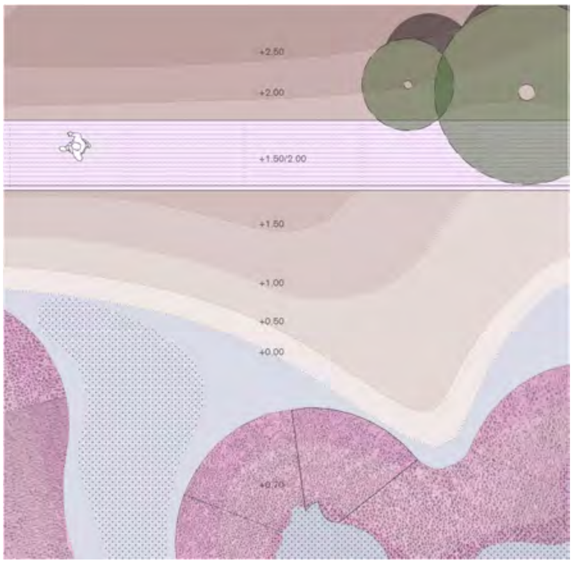


Figure 134. Visualisations for the Urban Zone as a "Democratic Amphitheatre" for humans and nonhumans. Coastal protection is achieved through a stepped dike that elevates to a 3m level. Image credit: Vejle Municipality and SUPERFLEX/Baldios.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).





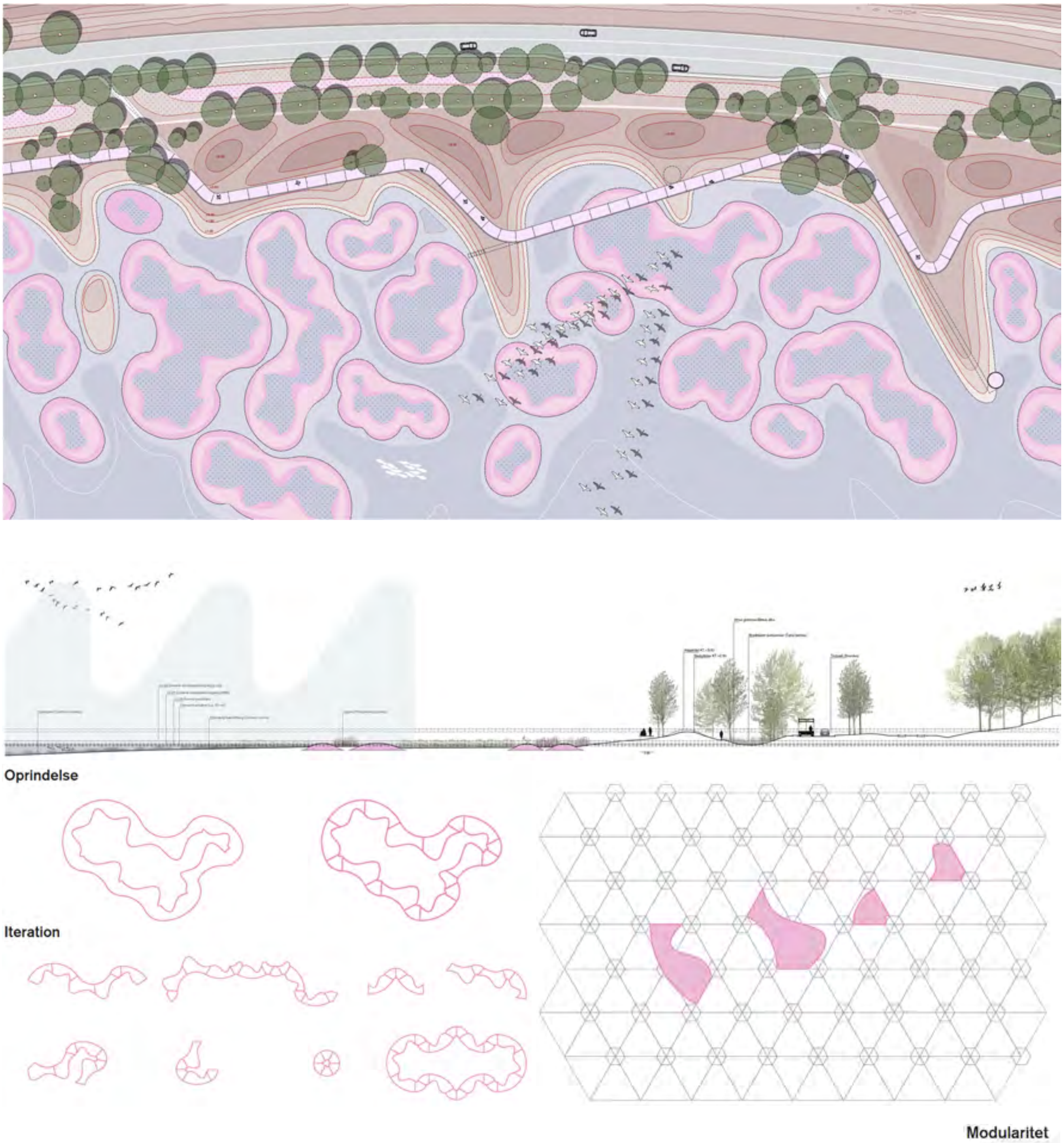


Figure 135. Visualisations for the Nature Zone as a walkway that weaves through islands of wetlands hosted by modular pink elements. Coastal protection is achieved through a mound that elevates to a 3m level, and these wetlands are designed to provide wave attenuation and habitat. Image credit: Vejle Municipality and SUPERFLEX/Baldios. (Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Another perspective on water

The project brings important questions to the forefront, which will be valuable to incorporate into the upcoming process in realising Kanten/The Edge project further and in the discussions about storm surge protection in Vejle. It is a good reference for working with artistic strategies when addressing and understanding future challenges (Vejle Municipality, 2020c, author's translation).

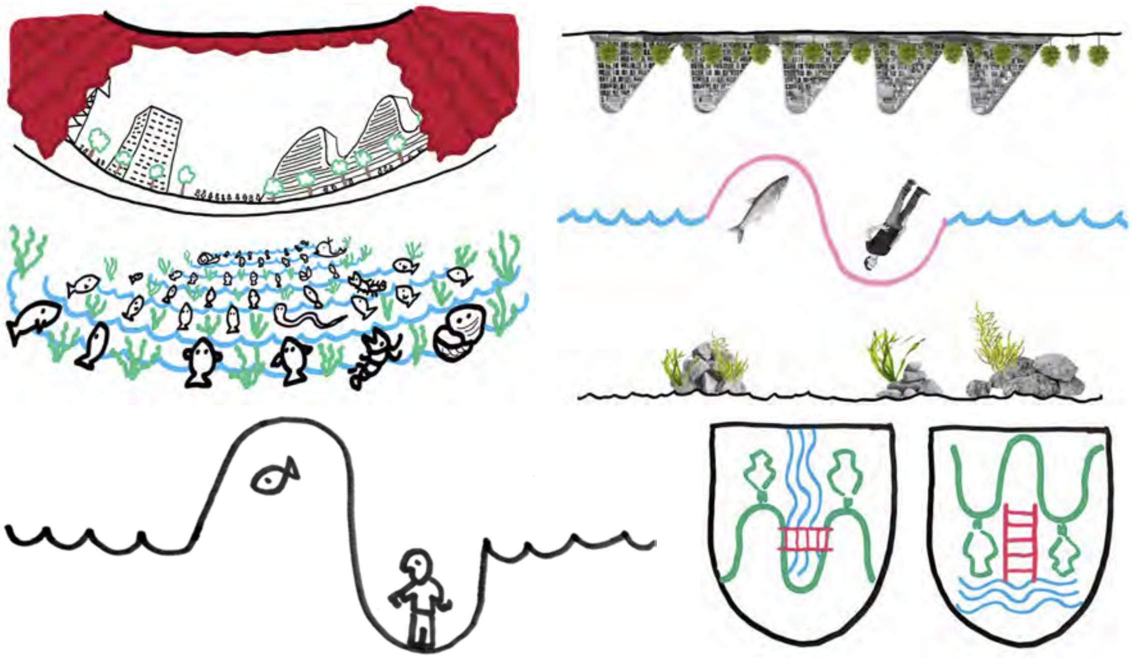


Figure 136. Images from their proposal indicate their approach of flipping the perspective upside down and viewing Vejle from the perspective of the water/fish. Image credit: Vejle Municipality and SUPERFLEX/Baldios.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Protective and adaptive measures and professional assessment

The storm surge protection at Havnepladsen and along Tirsbæk Strandvej consists of a traditional dike solution and a raised surface, as seen in most other proposals. Therefore, the proposal's real value as storm surge protection is not remarkable. In contrast, the artistic elements and the proposal's exciting considerations are rewarded as a special mention (4th place) (Vejle Municipality, 2020c, author's translation).

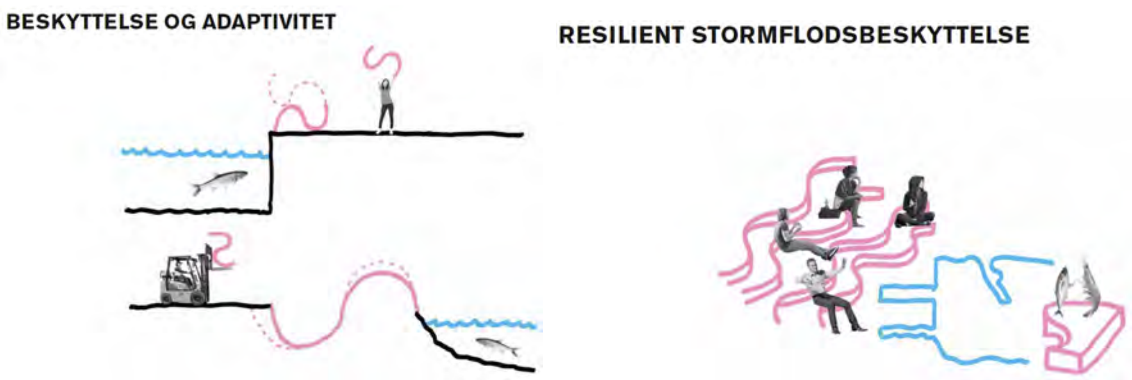


Figure 137. Their modular pink elements help rethink Kanten/The Edge conditions to provide resilience from storm surges while hosting a better meeting place between humans and nonhumans. Image credit: Vejle Municipality and SUPERFLEX/Baldios.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Overall work process

My analysis of the SUPERFLEX/Baldios proposal and the interview (only with Rasmus Rosengren Nielsen) suggested that their values, propositions and goals aligned well with two of the Urban Seascaping propositions; "Multispecies coexistence" and "Making the invisible visible". It demonstrated the possible design outcomes that could arise from designing with these two USS propositions.

SUPERFLEX has previously been working on transdisciplinary projects in the Pacific, responding to issues of sea level rise and ocean biodiversity with scientists and marine biologists (who study fish behaviour). It is clear that their other artistic works with the marine realm (as shown in Figure 94 in section 3.2.4) have a strong influence on their Kanten/The Edge proposal, especially in their theoretical and ethical positions. As an artist, Rasmus was preoccupied with creating things in different forms and shapes while trying to answer the main artist's dilemma, "what does it mean to think about making things for a changing world, and how will others perceive it in the future?" He questions the role of the creative disciplines in re-envisioning future cities and the infrastructures that will need to serve the next generation and other species that will be inhabiting these places in the future (i.e. how will our creations of today be perceived in the future?). Their inspiration for form-making in the marine realm came from their previous interactions with marine biologists and applying their findings in Vejle, which was their first iteration in Denmark. For instance, they referred to a report on marine biodiversity in the North Sea, where the largest biodiversity zones are around shipwrecks due to the hard surfaces they provided in the soft sea bed (i.e. known as "wreck biodiversity" (Mallefet et al., 2008)). Therefore, the findings concluded that in order to increase the level of biodiversity in a certain area, you need to increase surface area. The current edge conditions in Vejle are straight concrete bulkhead walls that provide the minimum surface area. They worked with mathematical algorithms and models to find a shape that produced the maximum amount of surface area given certain spatial parameters. They found that forms that undulate and curve (like an intestine) were the best shapes. Furthermore, they looked into 3D structures like stone reefs with crevices, holes and textures that increase marine biodiversity. These findings all became part of the design parameters for the final design outcome and narratives for Kanten/The Edge proposal (Rosengren Nielsen, 2020).

1. USS: Multispecies co-existence (with seaweed)

SUPERFLEX displayed a sophisticated theoretical and ethical approach that sought to take the perspective of the fish in Vejle fjord. This is an innovative method that actively takes into consideration nonhumans in the design process. They also displayed the most sensitivity and knowledge of the marine realm due to their previous workings with marine biologists, suggesting that any future building development in Fjordbyen should be designed with the reality that it will be inundated. As such, a working premise was that fish could occupy the structure in the future. Moreover, the team highlighted being influenced by various scientific studies. For instance, one study that the team was inspired by demonstrates that Damsel fish are self-conscious and self-aware of their environment. As such, they are, in many senses, like humans. Consequently, the team experimented with how different shapes affect the "design preferences" of different fish species. While such approaches are speculative, the team emphasized that thinking from the fish's perspective was predominantly thought of as an alternative way to tell the story of Kanten/The Edge. On the one hand, they admit to re-appropriating their findings, such as using the colour pink, based on their work from the pacific in the Vejle context (they had limited contextual information on Vejle). However, on the other hand, they believed the underlying questions and methods were the same in Vejle as in the Pacific; therefore, the colour pink is a way to discuss the often-unknown agency of the marine realm. As such, their report discusses the more fundamental importance of the sea through a visual and oral pedagogical storytelling format of our deeper connection to water from evolving from the sea to our mother's womb.

2. USS: Making the invisible visible

The modulated pink elements for this competition are connected to other series of similar works SUPERFLEX have done (as shown in Figure 94 in section 3.2.4), which already have recognition in the art world in different places. Therefore, these pink elements have notoriety as artistic sculptures catered for marine life, thus, giving attention and visibility to the underwater world, visually but also pedagogically. Also, due to their striking form and colour, they draw attention to themselves, potentially inviting curiosity about what is happening below the sea to the local residents and tourists.

3. USS: Beyond the edge

Their approach to providing coastal protection was a stepped dike to the level of 3m in the urban zone and a mound in the nature zone, which was not an innovative or integrated solution as the other entrants. Due to their art background, their approach was more "object" orientated with a more specific focus on serving the marine lifeforms (while other winning projects did the opposite). However, little consideration is given to the transition between seascape to landscape as part of their nature-based solution. Furthermore, unlike the other winning entries, this project was truer to the competition brief and did not engage with the rest of Fjordbyen or expand further out into the Fjord (i.e. from "an edge to a zone" thinking).

4. USS: Invite the agency of the water

They embraced the idea of thinking from the fjord's perspective and acknowledged the agency of the nonhuman as a design actor, specifically, using fish as the representative nonhuman actor. For instance, working with marine life's spatial preference resulted in an undulating organic form that envelops Kanten/The Edge conditions. Moreover, the urban zone's "Democratic Amphitheatre" provided a place to invite the fjord closer to the city to provide more direct spatial engagement between the human and the nonhuman residents.

Trends and challenges behind Kanten/The Edge

For Kanten/The Edge competition, the involvement of marine biologists and artists as part of an advisory role to the judges was influential in the selection of the winning entries and a departure from typical design competitions that usually do not involve (marine) biologists. For instance, during the judging process (see Appendix 11), design proposals that were popular with the judges with fancier visualisations were dismissed as valid proposals due to the marine biologist's concern that they would not work from a marine perspective (see Figure 138 and Figure 141). Therefore, the involvement of a marine biologist added an extra layer of complexity by showing how important decisions on what happens at the urban shorelines could be clouded by simply preferring more aesthetically pleasing entries, devoid of the understanding of how things work in the marine realm. For instance, the entry shown in Figure 138 by Atelier Entropic from Spain and "Vadestedet" (The wading place) was favoured by some of the judges, but the marine biologist pointed out that these floating "island" formations in the urban zone with connected walking paths and narrow channels created would restrict the movement of the water, sediments and nutrients, which is already poor in the inner fjord resulting in water rotting and smelling in these spaces. The lack of understanding of factors that can impede the hydrological movement that the marine life depended on was a common mistake in other entries by proposing designs that would radically compromise the flow. Moreover, this proposal displayed a case of terrestrial bias by proposing floating islands with land-based plants above the water rather than considering "nature below the water".

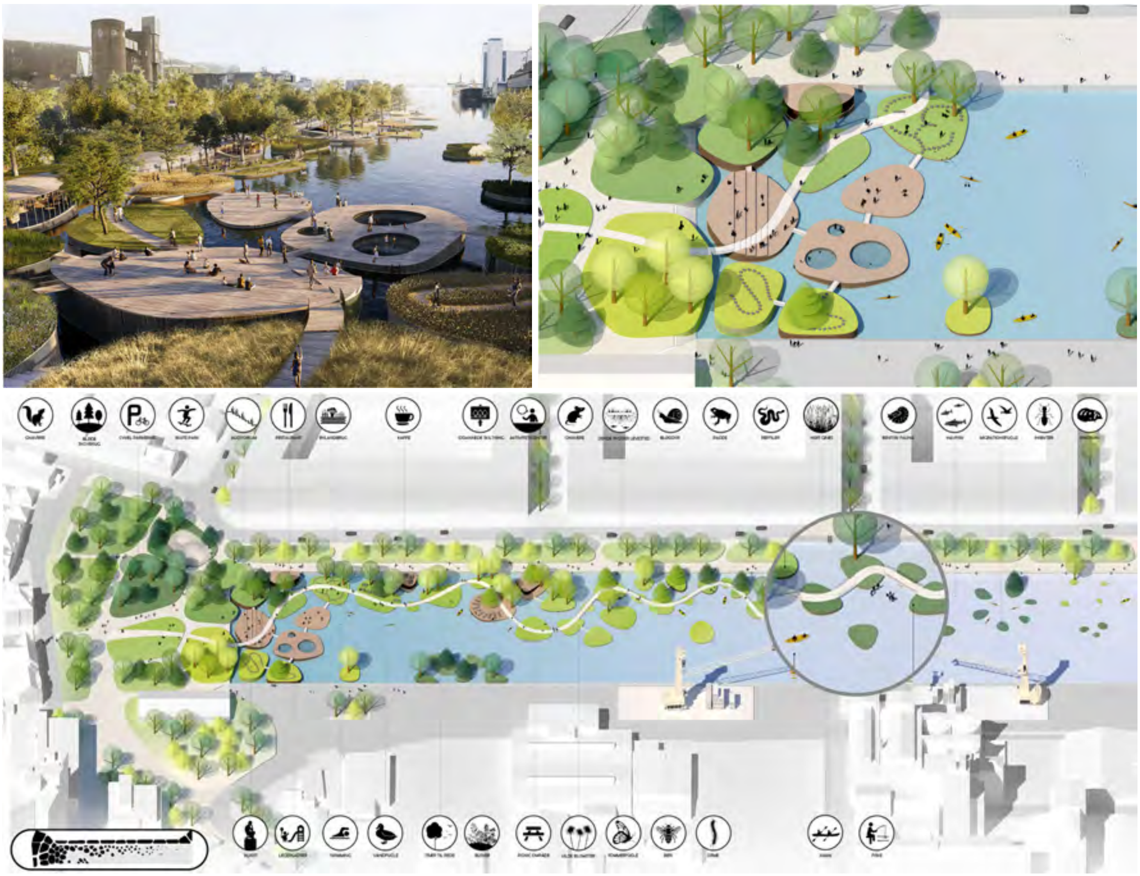
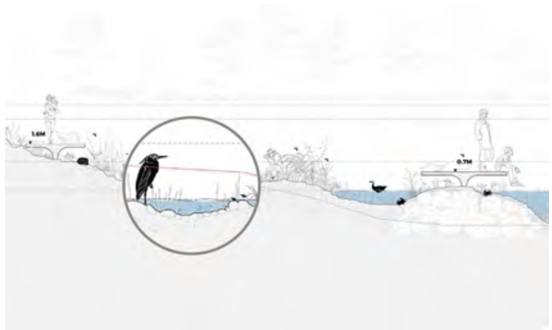


Figure 138. (Top-row and second-row images) The proposal for the urban zone by Atelier Entropic from Spain. The proposal is called "The Floating Gardens", with floating islands connected by pathways as the main design concept. Image credit: Vejle Municipality and Atelier Entropic (2020).
(Bottom Left image) The proposal is called "Vadestedet", with islands impeding the already compromised water, sediment, and nutrient flow in the inner fjord. Image credit: Vejle Municipality (the author of this entry is unknown).
(Bottom Right image) The proposal is called "Bøgespejlet" (Beech tree mirror), where it proposes a semi-circle extension of the land-based forest into the inner fjords to make it narrower in width, further compromising its current poor water circulation, radically altering the hydrology and sediment flows of the area, which will have a negative consequence on the marine life and water quality. Image credit: Vejle Municipality (the author of this entry is unknown).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Similarly, many proposals included isolated rock pools (including the winning projects), but due to Vejle's minimal tidal variance and waves, these pools need to ensure frequent water exchange; otherwise, they will rot and smell. Furthermore, the proposals by Atelier Entropic in Figure 139 (although a minor issue) even had vegetation and animals that did not belong in the fjord (i.e. there are no octopuses in the fjord).



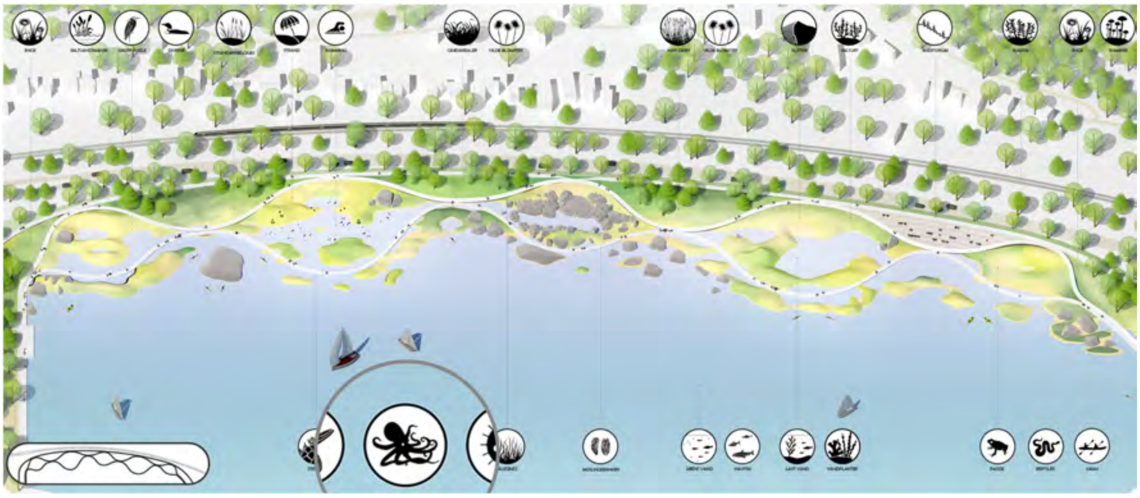


Figure 139. The proposal for the Nature Zone with undulating pathways and rockpools. An example of a project that impedes the hydrological flow of the fjord. Image credit: Vejle Municipality and Atelier Entropic (2020).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Other entries that caught the eye of the judges were called "Hvor er Kanten?" (Where is the Edge?) as shown in Figure 140, where it proposed a raised square where the trees are planted in a grid as an extension of the existing planting. Although the trees are protected with a membrane that can secure the roots against salt due to sea level rise, the proposal displays terrestrial bias – an unnecessary effort to keep land-based trees alive against the new salty wet conditions rather than focusing the attention on nature "underwater" that will be better suited to rise in sea levels.

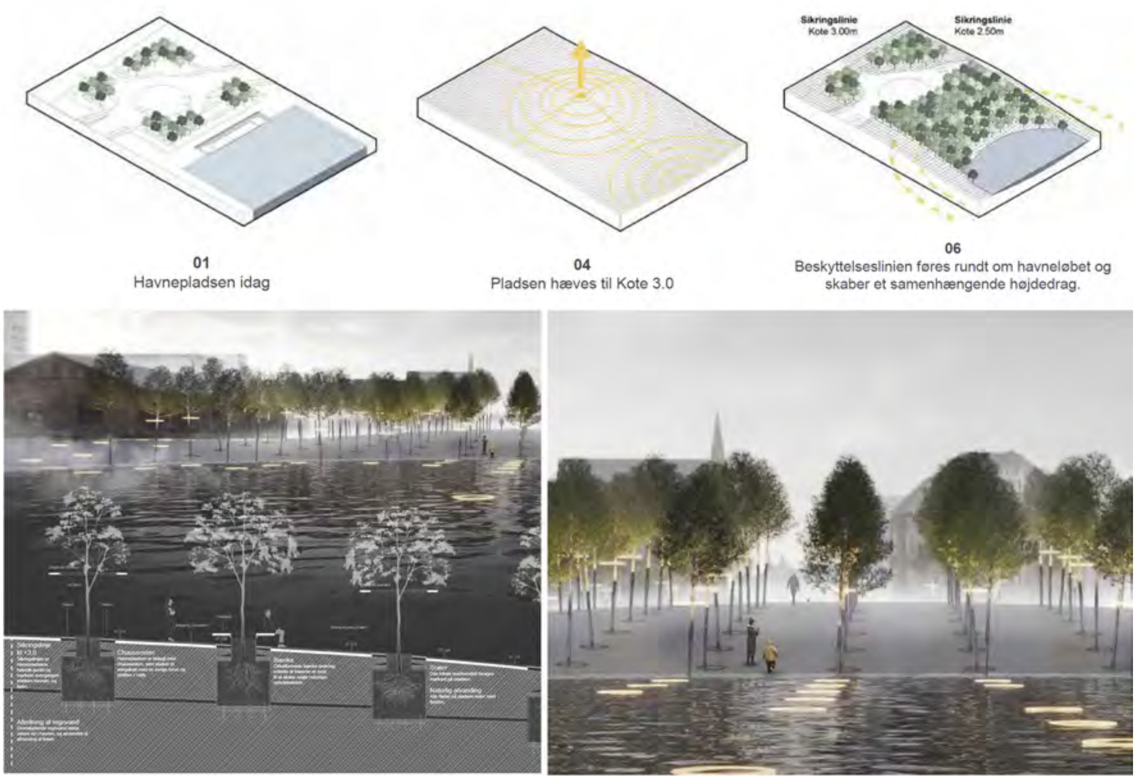
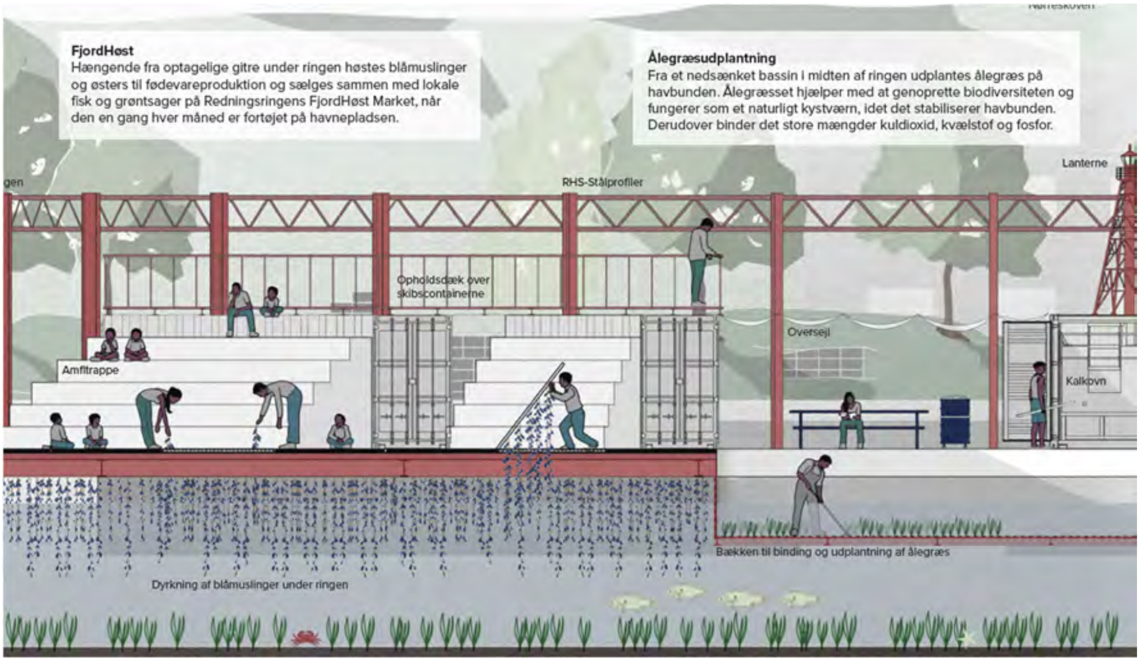


Figure 140. The proposal is called "Hvor er Kanten?" (Where is the Edge?) features extending the existing tree planting in the harbour zone on a raised mound with ring lights that light as the sea level rises. The trees are encased in a membrane that protects them from saltwater intrusion. It seems like an unnecessary cost for infrastructure required to keep these trees alive against their natural habitat of dry land. It could be considered an example of terrestrial bias. Image credit: Vejle Municipality (the author of this entry is unknown).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

While this next example, as shown in Figure 141, was commendable in its consideration of socio-cultural activities that it hosted (i.e. an oyster bar), unfortunately, it was dismissed due to major flaws pointed out by the marine biologist. For instance, the floating pavilion with blue mussels[216] hanging on lines below with eelgrass plantation on the sea bed would not work as they will have limited access to sunlight due to the floating platform (already compromised by the poor water visibility in the fjord). Moreover, the faeces created by the blue mussels will cast over the eelgrass stifling its growth. These proposals (and a few other proposals that made the same mistake) indicate a lack of understanding of marine ecosystems.



216 Blue mussels do not need sunlight to grow unlike the eelgrass (Organo Quintana, 2020).

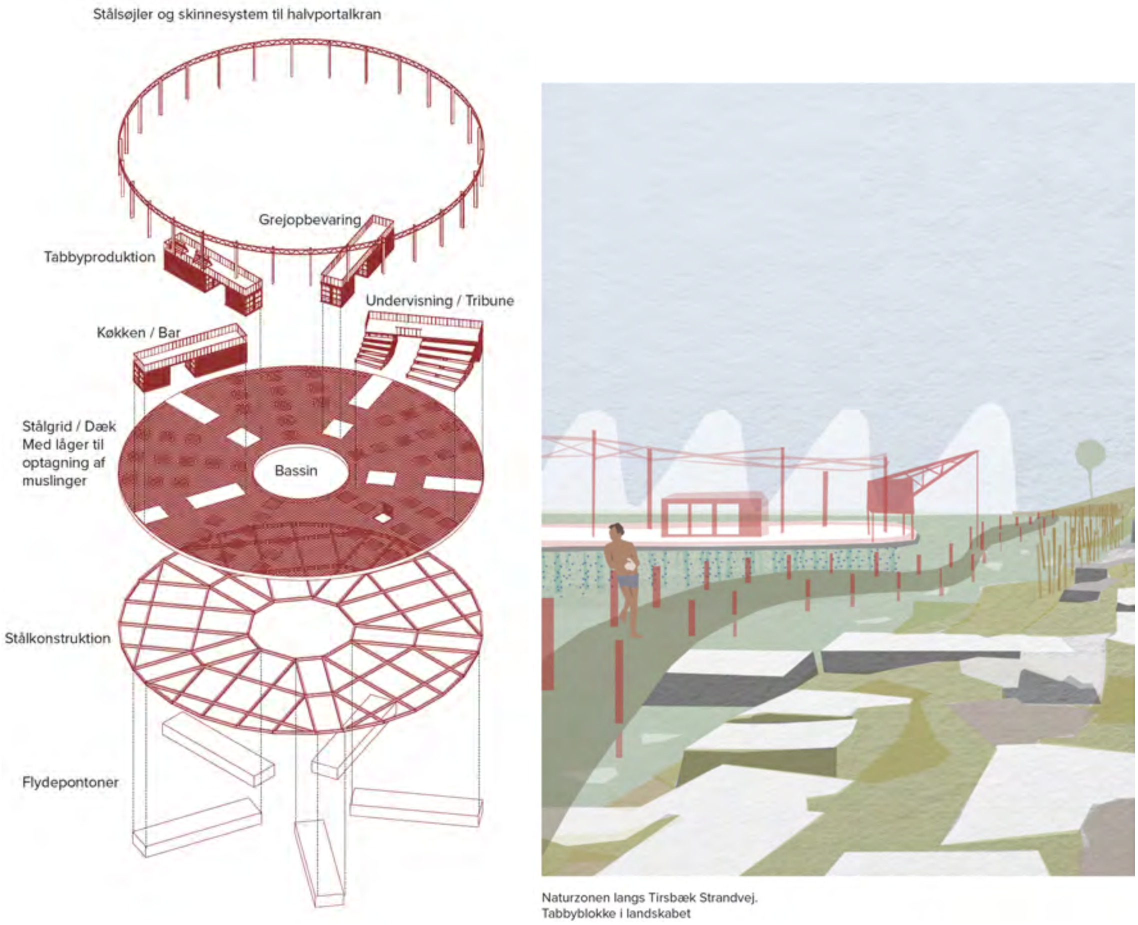


Figure 141. The proposal is called "En selvgroet stormflodssikring" (A self-grown storm surge protection), proposes floating pavilions with hanging blue mussels on lines and an eelgrass plantation below, which would not work from a marine perspective as they will have limited access to sunlight, and the faeces of the blue mussels over the eelgrass will stifle its growth. Image credit: Vejle Municipality (the author of this entry is unknown).
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

There was another tendency for some members of the judges to favour proposals that looked familiar to the concrete bulkhead walkways that are strife in many Danish coastal cities (as shown in Figure 142). These proposals do not push the boundaries of how these spaces could offer a different future that could address the numerous impacts of climate change. The tendency to favour these common prototypes of waterfront spaces showcases the lack of exposure to diverse possibilities and visions. There were few voices of scepticism towards projects that seemed like marine nature dominated the space (i.e. the first-place proposal), exemplifying their unfamiliarity with incorporating nature underwater. One of the judges commented, "this (space) is not a nature park… there is too much nature." These responses indicate the inertia in accepting new forms of blue commons, which was challenged by the artist (advisor to the judges). The artist played a role in presenting to the judges the merit of departing from B-A-U concrete bulkheads to not only consider different spatial qualities with marine life but the values of what it means to also engage with the paradigm shift needed at the coast. In particular, the advisor supported more artistic and philosophical approaches to Kanten/The Edge, such as the one presented by SUPERFLEX.

Figure 142. (Top image) The proposal resembles typical waterfront spaces in coastal cities of Denmark via stepped concrete bulkheads and fountains (referencing the artist Piet Hein's fountain that exists on Aarhus' waterfront, as shown in the image below). Vejle Municipality (the author of this entry is unknown).
(Middle image) Another proposal that resembles typical waterfront spaces in coastal cities of Denmark is similar to the one above. Some of the judges favoured the current status quo of waterfront areas with lots of concrete, favouring terrestrial plants, and little thought to integrating marine life into the urban realm. Vejle Municipality (the author of this entry is unknown).
(Bottom image) Some of the entries emulate the current status quo of urban waterfront design, like in the city of Aarhus. Image credit: Taken by the author on 17/09/21.
(Extracted from Kumu Multiscalar map – Kanten/The Edge scale node).

Having analysed the different entries of the case competition, the following sections will move through the next series of scales hosted in the first Kumu map (fjord scale, regional scale, national scale, global scale). The aim is to expand the site from "the edge" conditions to a multiscalar condition. By implication, this act of "zooming out" can be seen to challenge the restrictions of competition brief using the mapping as a form of spatial contextual analysis (i.e. Multiscalar Kumu map). The intention of doing so is to highlight the different insights that each scale may offer in the context of the Vejle competition whilst at the same time relating the competition itself to broader concerns that exceed that of the competition.

4.1.2 Fjordbyen (Fjord City) scale/networks

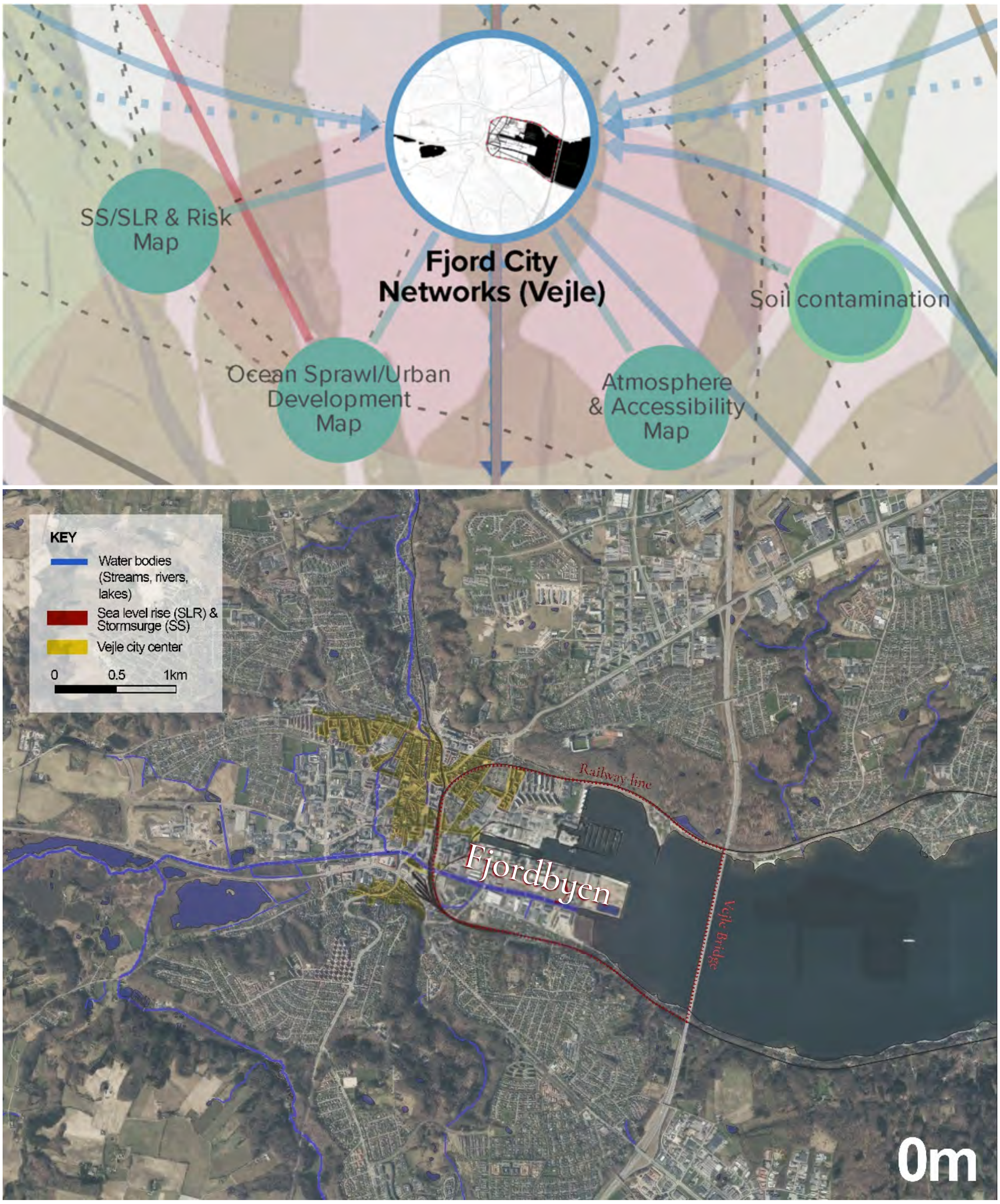
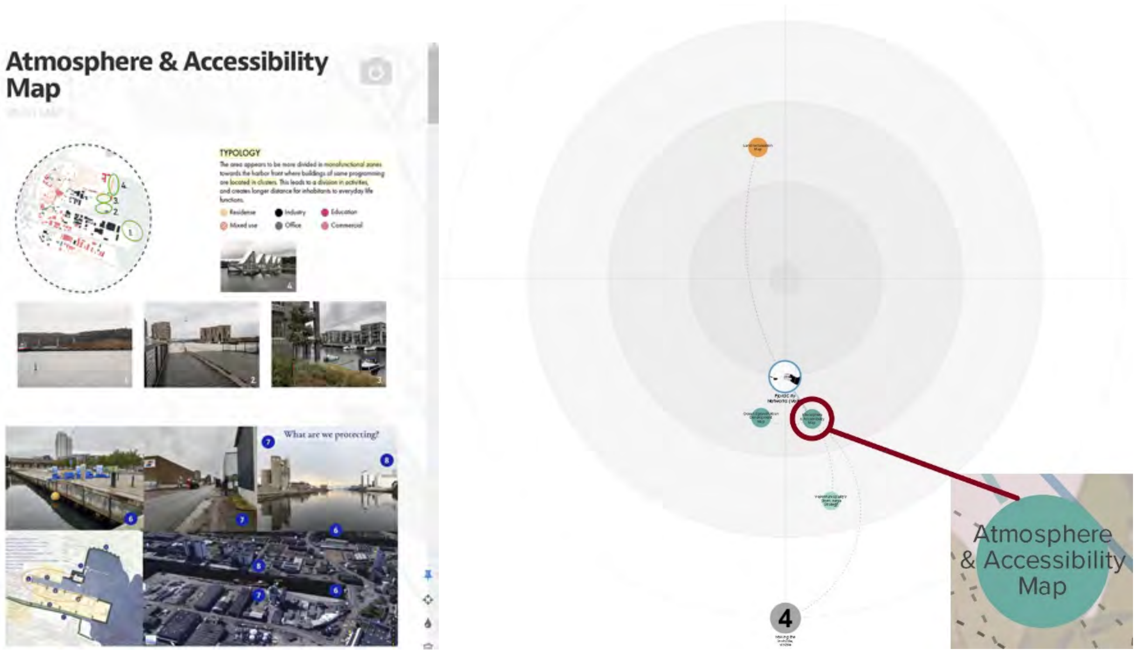


Figure 143. Kumu map at a Fjordbyen scale and its relationship back to Kanten/The Edge scale. Fjordbyen is delineated by the transportation infrastructure, the railway lines and the motorway bridge, which has little relationship to the Fjord despite being called "Fjord City" (Kumu, 2020). The map is made with the data from Miljøministeriet (n.d.). (Extracted from Kumu Multiscalar map – SS/SLR & Risk Map mini-node).

Having analyzed the different entrants for the Kanten competition, focusing especially on the two sites that represent the smallest scale of the deep site analysis, I now zoom out to examine the relations that makeup Fjordbyen as a whole. The Fjord City/Fjordbyen is a contested site with varying interests and uses. Site visits to the harbourfront and waterfront area (Lystbådehaven) in Figure 144 showcase the numerous building typologies and land uses. The analysis indicates that the boundary between the city and the fjord is largely inaccessible to the public due to the occupation of the industrial harbour[217] with limited blue-green public spaces (commons) (Sørensen et al., 2017). The urban shoreline is predominantly defined by a hard-concrete edge, making the delineation between the city and sea dualistic, sharp and distinct (as shown in Figure 144). It is also mainly paved with asphalt and impermeable concrete surfaces that contribute to the area's gloomy and uninviting mood (Sørensen et al., 2017). The newly developed waterfront area hosts more recreational activities with the kayak club, the marina and a restaurant. Moreover, the area has been developed with high-end residential apartments attracting residents from higher socio-economic backgrounds. These new residential buildings are not necessarily designed to adapt to changing climatic conditions, especially the increasing presence of water.



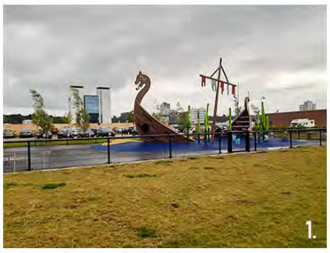
217 Due to the long occupation of the industrial harbour area in Fjordbyen for more than a century, the soil is polluted (SKALGO, n.d.). Furthermore, the main channel that leads to Kanten/The Edge's urban zone is docking space for boats and ships to serve the harbour, which makes this border inaccessible to the public (Vejle Erhvervshavn, 2022). Therefore, this Urban Zone from Kanten/The Edge competition's intention to implement NbS coincides with the current use as a docking place for ships.

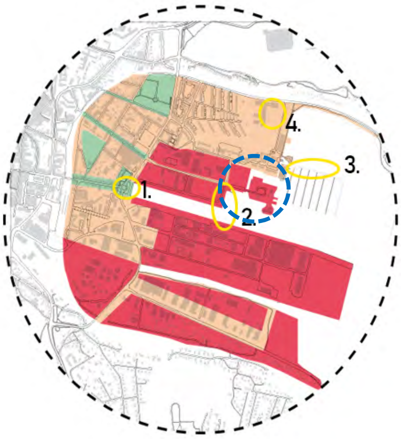
GREEN SPACE/INFRASTRUCTURE

The city is surrounded by great forests and nature open to the public which represents great recreational value for the citizens. However, the green spaces in the center of the analysis area lack connection to each other and does not seem to be designed for stay nor connected to pathways.

PUBLIC SPACES

The public spaces are located in relationship to the residential buildings in the north. There is potential for activity in the public spaces by the harbor but this part is poorly connected to the rest of the public spaces located near the city center. The size, location and programming of the public spaces does not appear to be planned according to each other.





ACCESSIBILITY

There is limited accessibility to different areas in the south. These areas are closed off to the public for safety reasons, and therefore creates humdrum activity in this part of the city.

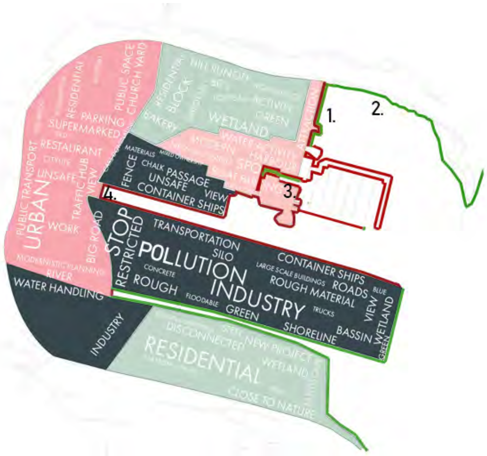
Good Medium Bad

**NB: The blue circle outline above has recently opened up to public access due to the residential development in this area – Therefore should be updated from Bad to Medium accessibility.*

TYPOLOGY

The area appears to be more divided in monofunctional zones towards the harbor front where buildings of same programming are located in clusters. This leads to a division in activities, and creates longer distance for inhabitants to everyday life functions.

Residense
Industry
Education
Mixed use
Office
Commercial



OVERALL ATMOSPHERE & EDGE CONDITIONS

Hard edges
(dominated by impermeable surfaces (i.e. concrete); sharp decline to the water (i.e. 90 degrees fall by approx 1-2m high)

Soft edges
(dominated by sand, plants, rocks and other lifeforms ; gradual decline to the water)

'In-between' edges
(dominated by permeable surfaces (i.e. steel mesh, timber boards); elevated but still close to the water)

**NB: See Klimatilpasning - KAMP (n.d.) map for the adopted municipal planning framework that indicates land use of Fjordbyen area*

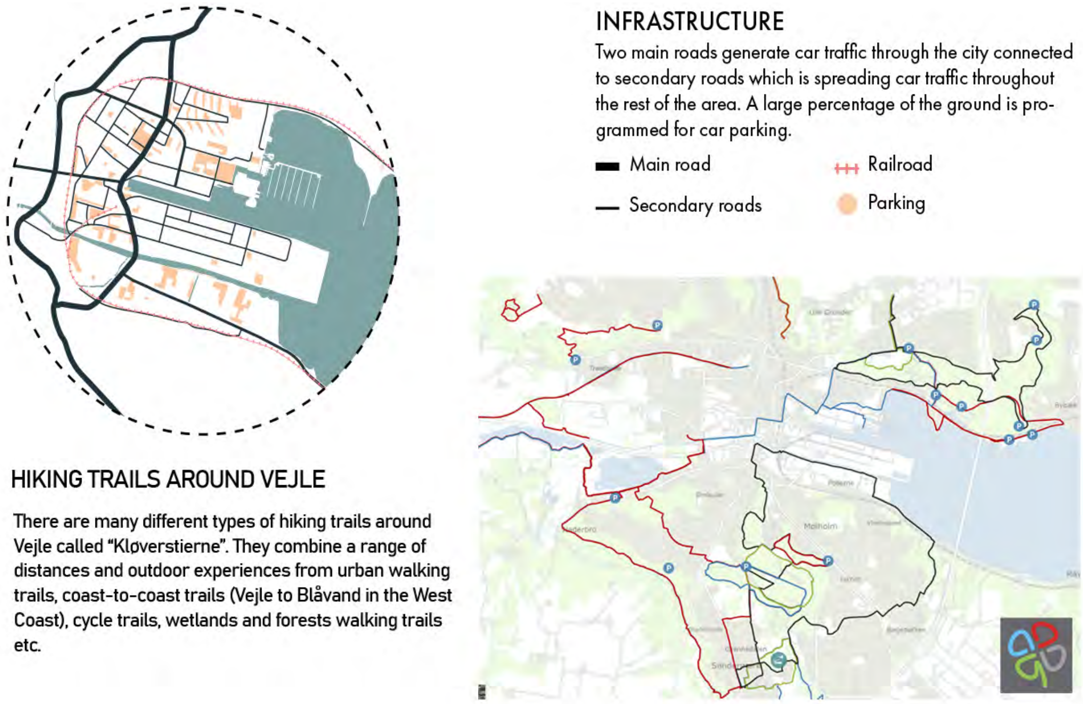


Figure 144. Photos were taken from various site visits to Vejle's Fjordbyen. The maps are created by site analysis from a master thesis by Sørensen et al. (2017). The site photos were taken by the author on 29/07/20. Image credit of the walking/hiking trails in Vejle: Vejle Municipality (2021).
(Extracted from Kumu Multiscalar map – Atmosphere & Accessibility mini-node).

For Vejle, as shown in Figure 145, one of the worst-case scenarios of SLR by 2100 of 0.9m (1.4m) will matter little, but in a combination of SS scenarios[218], a 20 and 50-year SS scenario by 2050 will inundate Fjordbyen due to water from the fjord and the city centre from rivers bleeding. With heavier cloudbursts, the city would need to make more retention ponds or other ways to store the excess water and make the current impermeable city more like a sponge (i.e. upgrade the rainwater infrastructure, pumps, and the combined sewage, which is planned after 2040 (Vejle Spildevand, n.d.)). Therefore, Vejle Municipality is making many efforts to re-establish the sponge and greening the existing grey corridors by increasing permeability back into the city through various urban development (i.e. Opland Østbyen[219] and Ny Rosborg[220]) and nature restoration projects[221] running in parallel (Vejle Spildevand and Vejle Kommune, n.d.).

218 Over the past few hundred years, average floods have been recorded in the city every 4 to 5 years, but the number of floods has increased in the last decade (Vejle Municipality, 2020a).

219 Opland Østbyen (translated, "The Upland East Town") is a municipal project to adapt the Østby (East town) quarter in Vejle to flooding (i.e. a 100-year rainfall until the year 2100). The project takes into consideration the catchment of the area to create a recreational "Climate Park" that functions as water basins and visible rainwater channels to hold and direct the excess water out of the area (Vejle Spildevand and Vejle Kommune, n.d.).

220 A new district in Vejle that is in development (at the bottom of the river valley). It plans to be a climate-adapted residential area built as islets on raised elevation surrounded by recreational water reservoirs to store excess water during cloudburst events (AART, 2022).

221 To see a comprehensive list of all the nature restoration projects in Vejle, see this document: (Danmarks Naturfredningsforening, n.d.).

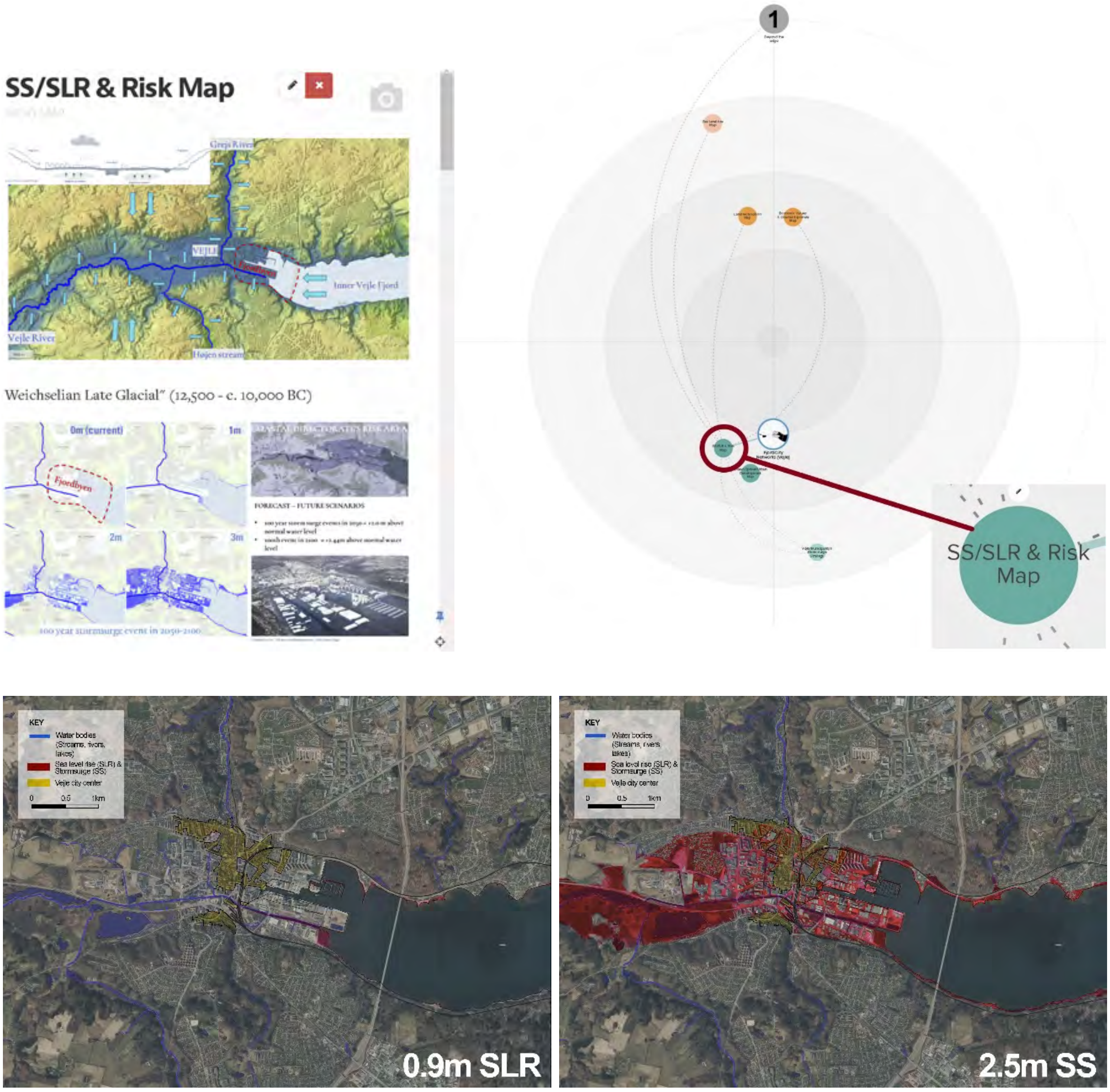


Figure 145. A predicted worst-case scenario of SLR of 0.9m alone will not wreak havoc in Vejle, but in combination with any form of storm surge (i.e. Storm Malik in 2022), the whole of Fjordbyen will be inundated (currently the tipping point of inundation in Vejle is approximately 1.6m+). 2.5m is the minimum protection level set by Vejle Municipality by 2050. The map is made with the data from Miljøministeriet (n.d.), Vejle Klimakort (n.d.) and SCALGO (n.d.).
(Extracted from Kumu Multiscalar map – SS/SLR & Risk Map mini-node)

4.1.3 Vejle Fjord scale/networks

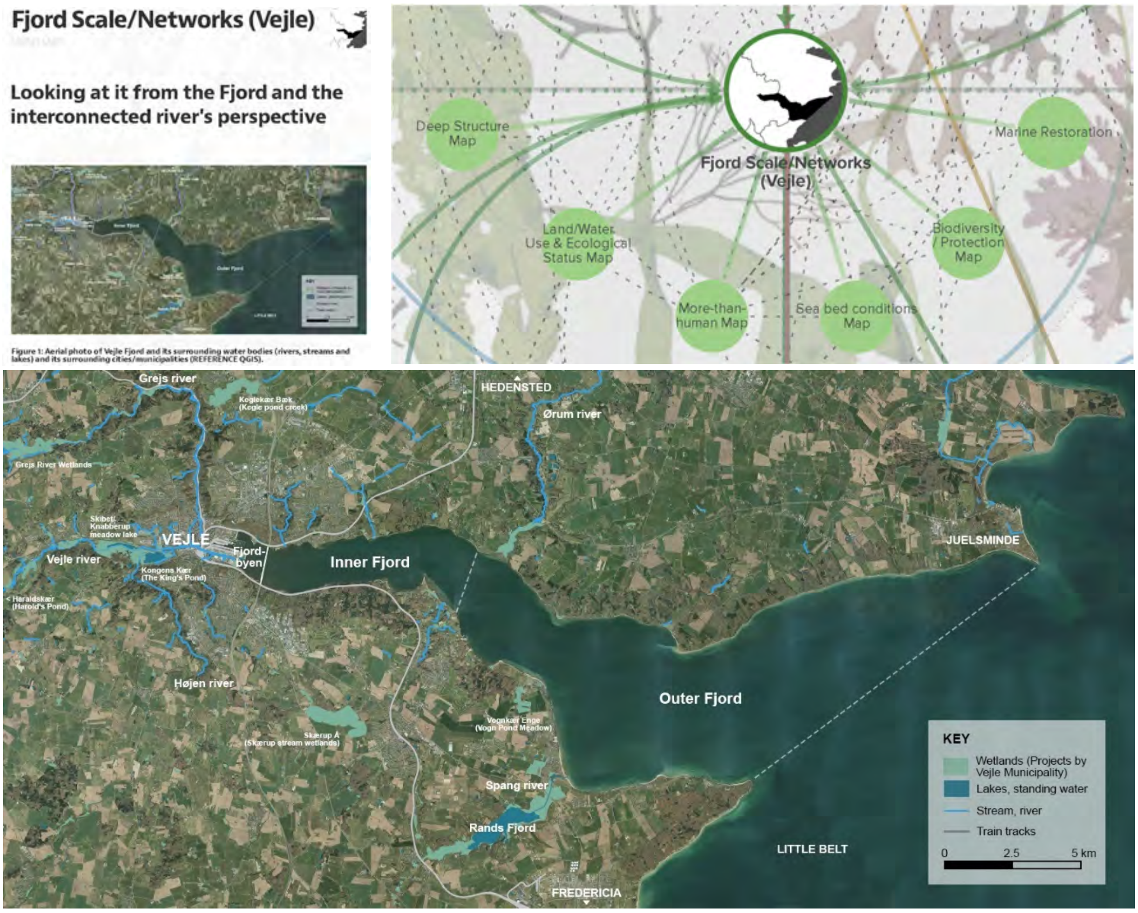


Figure 146. (Top image) Kumu map at a fjord scale and its relationship back to Kanten/The Edge scale. It encompasses six nodes, such as maps pertaining to land and water use issues, ecological status/condition of the fjord, the sea bed conditions, biodiversity and nature protection areas surrounding the fjord, and the location of marine vegetation growing in the fjord (Kumu, 2020).
(Bottom image) The city centre of Vejle, where the river and the fjord meet. The fjord is divided into two main parts, the inner and the outer fjord, surrounded by three main municipalities (Fredericia, Vejle and Hedensted).
The map is made with the data from Miljøministeriet (n.d.).
(Extracted from Kumu Multiscalar map – Fjord Scale node).

Zooming out once more from Fjordbyen to the whole of Vejle fjord, as shown in Figure 147, it becomes evident that the fjord, despite its relatively shallow water depth, protrudes deep into the landscape, which is surrounded by agricultural land (shown in beige in Figure 147). Furthermore, the fjord provides zones dedicated to cultivating mussels, oysters and seaweed (in yellow outline on the map in Figure 147). These zones are obvious candidates for hosting future potential nature-based solutions. However, they also coincide with shipping and recreational boat traffic (outlined in blue). Therefore, as a spatial corridor, Vejle fjord represents a contested zone involving marine transport and marine life[222].

222 For instance, large-scale marine restoration projects or NbS in the form of floating buoys to grow kelp and mussels would have to compete with maritime traffic as NbS to achieve wave attenuation would need to cover the

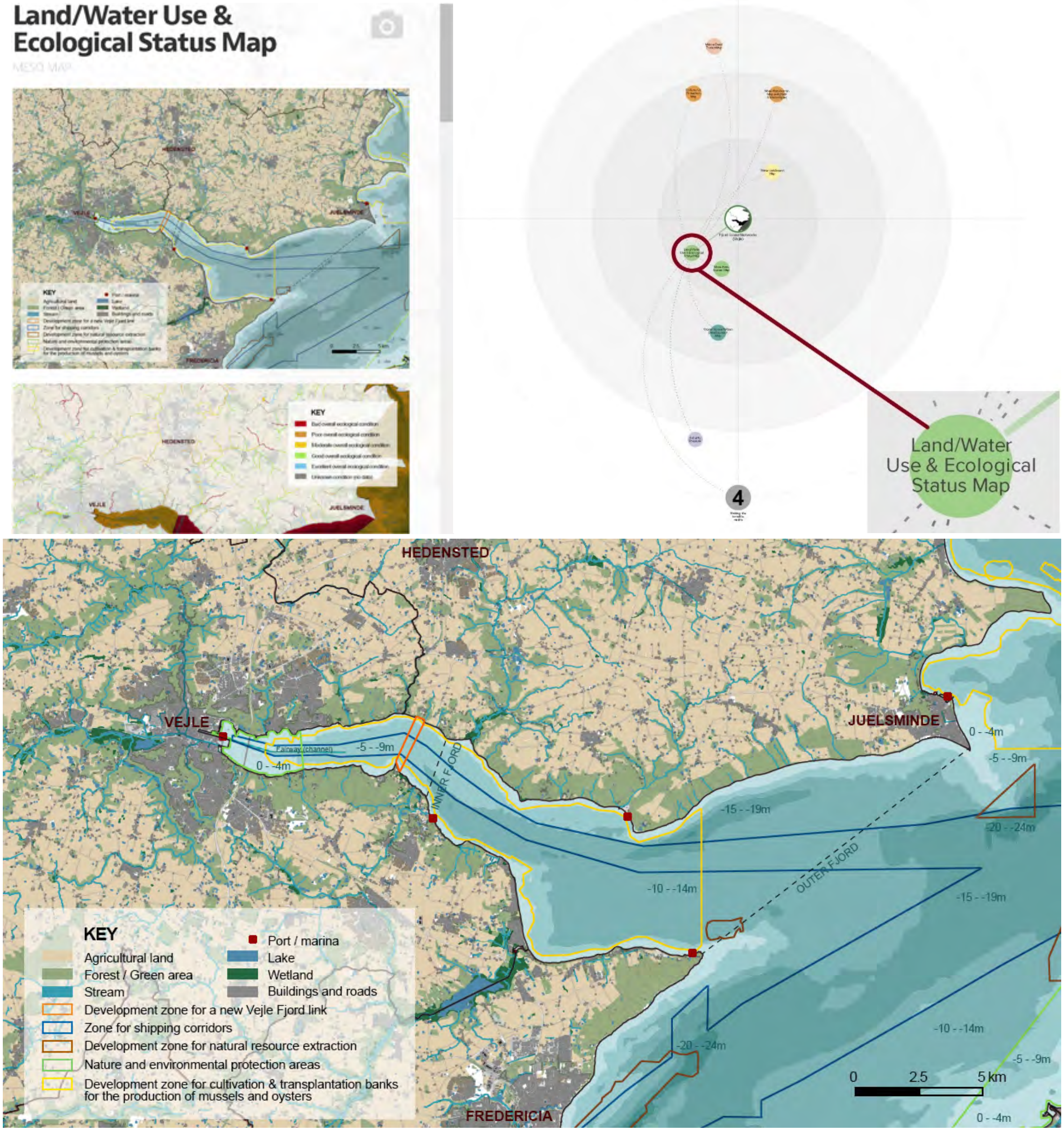


Figure 147. (Top image) Screenshot of the node "Land/Water Use & Ecological Status map" from the fjord scale isolated to show its connections to other corresponding nodes (Kumu, 2020).
(Bottom image) Vejle fjord is allocated for various uses, be it land-based transport (bridges for cars and trains), sea-based transport (recreational boats and shipping channels for the harbour), area for resource extraction, marine nature reserve and for cultivating marine life (which is currently at a very small scale). The map shows the urban sprawl of Vejle City (in grey), the green forests enveloping the fjord in green, and the huge agricultural land surrounding the fjord. The map is made with data from Miljøstyrelsen (2016) and the Danish Maritime Authority (n.d.).

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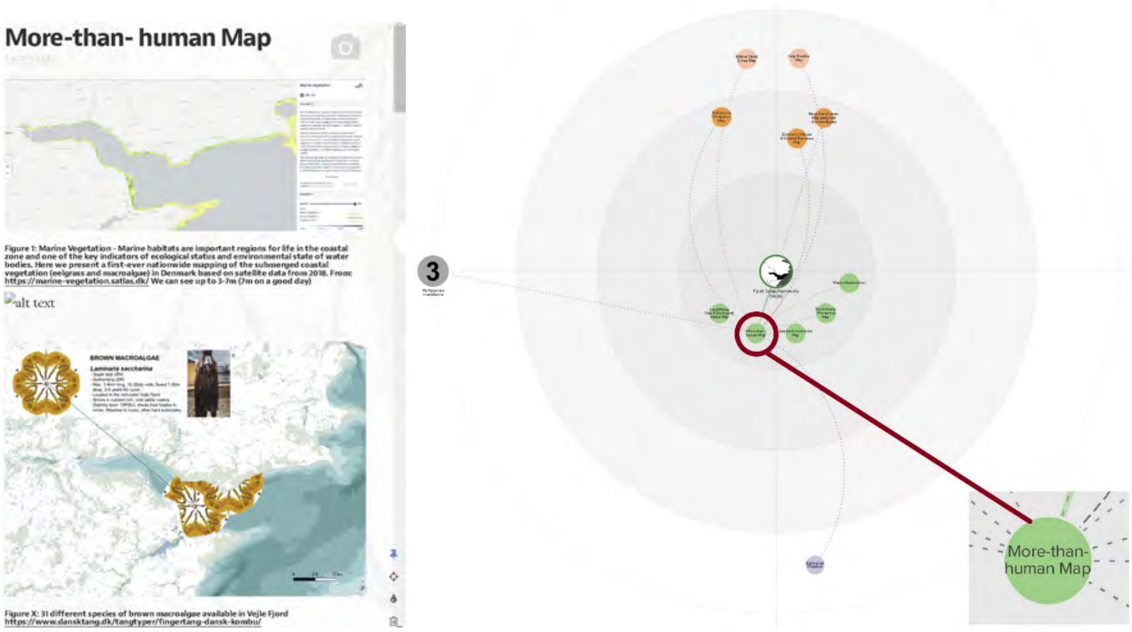
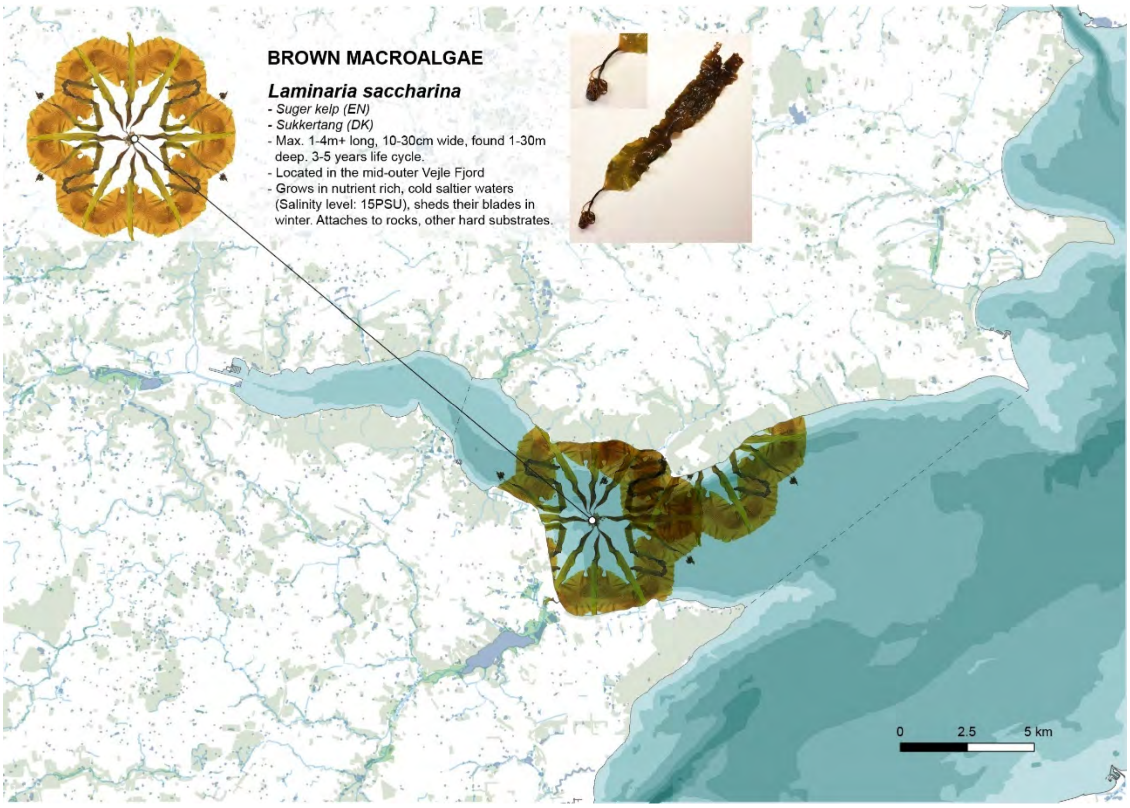
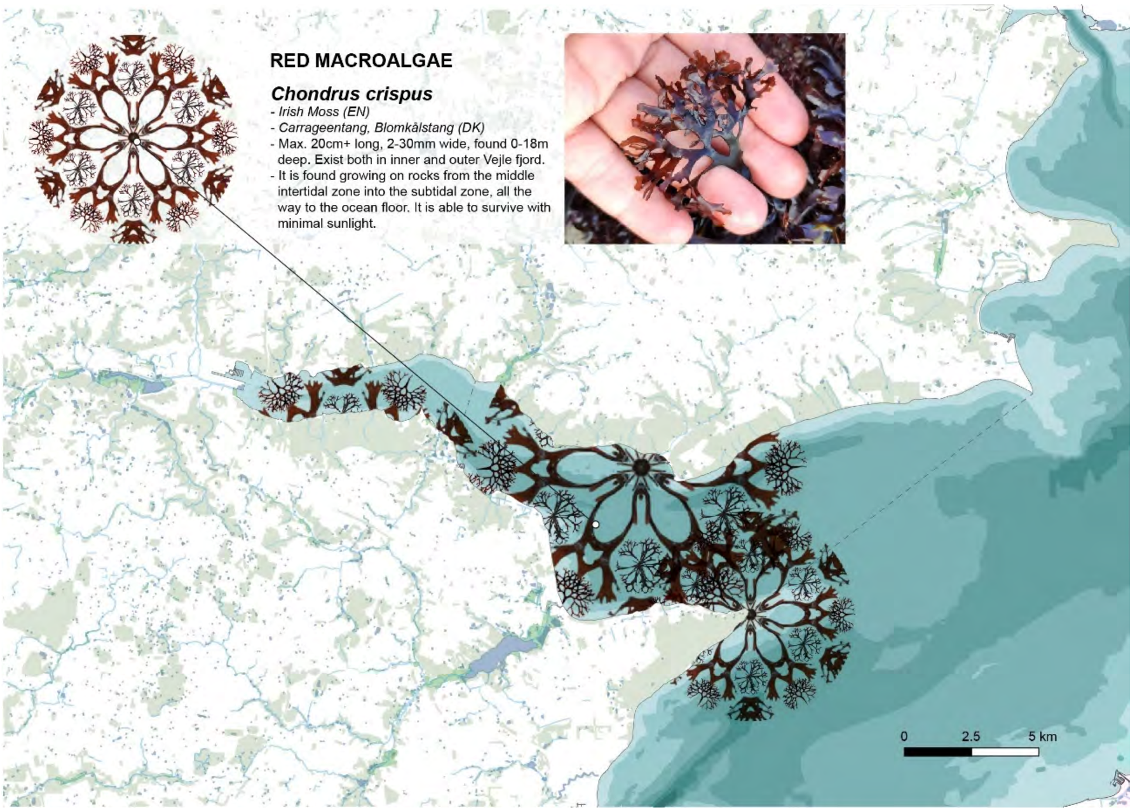
width of the fjord, blocking the passage of storms from reaching to the city. This could also pose a conflict in the future as Denmark and the EU is pushing for the increase of cultivation of marine life such as seaweed as a sustainable resource (Danmark and Ministeriet for Fødevarer, Landbrug og Fiskeri, 2010; Buschmann et al., 2017; Holdt, n.d.).

While Kanten/The Edge competition focused on the immediate boundary between city and sea in Fjordbyen, it becomes increasingly clear when engaging at a Fjord scale how NbS with seaweed, such as kelp with wave attenuating properties (and other benefits[223] for fuel, feed, fertiliser or food), are impossible to employ in the shallow waters of the inner fjord. This is because kelp requires deeper, colder water with stronger currents and higher salinity levels, such as conditions in the mid to outer Vejle fjord (see Figure 148). Therefore, working with kelp for coastal protection and/or climate mitigation necessitates expanding the site of intervention from the Kanten/The Edge scale to the mid-outer fjord.



223 However, for kelp to be cultivated at a large scale in Vejle Fjord to be used as fuel, feed, fertiliser or food to limit the water pollution and clear the water, it is currently not economically viable due to the high labour costs and low market demand in Denmark (Hornbek Nielsen, 2020; Boderskov, 2021). This highlights the problem with the current economic models (refer to discussion on Capitalocene in section 1.3) that prevent more eco-friendly solutions with diverse benefits from being implemented. Therefore, intrinsic values proposition of ecosystems needs to play a strong role in the future to aid green transition and climate mitigation.


BROWN MACROALGAE
Laminaria saccharina
- Suger kelp (EN)
- Sukkertang (DK)
- Max. 1-4m+ long, 10-30cm wide, found 1-30m deep. 3-5 years life cycle.
- Located in the mid-outer Vejle Fjord
- Grows in nutrient rich, cold saltier waters (Salinity level: 15PSU), sheds their blades in winter. Attaches to rocks, other hard substrates.
0
2.5
5 km


RED MACROALGAE
Chondrus crispus
- Irish Moss (EN)
- Carrageentang, Blomkålstang (DK)
- Max. 20cm+ long, 2-30mm wide, found 0-18m deep. Exist both in inner and outer Vejle fjord.
- It is found growing on rocks from the middle intertidal zone into the subtidal zone, all the way to the ocean floor. It is able to survive with minimal sunlight.
0
2.5
5 km

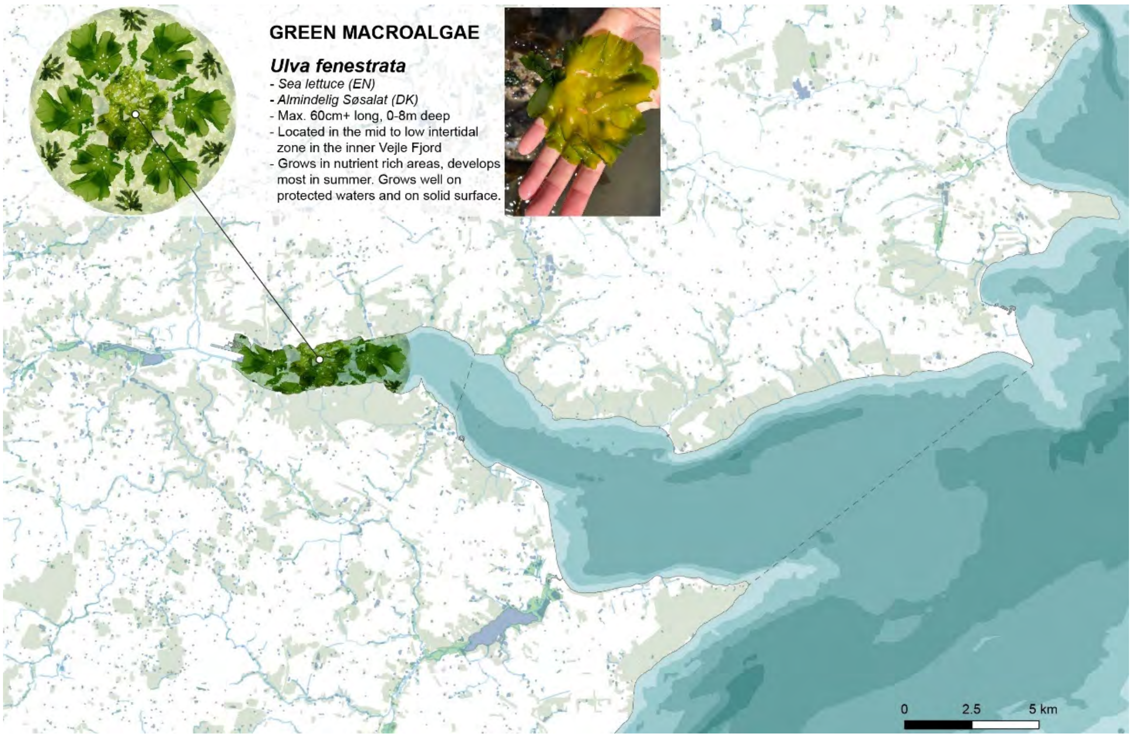
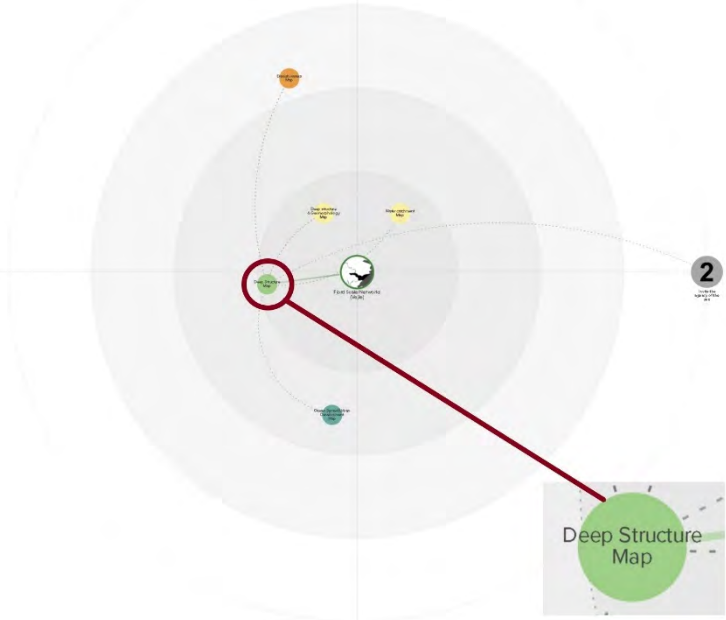


Figure 148. Screenshot from the Fjord scale node in the Kumu map isolated to show its connections to other corresponding nodes. (Kumu, 2020).
Fifty-nine different species of macroalgae have been recorded to be found in Vejle Fjord based on a study by Lundsteen and Nielsen (2019a, 2019b). The maps above show representative red macroalgae, green macroalgae and brown macroalgae in Vejle with relevant information on where they are likely to be found, what conditions they require to grow, how big they grow and the scientific and common name of the specific seaweed specie. Some seaweed species are only found in the inner fjords, while others are only in the mid-outer fjord's deeper waters.
For a full list of seaweed potentially available in Vejle Fjord, refer to Appendix 13 (Lundsteen and Nielsen, 2019a; 2019b). The map is made with the data from Miljø GIS and a study by Lundsteen and Nielsen (2019a, 2019b).

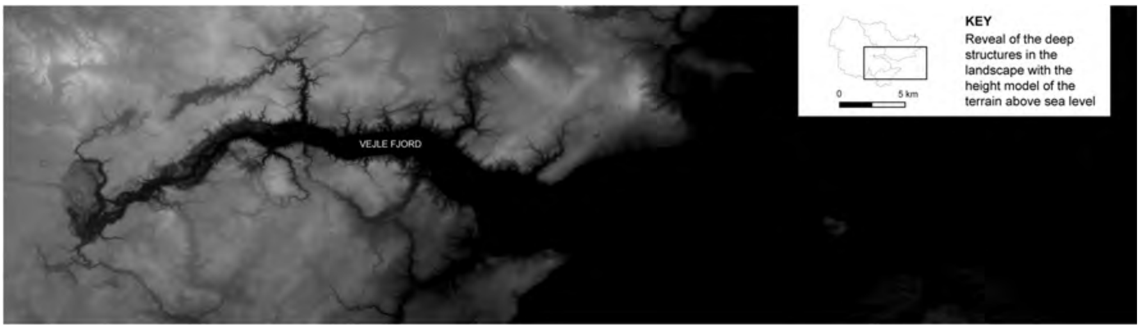
Exploring the potential of integrating seaweed as part of Kanten/The Edge's coastal development pushes the site from the edge to the zone – further out into the fjord but also further into the landscape to consider the water networks of river valleys. Vejle Municipality has already been conceiving the fjord not as a separate entity but in connection to the rivers (as shown in Figure 149) (refer to the workshop with Vejle Municipality Table 16 in Appendix 12). This conception is in line with the deep geological structures that show that while the city may stop at the water's edge, the deep structures of the river valleys continue along the fjord into the land connected to the river valleys (see Figure 149). Furthermore, Vejle Municipality also acknowledges that Vejle is not just a coastal city at the bottom of the river valley but rather a group of other areas/boroughs/suburbs, as shown in Figure 149. Thus, Vejle does not only refer to the historic city centre, the waterfront/harbourfront area of Fjordbyen, but also the surrounding satellite suburbs, which tend to be forgotten as part of the city's identity. Therefore, there is potential for redirecting urban development in the future to higher areas while the flood-risk areas are commissioned for "degrowth".


Deep Structure Map
Figure 1: Water risk map (SOURCE: TERRAIN MAP, DENMARK'S HEIGHT MODEL 2016-04-13, PLANDATA.DK, KLIMATILPASNING.DK, SDFE) ©Styrelsen for Dataforsyning og Effektivisering ©Geodatastyrelsen (From AAA document on East Jutland reference property)
SHOW THE GROUND WATER CONDITIONS AS WELL?
(include sectional diagram from the master students at AAU)
• Deep structures showing topography of Vejle (as a bath tub directing the water down from the valley)
• SLR and SS scenarios (SLR less of an issue in Vejle than SS but SLR will exasperate the impact of SS). 1.5m above the current normal water line is the rough tipping point where the city gets inundated.
• Ground water depths
• Flooding history?
• Topography/bathymetry
• Coastal erosion is not an issue in Vejle for now
• Infiltration map impermeable surfaces
Analysis:


2
Deep Structure Map


Thyregod
null
Vonge-Kollemorten "Hatten"
Give
Givskud
Farre
Hovedkær
Holtum
Gadbjerg
Jelling
Hornstrup
Assendrup
Vandel
Randbøldal
Søndermarken
Brejning
Ødsted-Jerlev
Egtved
Smidstrup
Børkop
Ågård, Gravens og Øster Starup


Grejs Ådal (river valley)
Vejle Ådal (river valley)
Vejle Fjord
Højen Ådal (river valley)
Egtved Ådal (river valley)


VEJLE FJORD
KEY
Reveal of the deep structures in the landscape with the height model of the terrain above sea level
0
5 km

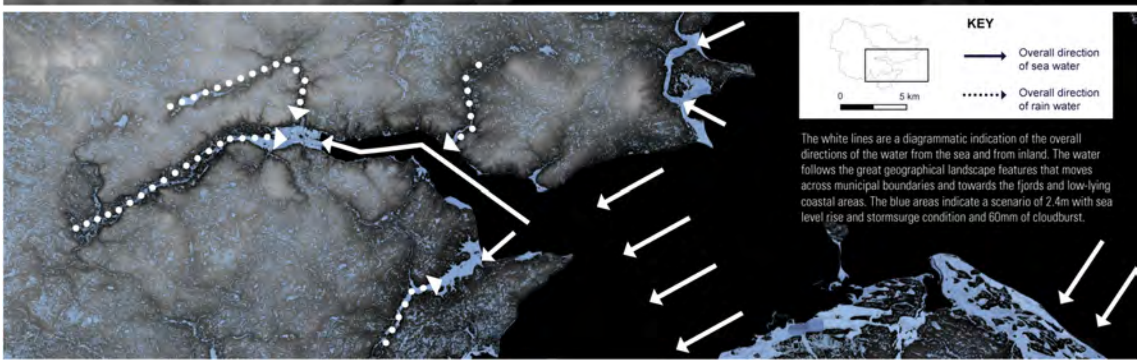

KEY
Overall direction of sea water
Overall direction of rain water
0
5 km
The white lines are a diagrammatic indication of the overall directions of the water from the sea and from inland. The water follows the great geographical landscape features that moves across municipal boundaries and towards the fjords and low-lying coastal areas. The blue areas indicate a scenario of 2.4m with sea level rise and stormsurge condition and 60mm of cloudburst.

Figure 149. (Top image) Screenshot of Kumu map of the Fjord scale node isolated to show its connections to other corresponding nodes (Kumu, 2020).
(Second row of images) Vejle also consists of many other districts/boroughs surrounding the historical city centre and Fjordbyen. Image credit: Vejle Municipality.
(Third row of image) Vejle Municipality's conception of the Vejle Fjord in connection to its river valleys. Seeing Vejle fjord as an inter-connected water body. Image credit: Vejle Municipality (2019).
(Fourth and fifth row of images). Black-and-white terrain imagery shows that Vejle Fjord is a continuation of the river valley deep into the landscape. The water pushes inwards from the sea and outwards from the hinterlands through the passageways indicated by the deep structures of the land. Image credit: (translated from) Wiberg and Odgaard (2019).

4.1.4 Watershed (regional) scale/networks

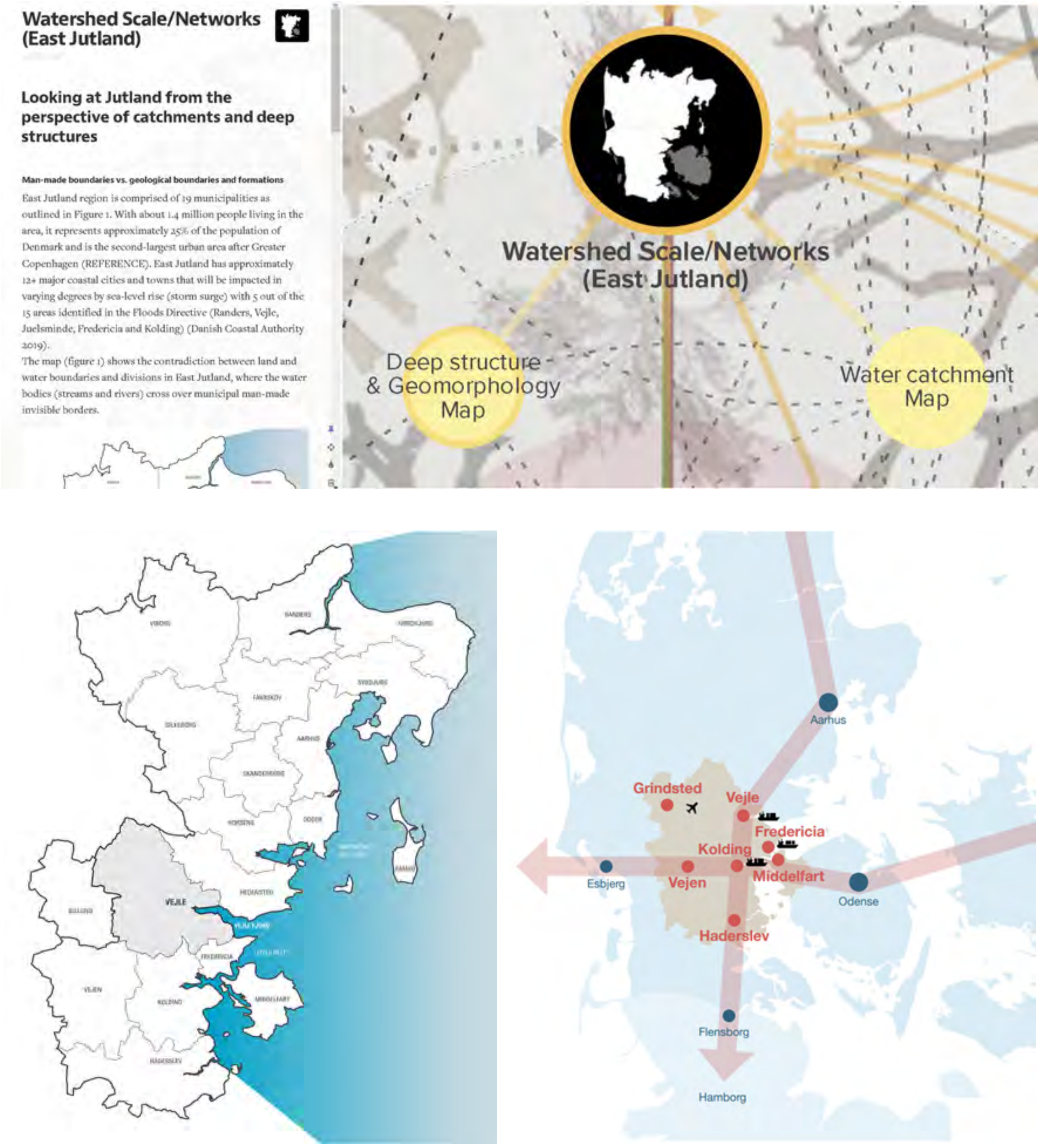
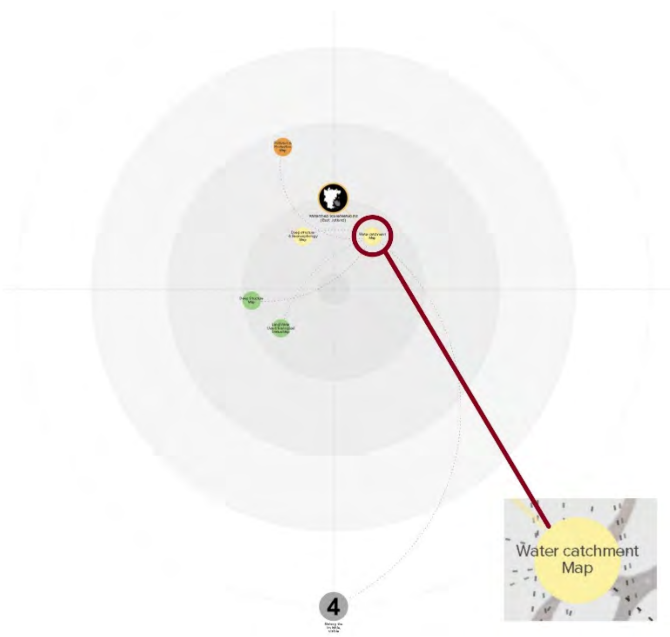
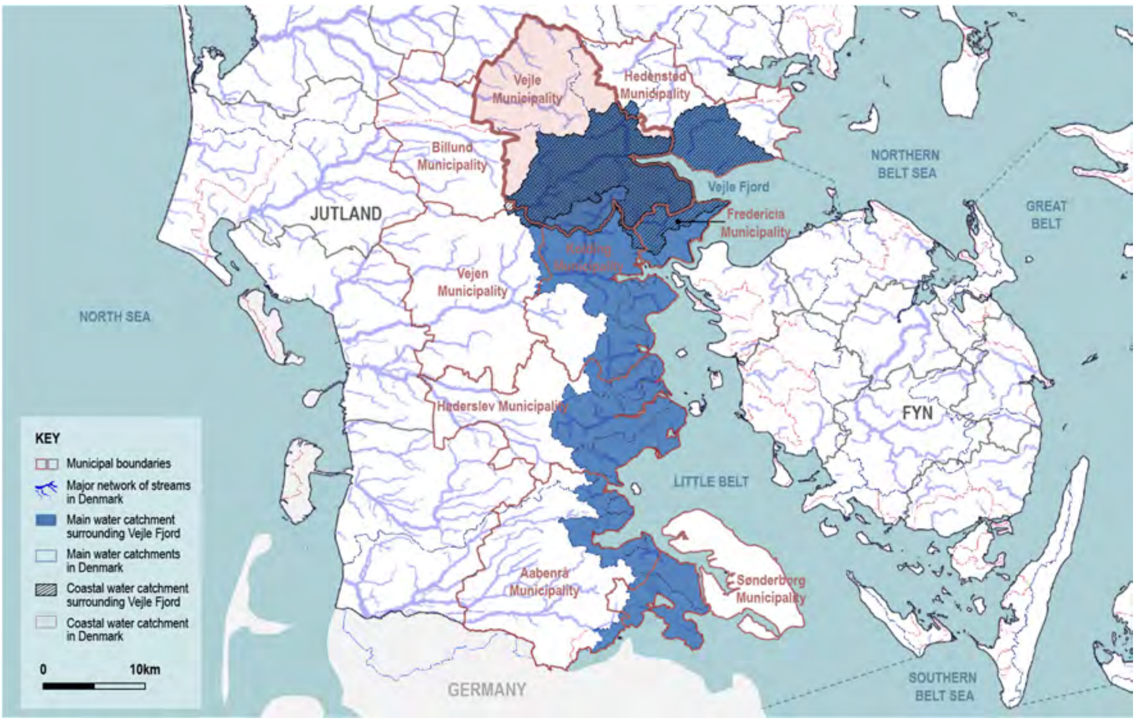


Figure 150. (Top image) Kumu map at a watershed/catchment scale and its relationship back to Kanten/The Edge scale. It encompasses two nodes, such as maps pertaining to issues around the deep structures and geomorphology of the area surrounding Vejle fjord and the water catchment/watershed areas that determine the flow of pollutants into the fjord (Kumu, 2020).
(Bottom Left image) The boundary of East Jutland has 19 municipalities, making up 24% of the Danish population (Odgaard, 2019). Image credit: (Odgaard, 2019).
(Bottom Right image) Within East Jutland, Vejle is part of the "Triangle Area" (Trekantområdet) that consists of seven municipalities (Vejle, Kolding, Fredericia, Middelfart, Billund (Grindsted), Vejen and Haderslev, which is an inter-municipal business region. It facilitates collaborations between companies, municipalities, and educational institutions in this region. Image credit: (Trekantområdet Danmark, 2021).
(Extracted from Kumu Multiscalar map – Wateshed scale node)

Zooming out once more – from the Fjord scale to the catchment scale – we note that Vejle is situated in the East Jutland region, which consists of 19 municipalities, as shown in Figure 150. Vejle Municipality is also part of the "Triangle Area" (Trekantområdet), an inter-municipal business region of seven municipalities that facilitates collaborations between companies, municipalities, and educational institutions. Importantly, these municipal boundaries and inter-municipal collaborations bear no correlation with issues regarding water, as water networks such as rivers and streams crisscross arbitrary and invisible land-based borders, as shown in the watershed/catchment scale in Figure 151. Moreover, the watershed/catchment area becomes particularly relevant when addressing water pollution and flooding. Because Kanten/The Edge proposals needed to limit water pollution[224] in Vejle Fjord, coastal catchment areas become relevant and paramount to address. As shown in Figure 151, the coastal catchment area envelops three main municipalities of Fredericia, Hedensted and Vejle, which all envelops Vejle Fjord via land borders. This means that by looking from the water's (and NbS) perspective, initiatives that concern at Kanten/The Edge scale would require inter-municipal collaboration with Fredericia and Hedensted, challenging the notion of terrestrial borders and responsibility.



224 For instance, there has been a proposal to limit the use of artificial fertilisers within 300m from the coast (in the watershed), which is a proposal that has been declined (Hedrup, 2021).


Vejle Municipality
Hedensted Municipality
Billund Municipality
JUTLAND
Vejle Fjord
Fredericia Municipality
Kolding Municipality
NORTHERN BELT SEA
GREAT BELT
Vejen Municipality
NORTH SEA
Haderslev Municipality
FYN
LITTLE BELT
Aabenraa Municipality
Sønderborg Municipality
GERMANY
SOUTHERN BELT SEA
KEY
Municipal boundaries
Major network of streams in Denmark
Main water catchment surrounding Vejle Fjord
Main water catchments in Denmark
Coastal water catchment surrounding Vejle Fjord
Coastal water catchment in Denmark
0
10km


Vejle Fjord
Kolding Fjord
Little Belt
Haderslev Fjord
Aabenrå Fjord
Flensborg Fjord


Horsens
Hedensted
Vejle
Vejle Fjord
Fredericia
Kolding
Haderslev
Aabenraa

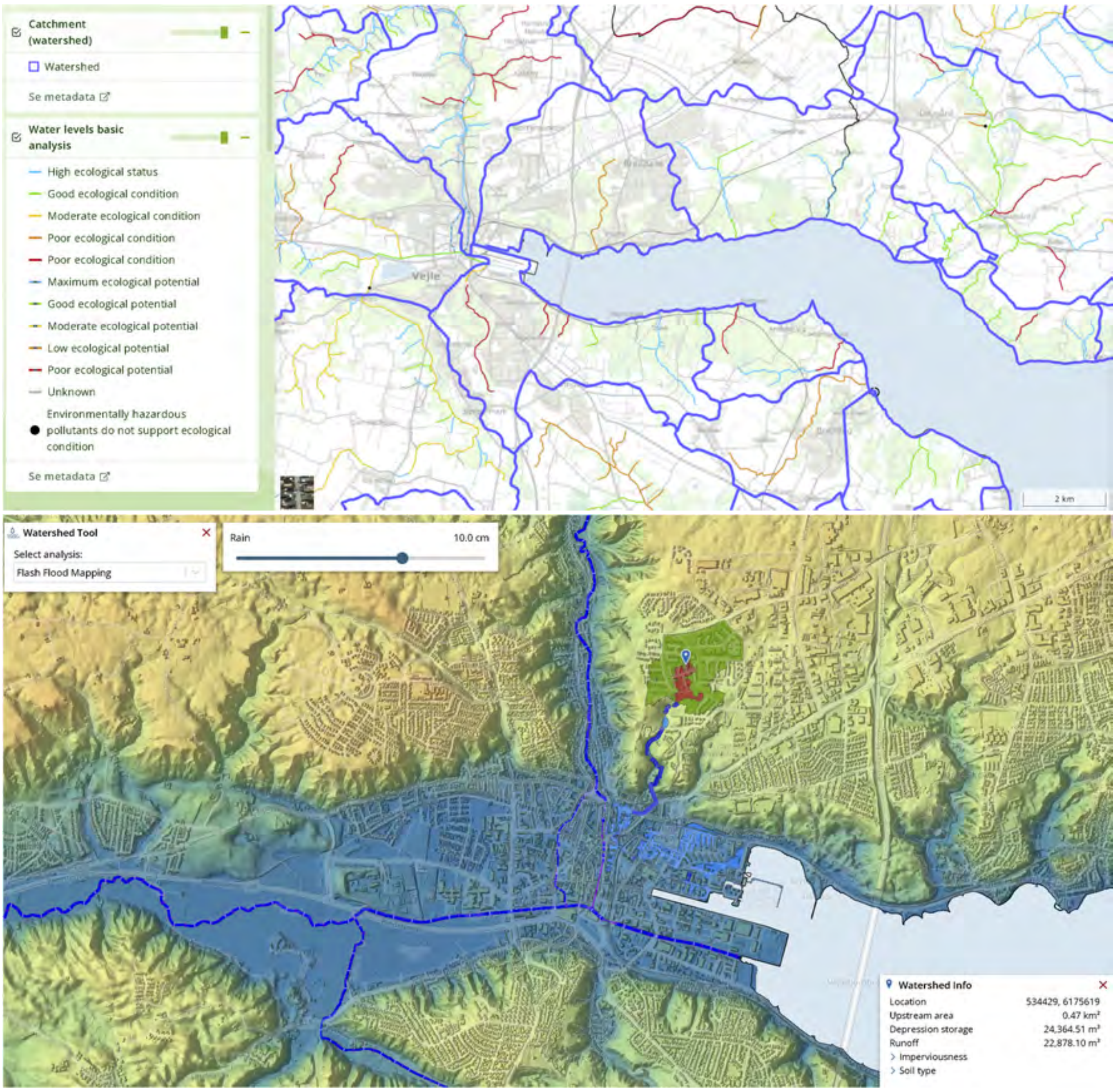


Figure 151. (Top image) Screenshot of mini-node Water catchment map from Kumu, isolated to show its connections to the "Pollution & Protection" mini-node from the National scale and "Land/Water Use & Ecological Status" mini-node from the Fjord scale etc. (Kumu, 2020). The map is made with the data from Miljø GIS from Miljøstyrelsen. (Second-row image) The map combines the major rivers, the catchment area for Vejle Fjord (shaded in dark blue) and Little Belt/Lillebælt (shaded in blue), against the municipal boundaries (in red), which bears no relationship to the water networks nor the catchment areas. GIS source: (Miljøstyrelsen, 2016; 2022c) and Vandløbsdata (Miljøministeriet Kystdirektoratet, 2018).
(Third-row image - Left) The map shows the major fjords on the Eastern coast of Jutland and its main catchment/watershed area with its main rivers. The catchment area is for the Little Belt Sea (Lillebælt). The topography of the land (its deep structures) influences the size of the watersheds. The pollutants travel along the water networks that consist of rivers and streams that eventually end up in the sea. Image credit: The water and the land are coloured to clarify the distinction. Image from Miljøministeriet Miljøstyrelsen (n.d.) and GIS data from Miljøstyrelsen (2016).
(Third-row image - Right) The map shows the catchment area for Vejle Fjord (in red). GIS data is from: Miljøstyrelsen (2016).
(Fourth and Bottom image) The bigger water catchments (i.e. Vejle fjord) can be further broken down into smaller catchments which can determine more tangible areas for designers to work with. GIS source: Klimatilpasning - KAMP (n.d.) and SKALGO (n.d.).

4.1.5 National water scale/networks

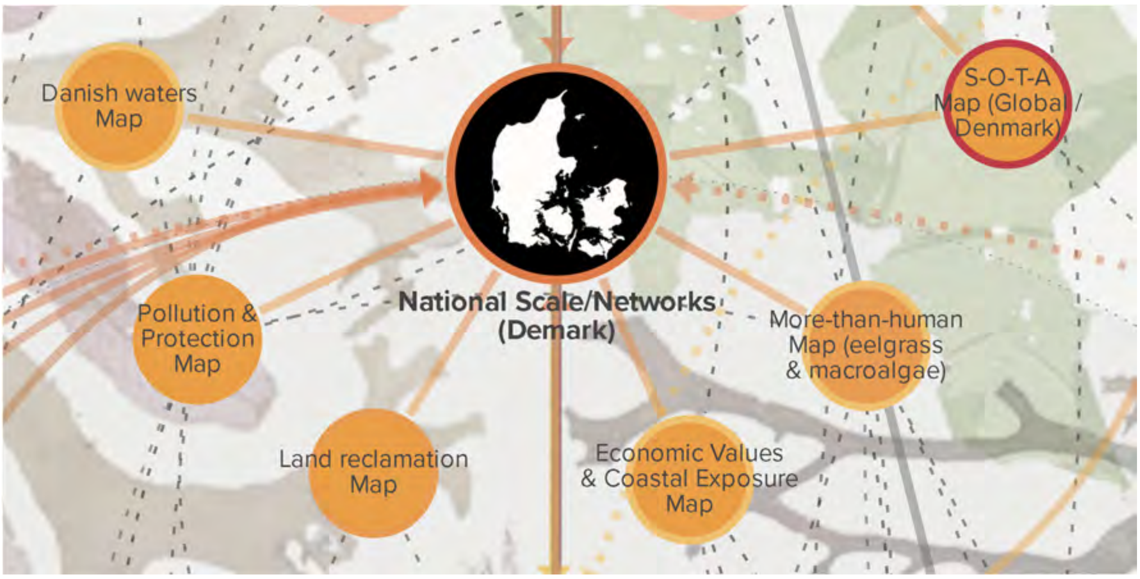


Figure 152. Screenshot of the Kumu map at a national water scale/network (Kumu, 2020). It encompasses six mini-nodes, such as maps pertaining to issues around the current ecological status of Danish national waters, its Marine Protected Areas, the history of land reclamation, the coastal areas at risk and their economic worth, a map of the current state of marine vegetation in Danish coastal waters, and the state-of-the-art (SOTA) projects hosted in Kumu Map 2.

Moving from the regional to the national, it becomes evident that the coastal cities in the East coast region of Denmark face a similar fate to SLR and SS as Vejle. The East coast of Jutland has a high concentration of economically valuable cities but a lower "natural value" (such as forests, eelgrass, marsh, etc., as shown in Figure 153) (Faragò et al., 2018). Therefore, the East coast cities pose a challenging site for introducing marine nature as there is a stronger priority to protect economic interests. Moreover, the East coast of Jutland has relatively smaller and milder storm surges than the wilder west coast (as shown in Figure 153). This is because storm surge on the east coast is induced by the rapid rise of water from the Baltic sea that is flushing back out into the Atlantic, as shown in Figure 153. This means wave attenuating properties of nature-based solutions have less relevance compared to the west coast cities that could benefit more from them (Boderskov, 2021). However, this also means that the NbS on the east coast need not be as resilient[225] to withstand strong forces as the west coast; therefore, NbS are less likely to be damaged after a major

225 For instance, young eelgrass plantations may need artificial structural support to prevent them from being rooted in a storm and for seaweed (kelp) grown on floating buoys (which are better at mitigating the strength of waves than those from rocks from the sea bed as discussed in section 1.5.2) need to have stronger structural systems that are better anchored to the seabed to prevent them from being destroyed in a storm. Therefore, learnings from Kanten/The Edge competition entries are not all transferrable as general knowledge as these contexts specific criterion heavily determine the design solutions.

storm to recover. Nevertheless, the strength and frequency of storm surges will likely increase on the East coast (refer to section 3.1.2).

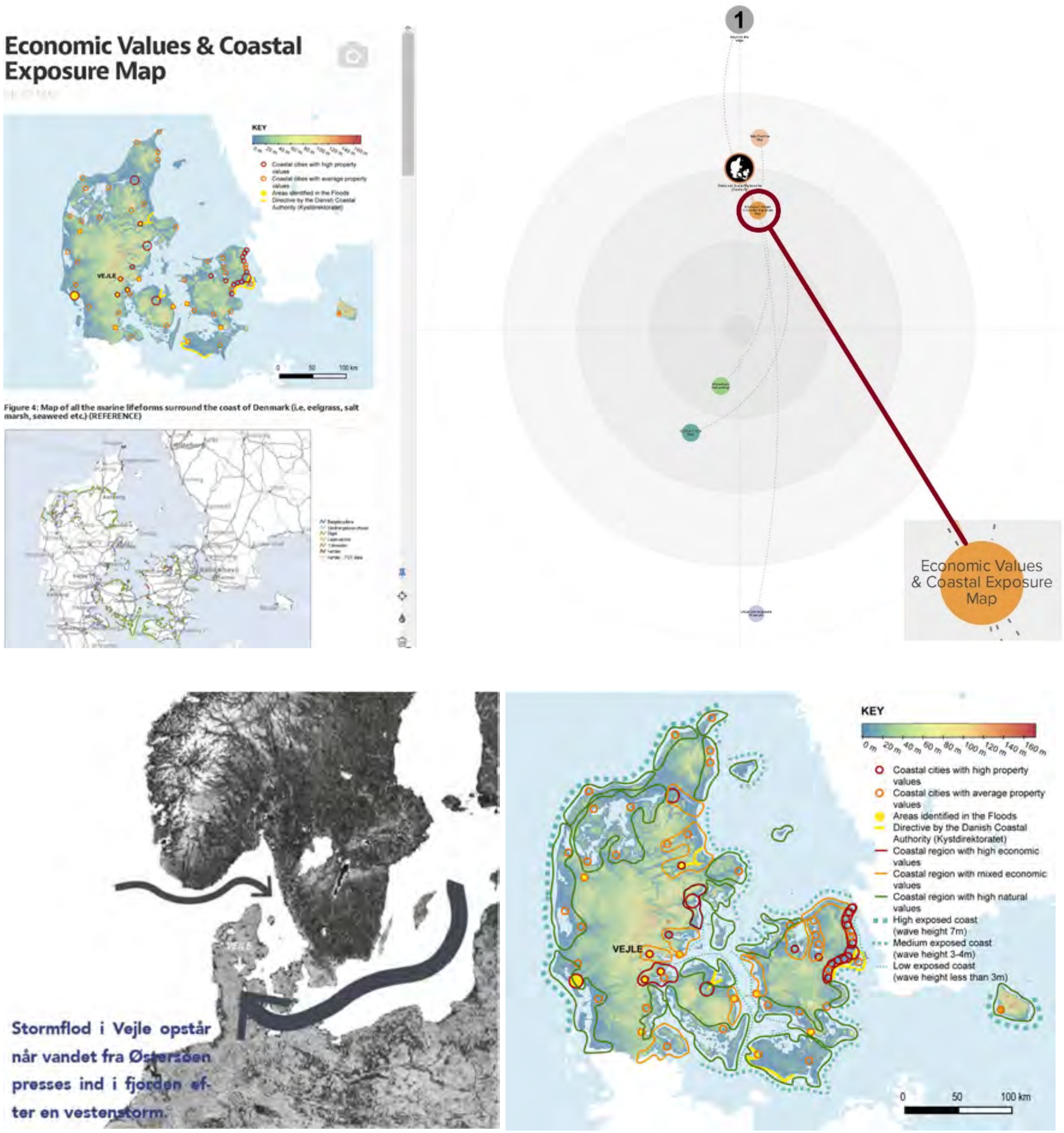


Figure 153. (Top image) Screenshot of mini-node Economic values & Coastal exposure map from Kumu isolated to show its connections to other corresponding nodes (Kumu, 2020).
(Bottom left image) A storm surge in Vejle occurs when large quantities of seawater from the Baltic Sea are forced into the fjord after a western wind storm has pushed water into the Baltic Sea (considered more of a “silent” storm surge event where the water level rises rapidly as the seawater flushes out from the Baltic Sea out into the North Sea). Image credit: Vejle Municipality (2020).
(Bottom right image) Map showing all the coastal cities with average to high property values, all the Coastal Directorate’s risk cities, the strength of waves and the coastal regions with low to high natural areas. Map made with GIS data from SKALGO (n.d.), Eva Sara Rasmussen, Faragò et al. (2018) and Tougaard (2006).

A unique opportunity lies in east coast cities, where smaller tidal variances and waves mean that the coastal protection system need not be as high, presenting calmer and safer water conditions. Furthermore, these conditions can enable a different type of engagement between land and sea, human and non-human, on the urban shorelines, where people can get closer to the water, as water does not pose a danger in the same way. For designers (LUDP disciplines), it presents an opportunity to explore alternative spatial engagement with the water that is more tactile (i.e. refer to the "On Water" artistic bridge installation in Munster – see Figure 90) and even bringing the water closer into the city (i.e. refer to the Membrane project for Kanten/The Edge - see Figure 116).

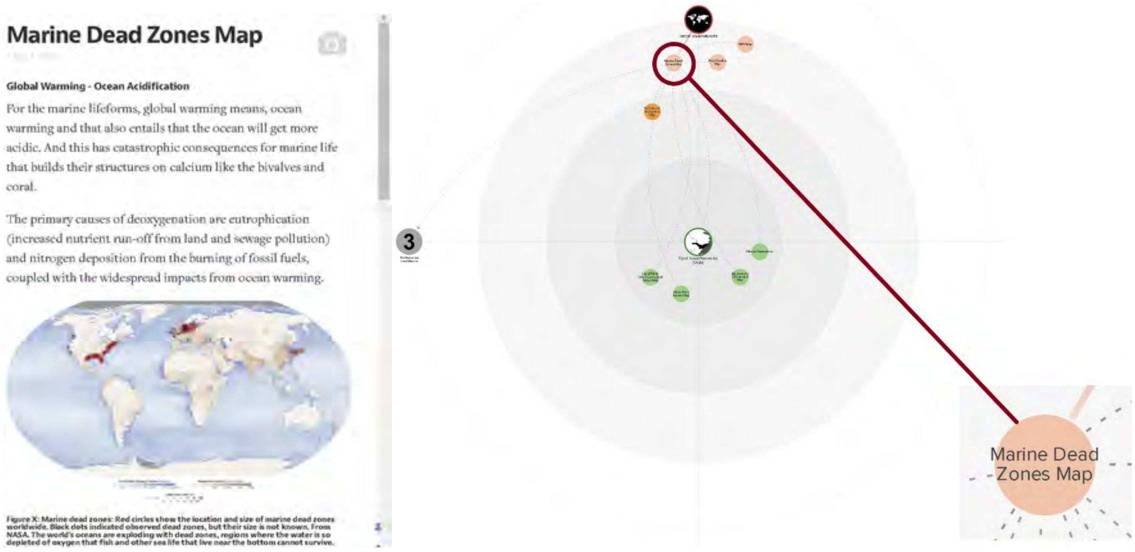
4.1.6 Global water scale/networks

Figure 154. Screenshot of the Kumu map at a global scale and its relationship back to Kanten/The Edge scale (Kumu, 2020). It encompasses four mini-nodes, such as maps pertaining to issues around sea level rise, marine dead zones, global kelp decline and marine protected areas.

Shifting from the national to the global, the trajectory of global GHG emissions in the next decades will determine how high sea levels will rise and how frequent and violent storm surges will be, with varying degrees of impact on local coastal cities such as Vejle. Since we are on the path to a B-A-U climate emission scenario (i.e. worst-case scenario as discussed in section 3.1.2), the current coastal protection level of 2.5-3m in Vejle would help protect against immediate storm surges, but it may be futile in the long run, especially without serious efforts to reduce, mitigate and sequester carbon on a global scale. These global issues require global efforts and accumulative efforts from different local places. Vejle's Kanten/The Edge has relevance as an experimental case study that could provide a precedent for other coastal cities in Denmark and abroad to proactively implement nature-based solutions as part of their approach to coastal adaptation and climate mitigation. Looking at the issue from a global scale focuses on the importance of climate mitigation, which highlights the role of seaweed in another light. While seaweed as NbS is limited in protecting coastal cities from sea level rise and storm surge[226], they are effective as blue carbon, water filtration, increase in biodiversity (habitat creation), and as a more sustainable source of food, feed and (bio) fuel (as addressed in section 1.5.2). Therefore, the ecosystem services provided by seaweed could play a key role in the green transition in Vejle, thus, should be more proactively included in future coastal adaptation and mitigation strategies, despite the current focus on coastal protection.

226 This is particularly the case in the east coast of Denmark where the storm surge waves are not as violent as west coast, thus, the wave attenuating capacity of NbS from seaweed may not be as impactful.

Without serious efforts to reduce and capture carbon, nature in Vejle could be seriously compromised in the future. This is particularly the case because climate change is accelerating marine dead zones due to ocean warming[227], acidification, eutrophication and glacial melt, contributing to desalination, as shown in Figure 155. Moreover, the coastal waters of Denmark are in worse conditions compared to the rest of the world[228] (see Figure 155). These data indicate the urgency of addressing the dire condition of coastal waters and that the future success of marine NbS in Vejle depends on efforts from a global to a local level[229]. Furthermore, Vejle can contribute to the current global and national goal to increase Marine Protected Areas[230] from 4.8% to a minimum of 10% in Denmark and 30% globally by 2030 (United Nations, 2019; Woollhead, Petersen and Normander, 2020) by expanding the marine protected area to cover the entire Vejle fjord and giving the current Wild and Nature Reservation in Vejle Fjordbyen a proper IUCN certified status[231].



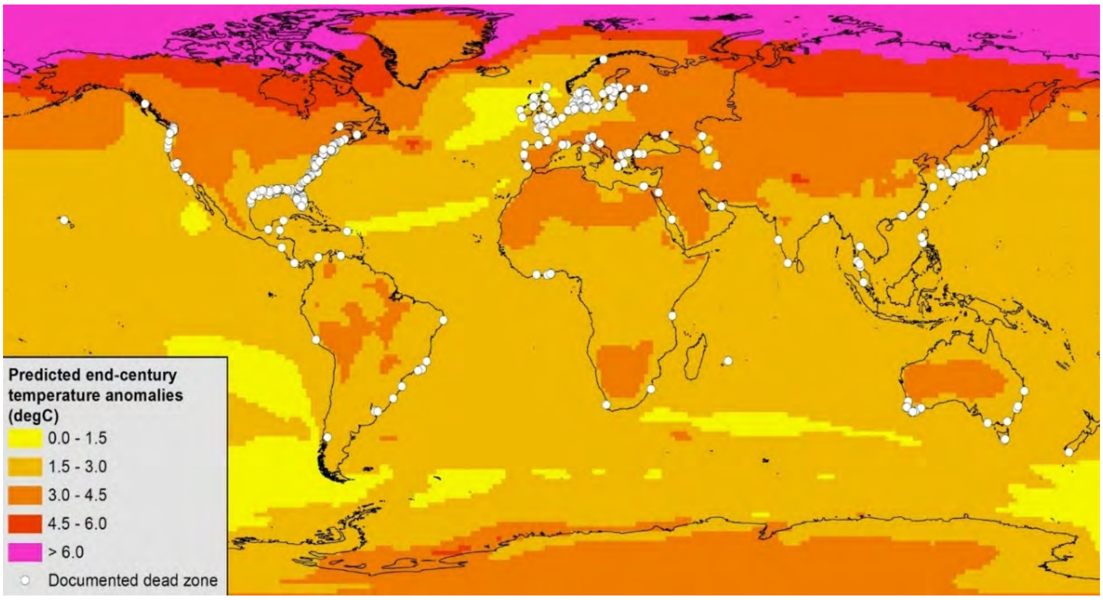
227 Ocean warming is already pushing kelp species to migrate to colder waters (refer to Figure 12 in Section 1.5), where new seaweed species may arrive on Danish shores in the future, transforming coastal nature for better or worse. Current seaweed species in Vejle may not be able to withstand the changing climatic conditions in the future, which may require human interventions such as in the form of new artificial structures that could help these coastal ecosystems to adjust to worsening conditions (i.e. kelp on floating buoys that could be lowered to colder temperatures during heat waves (Boderskov, 2021)).

228 This is due to higher agricultural activity in Europe with high demand and production but it could also be due to the availability of data in these areas compared to other parts of the world.

229 This type of global to local thinking has been explored through the discussion on the Anthropocene by the second winning entry: "while we wait for the water" in section 4.1.1.

230 A new report by Woolhead et al., 2020 shows that approximately 40% of 332 designated Danish marine protected areas (MPAs) do not meet international criteria for nature conservation. According to UN Sustainable Development Goal 14, a minimum of 10% of coastal and marine areas must be protected. This report documents that Denmark currently has 4.8% marine protected areas and is therefore only halfway (NaturTanken, 2020; Woollhead, Petersen and Normander, 2020).

231 Currently the Wild and Nature Reservation (Vejle Inderfjord Vildtreservat) in the inner Vejle fjord does not qualify for the IUCN category for MPA (International Union for Conservation of Nature). In the Lillebælt/Little Belt sea, only 5.1% of the total area are MPAs which meet the IUCN standard which needs to be increased (Woollhead, Petersen and Normander, 2020).



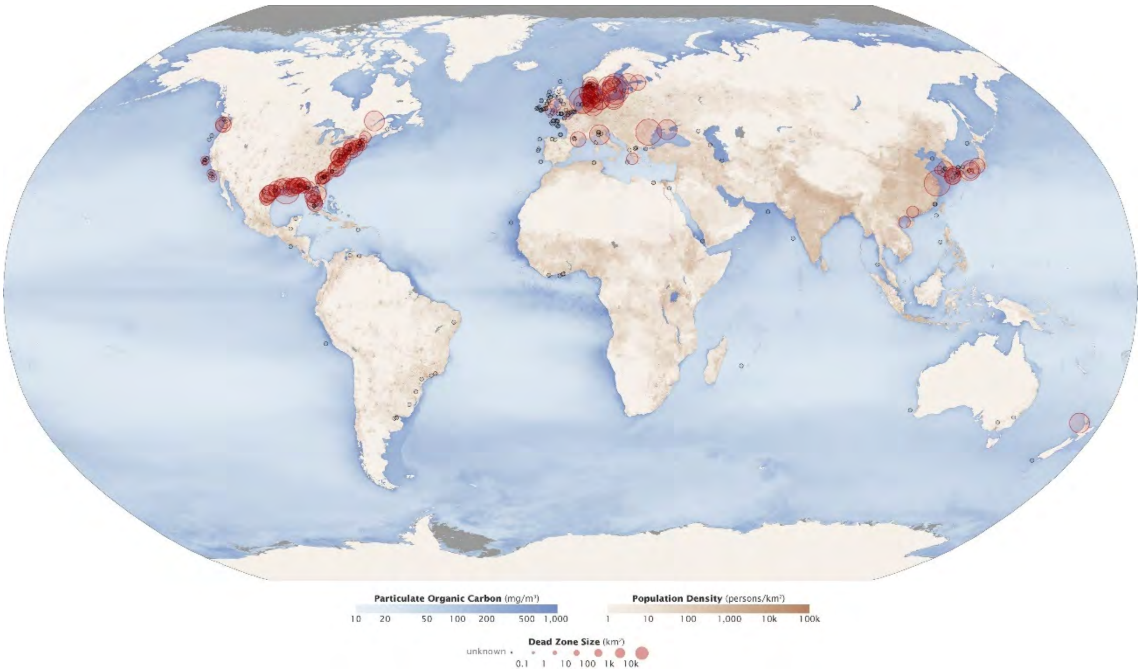


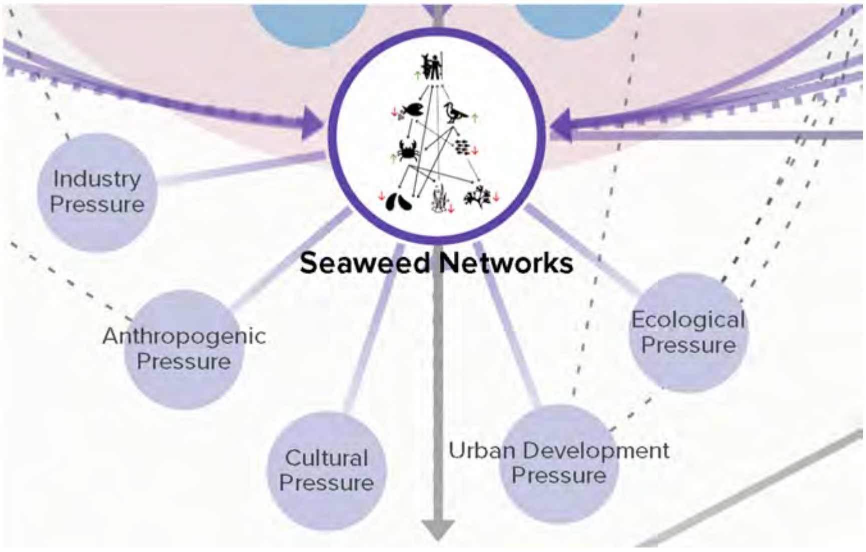
Figure 155. (Top image) Screenshot of mini-node Marine dead zone map from Kumu map isolated to show its connections to other corresponding nodes (Kumu, 2020).
(Middle image) Map of known dead zones in relation to predicted changes in annual air temperature based on the intermediate A1B Scenario predicted to end-century (2080–2099) (Diaz and Rosenberg, 2008; Altieri and Gedan, 2015). (Diaz & Rosenberg, 2008; NCAR GIS, 2012).
(Bottom images) The number and size of marine dead zones have doubled each decade since the 1960s, mostly due to agricultural pollution. They are concentrated on the East coast of the U.S. and Europe (Spector, 2013).

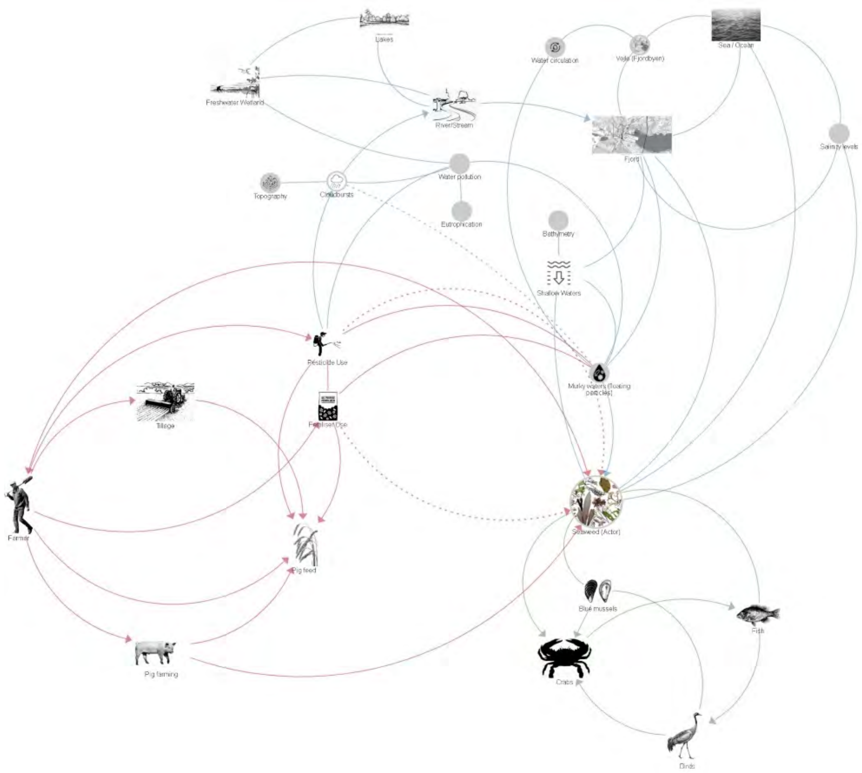
As addressed in section 3.2.5, concepts such as Archipelagic thinking could be an important narrative framework to help understand this global-local interrelation through the water as a connecting network that binds the fate of all coastal cities. Archipelagic thinking is one productive way of thinking about the potentially far-reaching impact of Kanten/The Edge beyond its immediate context of Vejle.

4.1.7 Seaweed networks

The First Law of Ecology: Everything Is Connected to Everything Else.

One of the four informal laws of ecology by Barry Commoner, *The Closing Circle: Nature, Man, and Technology* (Commoner and Egan, 2020, p.29).





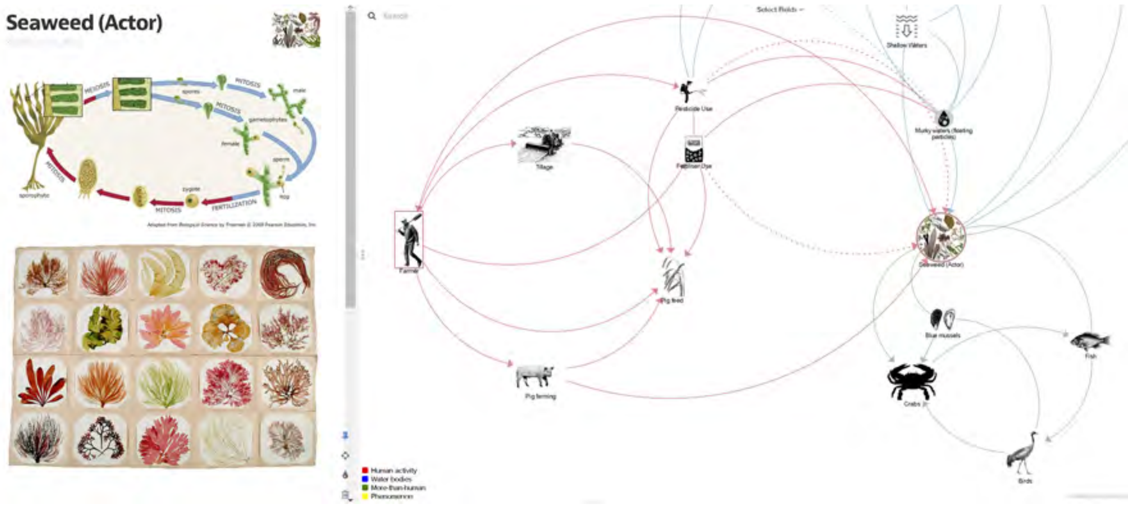


Figure 156. (Top image) Screenshot of the Kumu map at a seaweed scale and its relationship to Kanten/The Edge scale (Kumu, 2020). It encompasses five mini-nodes, such as maps pertaining to issues around industry, anthropogenic, cultural, ecological and urban development as pressures that impact marine life – such as seaweed. (Mid and Bottom image) A cyclic relational diagram (made in Kumu) of all the living and nonliving, human and nonhuman actors influencing the outcome of marine NbS in the inner Vejle Fjord (Kanten/The Edge proposals). The cyclic process above illustrates the different factors that need to be considered to implement NbS with seaweed successfully. For instance, the crab and starfish populations need to be managed → ensure the predatorial fish population is healthy → provide nurseries for the fish through stone reefs and artificial houses → ensure the water clarity is good so that eelgrass/seaweed can grow and provide habitat for fish → ensure nutrient load from agriculture (pig farming) is limited → etc.

Having gone through the micro, meso, and macro scales of the Kumu map, the final scale I will discuss in this section is unlike those addressed above, as I here focus on the intricate networks of seaweed, thus moving back again from the global to the microscopic. One of the key learnings from interviewing marine biologists is that when thinking about "Urban Seascaping" projects such as Kanten/The Edge, it is necessary to account for how complex and interrelated the ecosystems are. Simply put, when dealing with the marine realm, it is not as simple as allocating a plot of land to plant trees and flowers. The ecological collapse of the Vejle fjord happened in the eighties mainly due to agricultural activities (also commercial fishing[232]), which resulted in poor ecological conditions that destroyed crucial habitats for small fish (Fjeldsø Christensen, 2021). Only a few big predatorial fish are present to eat the crabs, resulting in an imbalanced food chain in the water (Fjeldsø Christensen, 2021) (see Figure 156). The absence of predators resulted in an explosion of crab and starfish populations that consumed vast amounts of eelgrass forests, mussel beds and seaweed as food (see Figure 157). Now, without human intervention[233] to proactively fish out these crabs and starfish, they will hinder marine nature restoration efforts by Sund Vejle Fjord (Fjeldsø Christensen, 2021).

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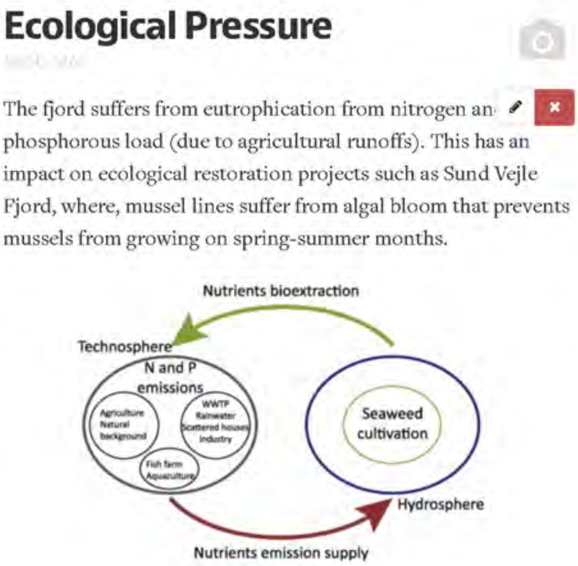
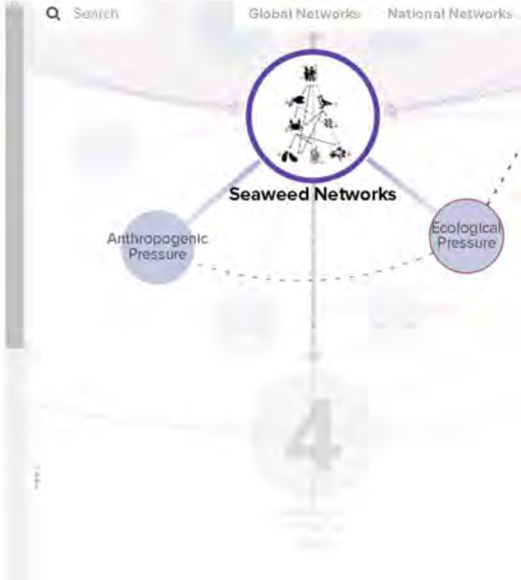
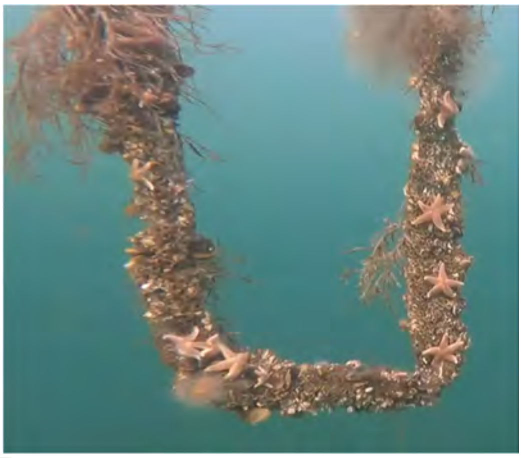
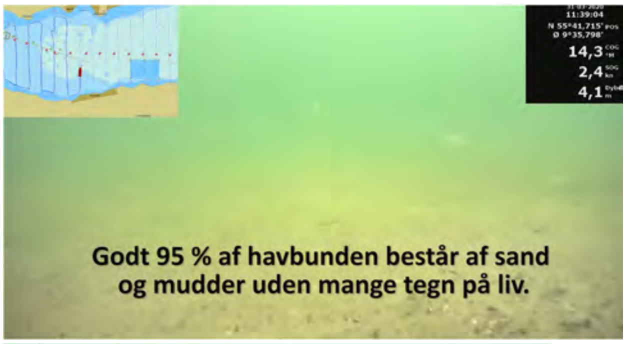
232 While commercial fishing is banned in the Wild and Nature Reservation (Vejle Inderfjord Vildtreservat) in the inner Vejle fjord, recreational fishing is not (Fishing in Denmark, 2021).

233 Due to proactive restoration efforts by Sund Vejle Fjord project, sea trout population are found to be on the rise with the fish lingering around the eelgrass meadows and new rock reefs strengthening the argument of the importance of creating habitats for the local fish stock (Sund Vejle Fjord, 2022).


Ecological Pressure
The fjord suffers from eutrophication from nitrogen an
phosphorous load (due to agricultural runoffs). This has an impact on ecological restoration projects such as Sund Vejle Fjord, where, mussel lines suffer from algal bloom that prevents mussels from growing on spring-summer months.
Nutrients bioextraction
Technosphere
N and P emissions
Agriculture
Natural background
WWTP
Rainwater
Scattered houses
Industry
Fish farm
Aquaculture
Seaweed cultivation
Hydrosphere
Nutrients emission supply


Search
Global Networks
National Networks
Seaweed Networks
Anthropogenic Pressure
Ecological Pressure




Godt 95 % af havbunden består af sand
og mudder uden mange tegn på liv.


Her er formålet, at skabe så stor en stenoveraflade som overhovedet
muligt, og dermed størst mulig positiv påvirkning af havbunden.


Ud over at fungere som fæstne for tang og som skjulested for torsk,
så har de nye stenrev også en tredje vigtig funktion.

Figure 157. "The Ecological Pressure node" showcases the impacts of floating particles (agricultural runoff – Phosphorous and Nitrogen nutrients) (Seghetta et al., 2016).
(Second row of images) Due to the ecological imbalance in Vejle Fjord, there is an exploding population of crabs and starfish. Marine biologists are proactively fishing out the local crabs to help minimise the damage to new eelgrass plantations. Starfish hinders Sund Vejle Fjord's efforts to reinstate mussels on the sea bed and lines via floating buoys by eating through them[234]. Image credit: Sund Vejle Fjord (n.d.).
(Third and fourth row) Sund Vejle Fjord project documented 70 hours of video scanning the bottom of Vejle fjord; it is mostly a lifeless area with mud and sand making most of the conditions. However, areas where eelgrass, blue mussels and rock reef have been reinstated, are showing signs of improvement, where diverse marine life have come back. Due to the muddy sea bed condition of the Vejle fjord, coconut mats are used to ensure that the mussel beds do not sink to the bottom and disappear in the mud (Organo Quintana, 2020). Image credit: Sund Vejle Fjord (n.d.).
(Bottom row – Left to Right) Young eelgrass plantations are grown in containers to help them settle and grow bigger before being planted onto the seabed. Stone reefs installed in July 2022 are already showing signs of seaweed (Savtang, blæretang, Sukkertang) monitored in inner Vejle Fjord in November 2022, despite the fact that the water conditions are not good. Image credit: Sund Vejle Fjord (n.d.).
(Extracted from Kumu Multiscalar map – Seaweed scale node).

Understanding these "micro-scale" ecological food chains and their relationship to anthropogenic activities such as agriculture is necessary as they impact any NbS initiatives at Kanten/The Edge. Thus, designers (LUPD disciplines) have an important role in finding creative and artistic ways to reinstate the ecological balance in Vejle Fjord by designing *for* marine life. For instance, design proposals could aid in creating artificial nurseries for fish while preventing crabs from entering, a frame to support young eelgrass[235] plantations, hard materials and shapes that

234 Sund Vejle Fjord has been growing mussels on lines (floating buoys), so crabs can not reach them. However, what marine biologists have noticed is that due to ocean warming, the starfish eggs are spawning earlier in the season than usual (before the mussels develop to grow hard shells). Thus, these starfish eggs can attach to the mussels, grow up and eat mussels on these lines (Sund Vejle Fjord, 2022).

235 During strong storms, young eelgrass plantations struggle to withstand the impact of the force. Therefore, until they form strong roots, they need support structures that can help mitigate the impact. Furthermore, eelgrass replanting/propagation is a manually laborious task, thus, an expensive venture. It requires divers to separate existing eelgrass shoots to replant them elsewhere by hand. Therefore there is a limit to how much eelgrass people can propagate from existing adult eelgrass (Organo Quintana, 2020; Fjeldsø Christensen, 2021). For these reasons, artificial habitat/nursey created for fish (which cannot be eaten by crabs) could speed up the process and increase the success of providing protection for small fish while eelgrass plantations take longer time to mature.

respond well with seaweed, etc. These human interventions can speed up and improve the success of nature-based solutions and nature restoration efforts while finding creative ways to communicate the initiatives happening below the water (i.e. see SUPERFLEX's projects in Figure 94). It is important that initiatives like Kanten/The Edge that seek to convey marine nature to the wider public put their best foot forward to show the invisible world underneath and not be left with a lifeless marine dead zone.

4.2 MAP 3: Temporal-Projective mapping

A design proposal is seen as a collaborative, sophisticated plan for working towards what should be. Viewed in this way, it binds technical experts, students, local residents and municipal representatives with eelgrass, oyster reefs, sedimentary cycles and storm surges. Such an approach is uniquely appropriate for public landscapes, which are dynamic and temperamental, cyclical and conflicted and marked by overlapping boundaries and competing intentions. And it reorients priorities away from knowing the answer toward doing the work – the work becomes a means of discovering what we want the future to look like.

Brian Davis, *Public Sediment in Toward an Urban Ecology*
(Davis, 2016, p.233).

The intention of this section is to reconfigure the learnings from the multiscalar map into a more temporal-projective format (see Figure 158). By shifting from a spatial to a temporal perspective, it becomes possible to elucidate how the past decisions in urban development have impacted the current situation with water and how present-day decisions might influence the city's future relations. The research adopts what Wiberg et al. (2022) refer to as comprehensive long-term thinking, which engages time scales beyond this century (outlined in the methodology chapter in method section 2.3.3 Figure 48). Ultimately, the purpose of design research design is to engage in future projections that have not been created yet. The second part of this chapter will generate one possible speculative future scenario based on learnings from Kanten/The Edge competition entries, guided by the criteria set out by the Urban Seascaping proposition. Vejle's future projections (i.e. design and planning decisions) are addressed from a multiscalar approach to aid the future of green transition and coastal adaptation/mitigation by marine nature-based solutions. Importantly, the projections should not be read as the only viable solution but as one of many possibilities (scenarios) of translating the learnings into more concrete solutions. The focus of this section is the design process towards a possible outcome from the research-through-design methodology through the aid of Kumu mappings.

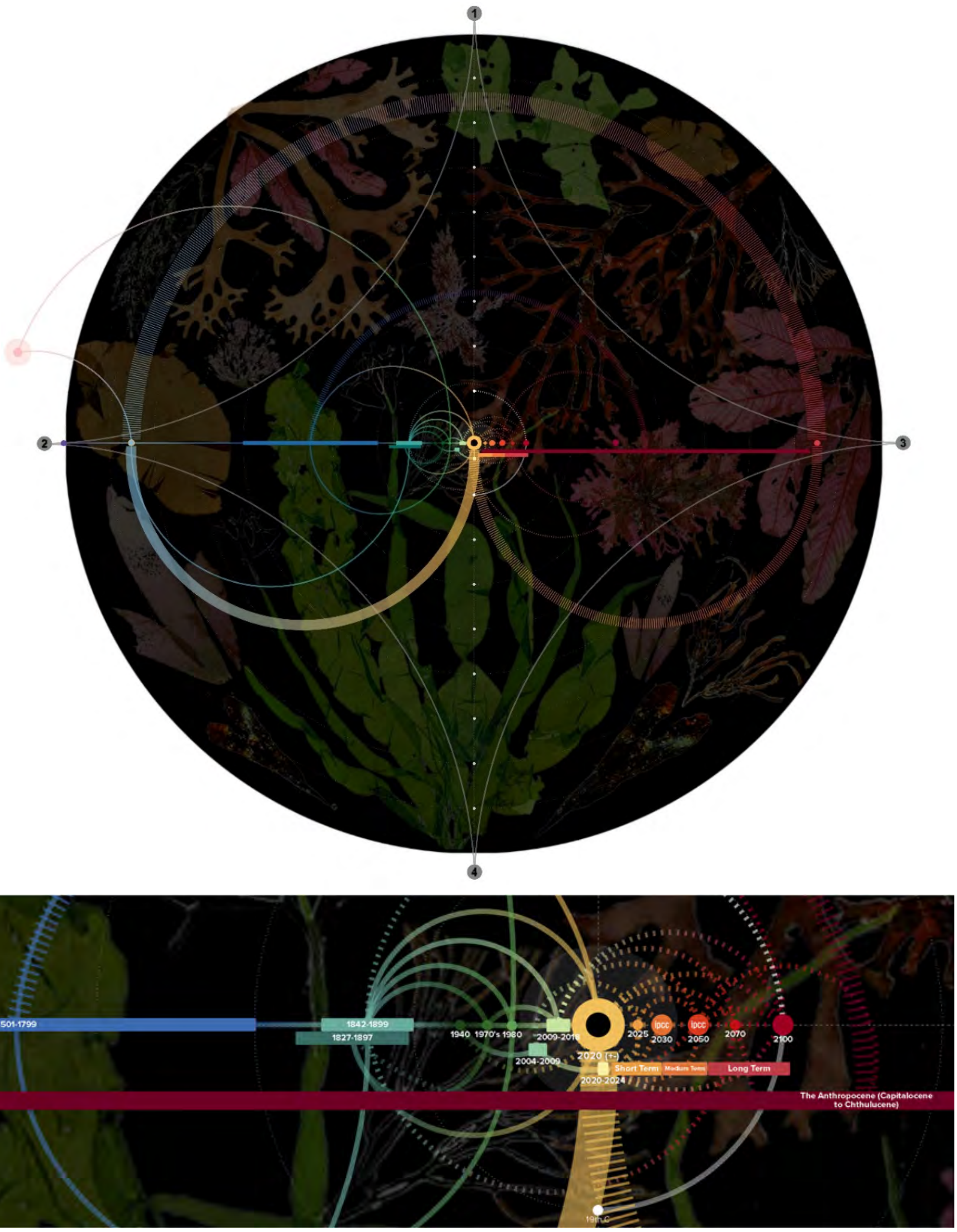
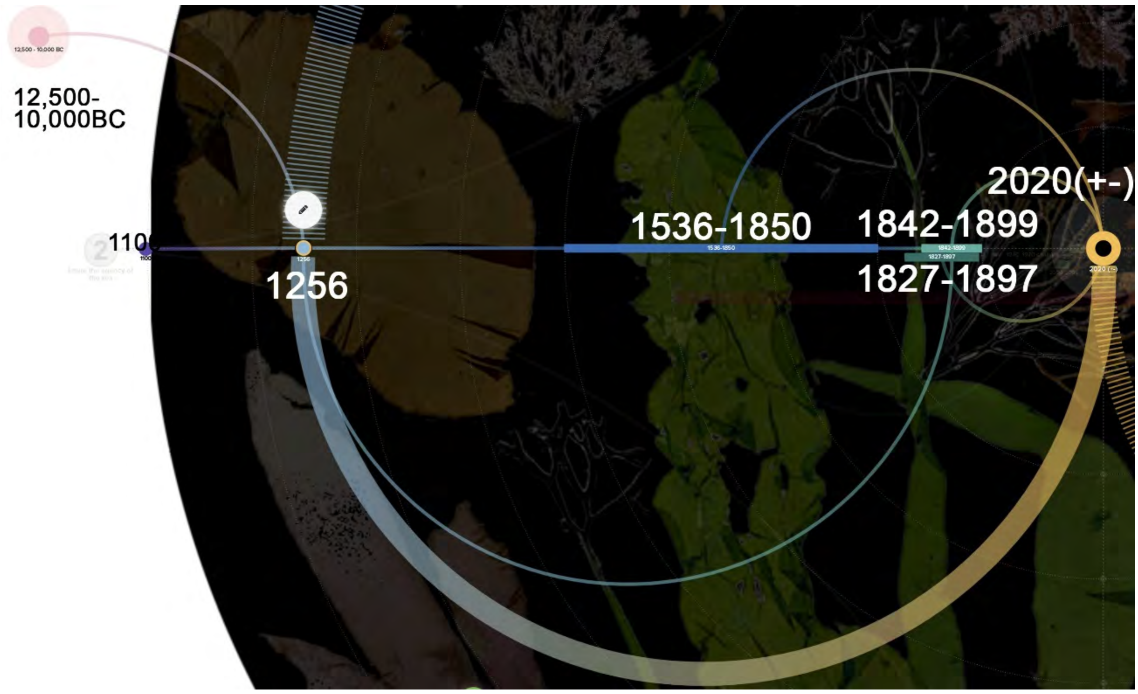


Figure 158. Screenshots from the Temporal-Projective Kumu map. The present-day node is presented in the centre (in yellow 2020+-) with the IPCC deadlines (in orange, 2030 and 2050) and Vejle Municipality's Stormsurge Strategy document goals (in orange and red, 2025, 2050 and 2070) and other future timelines in red. The past nodes represent significant historical developments, such as the start of the land reclamation process of Vejle Harbour in 1842-1899 (in turquoise) and the recent waterfront residential development 2009-2018 (in lime green). The solid lines indicate past connections, and the dashed lines indicate future connections.

4.2.1 Looking at Vejle's main turning points in history

Vejle was constructed in 1256[236] at the highest point at the bottom of the river valley but next to the stream, which was particularly shallow, allowing the safe and easy river crossing as shown in Figure 159 (VisitVejle, 2022). Therefore, Vejle was a place many travellers passed, creating a vital transport route that birthed the city (see Figure 159). Vejle was a market town from the 16th to 19th century, and the industry developed at the harbour (Klinker Hansen et al., 2020; Dansk Center for Byhistorie, 2022a). It experienced prosperity and growth from rising exports and trade with merchants through the passage of the sea (Figure 160). Furthermore, during the 19th century, the water in the streams created the basis for mills, making Vejle the centre of cotton spinning in Denmark (Klinker Hansen et al., 2020). The cotton factory's use of ships and water as a transport channel changed how people used the water (Vejle Municipality, 2020a). As the harbour developed due to industry, the land reclamation process of Vejle's current Fjordbyen ramped up towards the latter part of the 19th century (refer to section 3.1.5 Figure 155). This decision to start developing a city at the bottom of a river valley 766 years ago and extend the city towards the water via land reclamation has implications in current times. Now, Vejle[237] is one of the risk areas listed under the EU Coastal Directive (refer to Figure 5), with Fjordbyen as the most vulnerable area to future storm surges and sea level rise (refer to Figure 6).



236 Earlier records show that Vejle could have formed as early as the 1100s, and the river valley was formed during the ice age in 12,500-10,000 B.C.) (Dansk Center for Byhistorie, 2022a).

237 The historic city centre has a population of around 60,000 (Statistics Denmark, 2022; Vejle Municipality, 2022), with the Vejle municipality having a population of 116,992 as of 2021 (Statistics Denmark, 2022). Currently it is the ninth largest city in Denmark (a medium-sized Scandinavian city) (Vejle Municipality, n.d.).

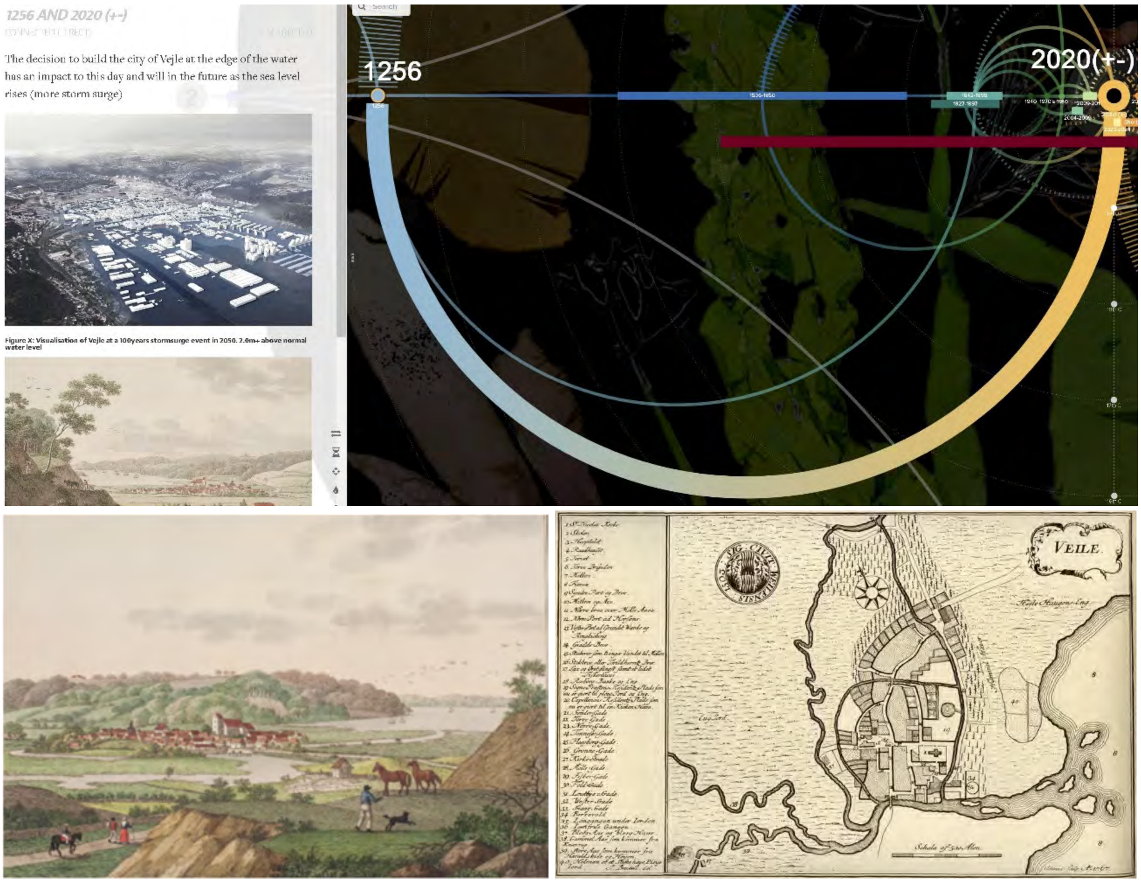
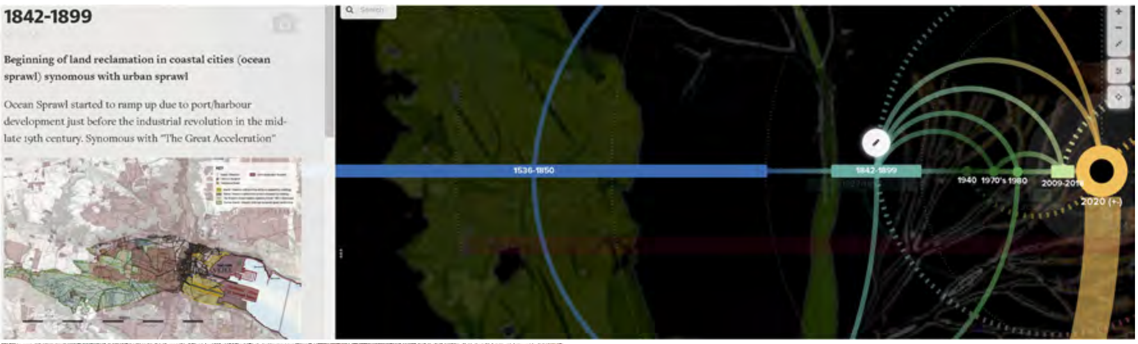
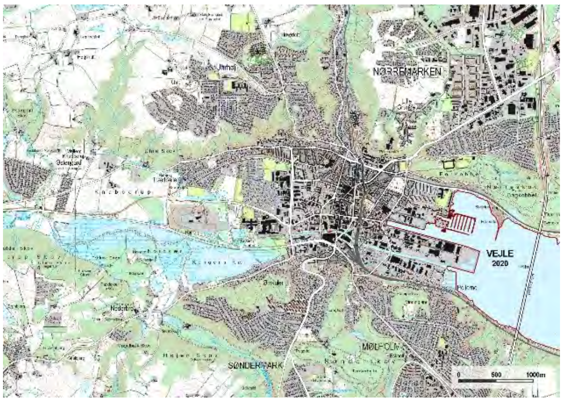


Figure 159. (Top image) Kumu map illustrates some of the major periods in the past that influenced the current state of Vejle today, such as the birth of Vejle (1100-1256), its transition to a market town, the development of the harbour via land reclamation, etc. (some of the nodes purposely hidden for clarity and the years are enlarged).
(Second row of image) The Kumu connection line between 1256 (birth of Vejle) to 2020 (present) indicates that the decisions made 766 years ago still have implications today, especially as Vejle deals with issues regarding the increasing presence of water (SLR/SS) (click on the connection line to open the left-hand side information panel).
(Bottom left image) A Danish painting by Søren L. Lange of former Vejle in the 19th century with salt meadows and marshes in front of the town. Titled: "Vejle fra nordvest" (Vejle from North West) in 1823. Image credit: Lange (1823).
(Bottom right image) an old map of Vejle indicates the first settlement on the highest point (islet) in the river valley where the stream and the fjord meet. Vejle town was surrounded by a salt marsh, meadows (eng) and bogs. Image credit: Dansk Center for Byhistorie (n.d.).
(Extracted from Kumu Temporal-Projective map – 1256-2020 node and connection).

Land reclamation and rapid urban development from the 19th century gradually removed former meadows, bogs and marshes that extended more than 6km into the landscape as a wet spongy area (as shown in Figure 160). Moreover, the land reclamation process took over 72ha (the equivalent of 135 football fields) of the coastal waters (with the likely presence of eelgrass and seaweed), along with the removal of 55ha (the equivalent of 103 football fields) worth of former nature-based protective "edge" that consisted of meadows and salt marshes (see Figure 160). The bottom of the river valley was topographically and biologically not meant to be dry. Therefore, in hindsight, removing the "natural sponges" that used to soak up excess water and act as a buffer from storm surges and replacing it with non-permeable surfaces was a short-sighted decision that currently resulted in Vejle's precarious relationship with water.


1842-1899
Beginning of land reclamation in coastal cities (ocean sprawl) synomous with urban sprawl
Ocean Sprawl started to ramp up due to port/harbour development just before the industrial revolution in the mid-late 19th century. Synomous with "The Great Acceleration"
1536-1850
1842-1899
1940
1970's
1980
2009-2019
2020 (+)


KEY
1842-1899
VEJLE
0
500
1000m


NØRREMARKEN
VEJLE
2020
MØLHOLM
SØNDERMARK
0
500
1000m

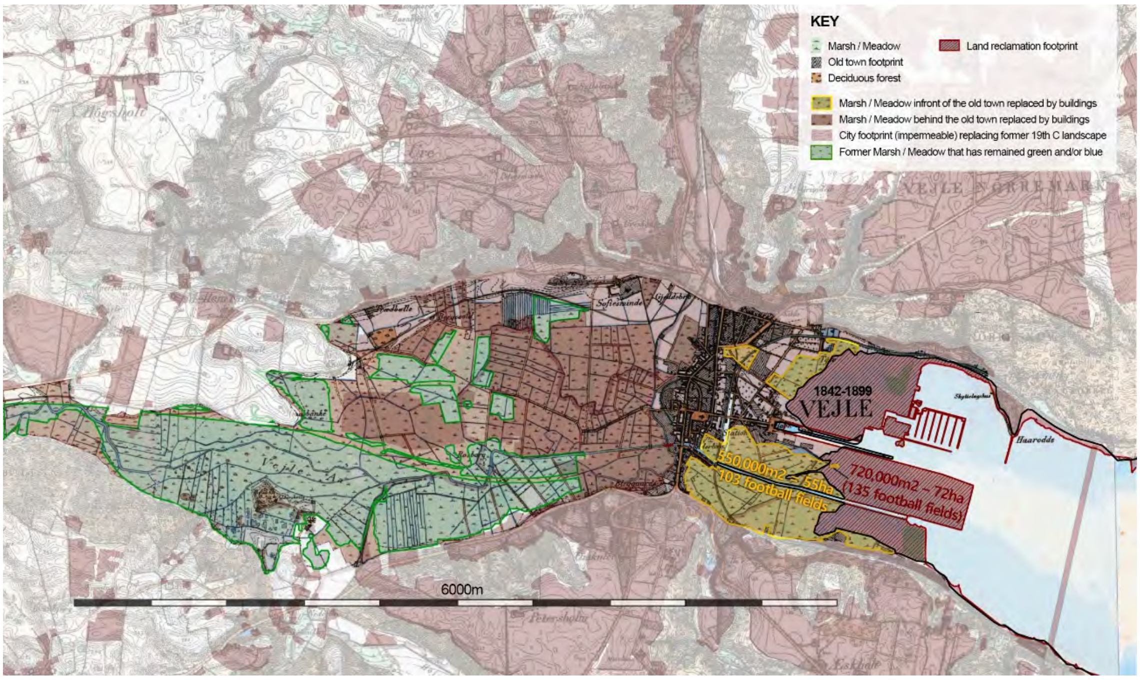

KEY
Marsh / Meadow
Land reclamation footprint
Old town footprint
Deciduous forest
Marsh / Meadow infront of the old town replaced by buildings
Marsh / Meadow behind the old town replaced by buildings
City footprint (impermeable) replacing former 19th C landscape
Former Marsh / Meadow that has remained green and/or blue
1842-1899
VEJLE
550,000m2 ~ 55ha
103 football fields
720,000m2 ~ 72ha
(135 football fields)
6000m

Figure 160. (Top image) Kumu node for 1842-1899, where Vejle Harbour starts to develop via land reclamation. (Second row – Left image) History of urban transformation in the coastal city of Vejle in East Jutland, Denmark. The map of Vejle during 1842-1889 consist of large areas of green meadows at the bottom of the river valley. Source of map: Historical QGIS map from Miljøstyrelsen Denmark (Miljøstyrelsen, n.d.).
(Second-row image – Right) The city of Vejle as of 2020. The grey shades are now built as impermeable areas that have replaced the former green meadows. The former urban shorelines in the 19th century have been extended in the 2020 map via land reclamation. Source of map: QGIS map from Miljøstyrelsen Denmark (Miljøstyrelsen, n.d.).
(Third-row image) The mapping overlays Vejle from the late 19th century to 2020, showing the extent of land reclamation out to the sea and the loss of approximately 6km worth of "sponge" (i.e. former meadows) at the bottom of the river valley. The red fill indicates the replacement of former green areas with non-permeable development. Map created by the author with data from Miljøministeriet (n.d.).
(Fourth-row image - Left) A Danish Golden Age painting called "Indsejlingen til Vejlefjord" from Wilhelm Kyhn (Kyhn, 1862) on the Vejle Fjord and the former salt marshes and meadows that used to form the coastline, which is now replaced with Vejle's waterfront buildings.
(Fourth-row image - Right) A photograph was taken of Vejle Harbour, seen from the West in 1897, with the earliest form of land reclamation. Image credit: A. H. Faber (Historisk Atlas, 2022).
(Bottom image) Photo of Vejle waterfront area with residential, commercial, recreational and industrial developments. The Danish Environmental Protection Agency identifies Vejle harbour as "a highly modified area" (Miljøstyrelsen, 2022a). Photo credit: Vejle Municipality (Danske Landskabsarkitekter, 2020).
(Extracted from Kumu Temporal-Projective map – 1842-1899 node).

The sheer scale of the areas that have been converted to non-permeable spaces indicates just how small the site of Kanten/The Edge competition proposal is in comparison. Due to the removal of these former "sponges", the current situation requires efforts to bring them back in the form of nature-based solutions. Nevertheless, these efforts to restore nature are highlighted in initiatives, such as the creation of the Vejle Inner fjord Wildlife Reserve in 1940 (Vejle Inderfjord Vildtreservat) (Vejle Municipality, 2019b), an artificial wetland construction of Kongens Kær in 2004-2009 (refer to Figure 113) and Sund Vejle Fjord which is funded for 2020-2024 (as shown in the nodes in Figure 161).

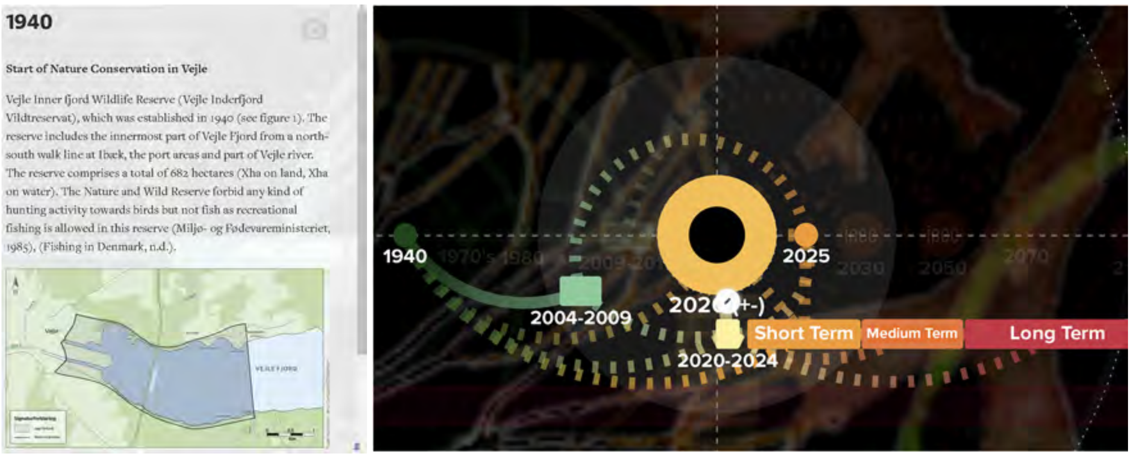


Figure 161. The node 1940 and its relationship to other major nature restoration initiatives in Vejle: node 1940 (Vejle Inner fjord Wildlife Reserve), node 2004-2009 (artificial wetland construction) and node 2020-2024 (Sund Vejle Fjord) (not an exhaustive list). The dashed lines indicate how these efforts will continue to contribute towards improving the ecological conditions in the short-long term (e.g. Sund Vejle Fjord initiative is already showing signs of improvement). Moreover, all these initiative contributes to the success of future nature-based solutions (such as the ones proposed for Kanten/The Edge) and meeting future climate goals.
(Extracted from Kumu Temporal-Projective map – 1940, 2004-2009, 2020-2024 nodes).

Vejle also experienced major infrastructural development, such as the Vejle bridge built in the 1980s (refer to Figure 78). Vejle's waterfront underwent a significant transformation in the past ten years from an industrial harbourfront to a recreational waterfront (see Figure 162) (Sørensen, 2018). These developments consisted mainly of high-end residential buildings that were not designed to adapt to be flexible to accommodate the changing climate. The residential building boom during this time also expanded the marina to cater to a desirable waterfront lifestyle (initially constructed in the 1970s). As the waterfront area became attractive to live, work and play, these areas contributed to increasing economic costs for future damages from water issues, which would require infrastructural upgrades for the protection of the assets in the area (i.e. see Figure 162 below for the relationship between 2009-2023+ node to 2050 node, where frequent and severe storm surge events are to occur. Additionally, refer to see Figure 53, section 3.1.1 on the growing economic costs of Fjordbyen).

Moreover, until Kanten/The Edge competition, the urban transformation of the waterfront area did not consider designing with the marine life forms as part of the development.

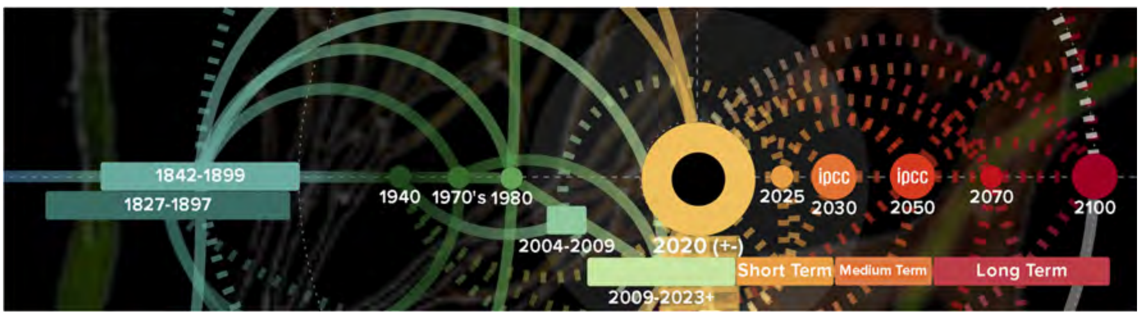
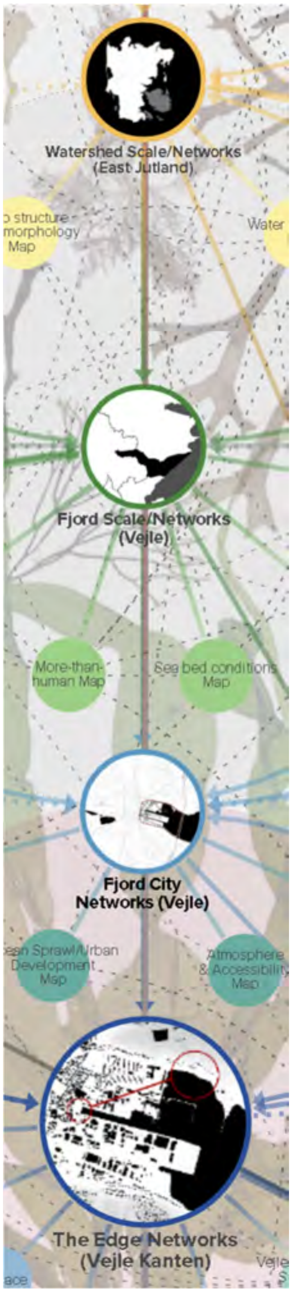


Figure 162. (Top image) The relationship between different periods of urban development and its contribution to future issues with water (i.e. IPCC deadlines and predictions based on the end of the century). Between 1842-1899 was the initial development of Vejle Harbour (which continued to grow in size), the 1970s the initial development of the marina (which continued to grow), the 1980s Vejle bridge and during the 2009-2023+ new wave of high-rise residential developments in the waterfront.
(Second-row image) Kumu node showing the relationship between the waterfront housing development and its future impact (economical) on the storm surge predictions for 2050 (especially at the current B-A-U trajectory by 2050).
(Third-row image - left) Aerial photo before the residential boom in the waterfront area. Image credit: marinas.com (n.d.). (Third-row image – right) An aerial photo during the boom (more apartment complexes have been built) shows new high-rise, high-end residential developments and recreational areas, such as the kayak club and the marina, as part of the waterfront development. Image credit: Finn Byrum (Næs Bertelsen, 2019).
(Bottom row of images) Visualisation showing more conventional high-rise residential apartments (called "Havneøen", translated Harbour Island) coasting approx. 4.5 to 16 million DKK (€600,000 – €2.100,000) in the waterfront area of Fjordbyen. Some of the new apartments are built, and some are expected to be completed by 2023. There are plans for more apartment complexes in this area in the future (Elgaard, 2018). Image credit: Havneøen (n.d.).
(Extracted from Kumu Temporal-Projective map – 2009-2023+ node).

4.2.2 Anthropocene: Now to 2756



Turning our attention from the influence of the past on the present towards the impact of the present on the future, this section covers Vejle's future timelines (see Figure 163), mainly focusing on the storm surge strategy deadlines for 2025, 2050 and 2070 (refer to Figure 114 in section 4.1.1) and the IPCC deadlines (2030 and 2050 refer to section 3.1.2). The intention of this section is to go beyond Vejle's Storm surge strategy and Kanten/The Edge competition by incorporating some key learnings from the research so far. In the map, these projections are presented as future scenarios that have been divided into short-term (2025/2030), medium-term (2050), and long-term (2070/2100), as well as some projections beyond this century (2100+) (see Figure 164). As above, these relations will be explored from the same four main scales: the watershed scale, the fjord scale, and the Fjord City (Fjordbyen) scale, which incorporates Kanten/The Edge scale. These levels of scale are within the operable scope of the LUDP disciplines (i.e. the bigger scales of the watershed and fjord scales are engaging from a more urban planning perspective, while smaller scales of Fjordbyen and Kanten/The Edge are more from landscape architecture and urban design perspective). Furthermore, the future projections consider the USS propositions and seek to address biodiversity loss and water pollution as part of the green transition of Vejle and explore alternative urban development models due to SLR/SS.

Figure 163. (Left image) Engagement of the four major scales of the projective scenarios (screenshot from the multiscalar Kumu map).
(Right image) The projective scenarios are hosted in the "short, medium and long term" nodes, paired against Vejle Municipality and IPCC's climate deadlines.

Figure 164. Screenshot of the future timeline showcasing the potential future strategies for Vejle based on all the learnings from the past and present nodes. The deadlines for future strategies are informed by IPCC (i.e. 2030 and 2050) and Vejle Municipality (2025 (short-term), 2050 (Medium-term) and 2070 (long-term)). The Anthropocene-Capitalocene node spans from the 16th century (refer to section 1.3 for when Anthropocene/Capitalocene started) to the 27th century (by then, most likely, it will no longer be the Anthropocene, but perhaps Chulucene proposed by Haraway (2016) in section 1.3).

Watershed/Catchment scale: Improve water quality in Vejle Fjord

Figure 165. Three major nature restoration projects (1940, 2004-2009 and 2020-2024 nodes) contribute to addressing IPCC's climate goals (2030 and 2050), Vejle's Stormsurge strategy (short term of 2025, medium term of 2050 and long term of 2070/2100) and Urban Seascaping's strategy for coastal adaptation and green transition with a marine nature-based solution for Vejle.

Short to medium-term strategies that need to continue until the issue is rectified

In terms of already ongoing short to medium-term strategies, the path to the success of any initiative to integrate the marine nature-based solution in Vejle Fjord needs to continue tackling the sources of water pollution. Other than restricting or replacing the current artificial fertiliser by the farmers[238] in the catchment area (outlined in beige in Figure 166), a landscape approach would have to convert the low-lying areas[239] shaded in turquoise in Figure 166 into pockets of multi-purpose wetlands distributed over the land (Vejle Municipality, 2021a; Miljøministeriet, 2022). These low-lying areas are often located next to river valleys and around watercourses that could filter and limit pollutants[240] expelled into the fjord (Vejle Municipality, 2021a). Wetland construction would be more than a nature reserve but a landscape architecture approach (see Weiliu Wetland Park example in Figure 166), taking inspiration from Archipelagic Thinking where water plays the connecting force of all the constructed wetlands that can tell a holistic story about filtering water, buffer zones (sponge) to soak up and hold excess water during flood events and providing habitats and recreational opportunities for humans and nonhumans. Landscape architecture, art and design could also play a stronger role in creating spatial experiences for people using art, nature and water that provide a connecting element to the "archipelago" of wetlands.

Moreover, restricting pollutants in the watershed of Vejle Fjord would require the inter-municipal collaboration between Vejle, Hedensted and Fredericia, as shown in Figure 166. The proposal here is to rethink the existing "Triangle Region" collaboration that is predominantly driven by economic growth to expand its scope into a shared responsibility for the ecological health of Vejle Fjord (refer to section 4.1.4, Figure 150 on triangle region). While future wetland restorations upstream need to continue its ongoing projects[241], gradually scaling up and expanding its coverage along the watercourse until the health of the Vejle Fjord is restored to an overall "good ecological condition" (refer to section 1.5.1, Figure 13). Furthermore, marine restoration projects like the "Sund Vejle Fjord" need to continue longer than its current funding of five years to further improve the water quality in the fjord.

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238 While this is the most effective solution to eliminate sources of water pollution, it is outside the jurisdiction of LUDP disciplines as it requires a change of regulation. However, filtering the sources of pollution through NbS is within the domain of LUDP disciplines. The Danish Ministry of Environment has designated certain water bodies to be restored from bad to good ecological condition, however, Vejle Fjord is not one of them (Miljøstyrelsen, 2016).

239 Many low-lying areas (Lavbundsarealer) are meadows, bogs or former shallow lakes, that can be restored as artificially drained wetlands. The low-lying areas form a transition between water areas and the dry land areas, therefore, constitute important habitats for plants and animals. These restored wetlands retain nutrients for the benefit of coastal waters, help reduce the flow rate of rivers and reservoirs for surface water in the event of heavy rainfall events. Restoration of low-lying areas to wetlands can therefore be an essential element in the efforts to address the consequences of climate change (Vejle Municipality, 2021a). This is all in the Danish Planning Act section 11a, no.13) that allocates "low-lying areas that can be restored as wetlands" (Planlovens § 11a, pkt 13 "Lavbundsarealer, herunder beliggenheden af lavbundsarealer, der kan genoprettes som vådområder") (Bekendtgørelse af lov om planlægning).

240 The nitrogen-reducing effect of the wetland is achieved because bacteria in the wet soils break down nitrate in the water. In this way, nitrogen is released in air form (Vejle Municipality, 2021c).

241 As part of the realization of the EU's Water Plans, Vejle Municipality is establishing many new wetlands (currently 15 wetlands have been artificially created by Vejle Municipality). The aim is to improve water quality by limiting the discharge of nitrogen and phosphorus from agricultural runoffs (Vejle Municipality, 2021c).

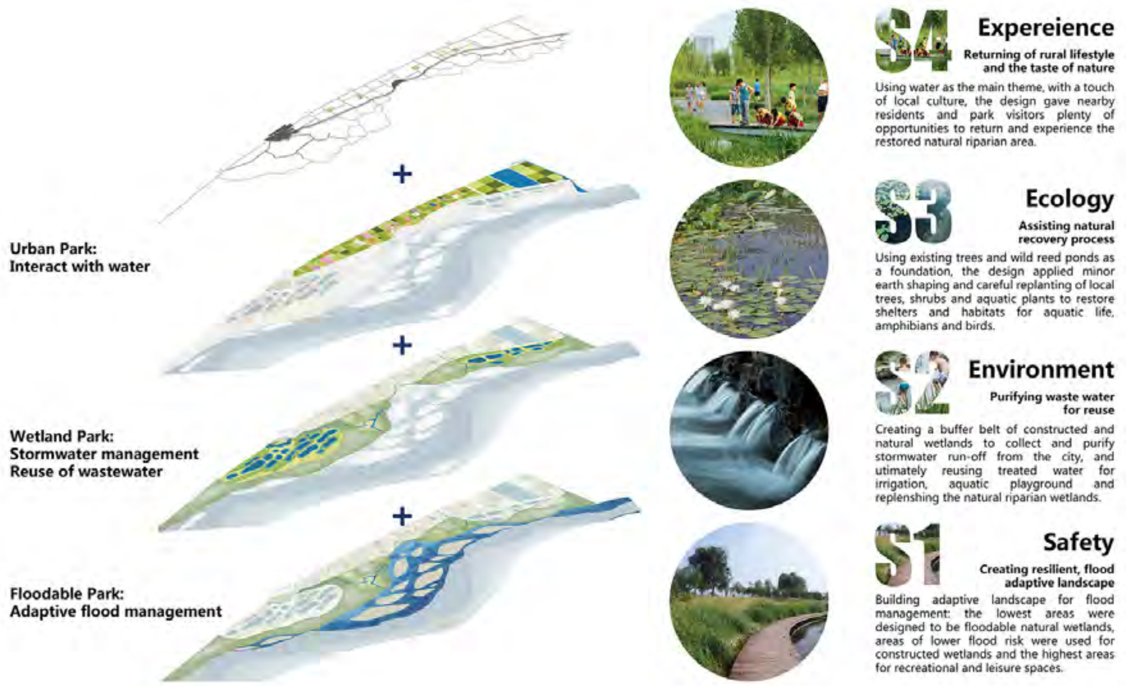

Figure 166. (Top image) A map (watershed scale) of short to medium-term strategies that need to continue into the medium term until the issue of poor water quality in Vejle Fjord is in a good ecological state.
(Extracted from Kumu Temporal-Projective map – Short-term node).

(Bottom image) An example case of a wetland conversion in Weiliu Wetland Park in Wei River's floodplain outside of Xianyang City, China, that serves multiple purposes as an urban wetland park providing recreational opportunities while providing stormwater/flood management and habitat for animals (refer to Figure 82, section 3.2.1). Image credit: Yifang Ecoscape (Landezine, 2019).
(Extracted from Kumu S-O-T-A Weiliu Wetland Park, China node).

Vejle Fjord scale: Expanding the edge to Vejle fjord with seaweed

Short to medium-term strategies

The research presented above has shown that Vejle Fjord is inextricably connected to the river valleys as well as the watershed, signalling that the land-sea boundary is a continuum. This boundary needs to be conceived of and dealt with as a zone of interconnected entities. Departing from this understanding, if Vejle Municipality is serious about marine nature-based solutions to meet the climate and environmental goals[242] (Miljøstyrelsen, 2016; Vejle Municipality, 2021c) and its own storm surge strategy, Vejle Fjord[243] and its connecting water bodies require stronger protection from further degradation. First, the fragmented existing nature protection areas (refer to Figure 79, section 3.1.6) need to extend into the Fjord to use the water as a connector to other protected areas that strengthen the seascape-"landscape corridors"[244] (see Figure 167 below). Second, the current Nature and Wild Reserve (Natur og vildtreservater) need to expand to envelop the rest of the inner and outer fjord and the river valleys. There are several precedents in section 3.2.5 that could inspire Vejle and provide more visionary and inclusive narratives that include the local communities. For instance, the possibilities of invoking a living entity status of Vejle Fjord and assigning guardians from the local community to make decisions on behalf of the Vejle Fjord (in its interest) or perhaps enacting Vejle Fjord as the water-based "sixth borough" from an urban planning perspective with legal human representation. This would be the first in Denmark to acknowledge the agency of a water body in a dire condition (close to an urban context) and its right to better conditions beyond its utilitarian purpose (i.e. ecosystem services).

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242 However, according to Miljøstyrelsen (2016), while there is a goal to restore the water bodies to a good overall "ecological condition", Vejle Fjord as a coastal water is exempt from requirements to meet the environmental targets by 2021.

243 From now on, it will be called "Vejle Fjord+", which includes its connecting river valleys, streams and watershed.

244 Landscape (biological) corridors are "thin strips of habitat that connect isolated habitat patches" (Damschen, 2013). It suggests "that larger areas of habitat are better than smaller areas, that habitat patches closer together are better than those farther apart, and that otherwise isolated habitat patches connected with a corridor are better than those without such a connection" (Damschen, 2013).

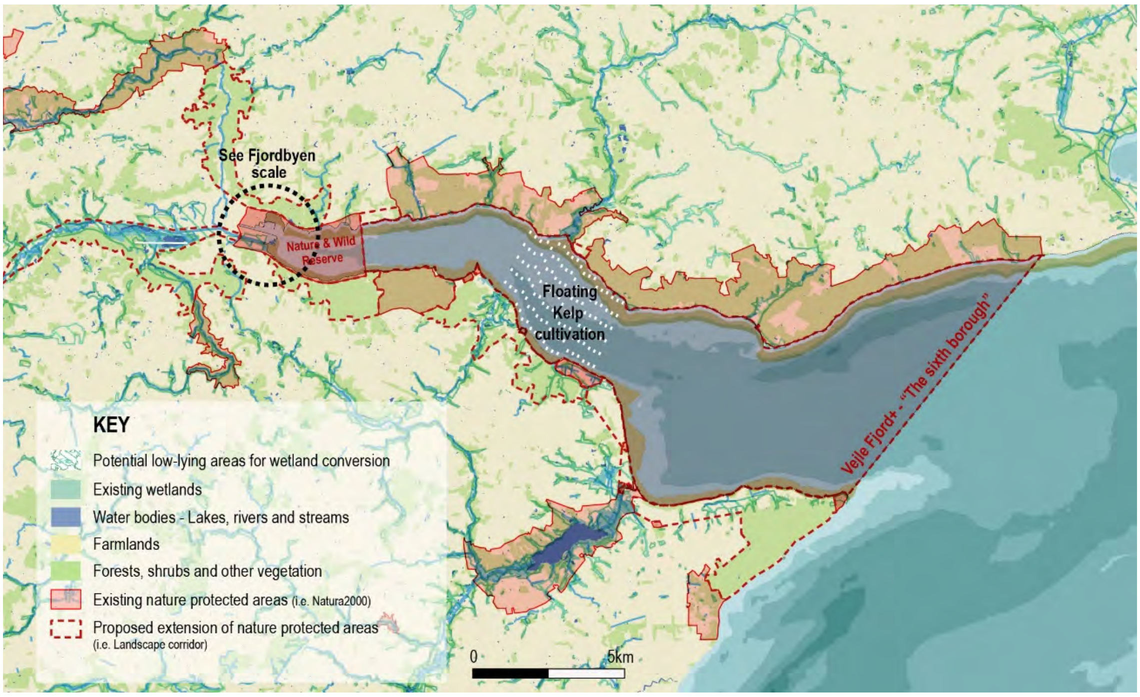


Figure 167. Short-Medium strategy for the Fjord scale. The red fill line is all the nature protection areas (i.e. Natura2000 areas, Ramsar, Nature and Wild reserve and Nature Protected areas under the Danish EPA, as shown in Figure 79, section 3.1.6). The dashed red line shows that, where possible, the different current nature protection areas need to be connected together and envelop the shorelines where possible to improve the land-to-sea connection, extend the protection to the fjord and protect the rivers to help limit agricultural runoffs. The land-based nature protection areas on either side of the fjord are connected through the water under this proposal.
Image credit: Map made with GIS data from Miljøstyrelsen and kelp location maps from Lundsteen and Nielsen (2019).
(Extracted from Kumu Temporal-Projective map – Short and Medium-term node).

To implement seaweed as part of Urban seascaping, there are two main potential areas in Vejle fjord, one at Kanten/The Edge in the shallow area of the inner fjords and one out in the deeper, colder and saltier waters of the mid-outer fjords where kelp species can grow (refer to Figure 148, section 4.1.3). Therefore, projects like Kanten/The Edge are developed and constructed in the short term, where the seaweed close to the urban shorelines bridges the gap between nature-culture binaries and enhances ocean literacy. While a large-scale[245] floating kelp garden can be grown in the mid-outer fjord as the first line of defence for wave attenuation, water filtration, mitigation of coastal erosion[246] and other ecosystem services (as shown in Figure 168), it could also convey the story of seaweed in deeper waters as "gatekeepers" that keep the fjord cleaner, safer and provide benefits for both humans and nonhumans.

245 There are various reasons to warrant a larger scale intervention as it would withstand stronger storm surges in the future (as more violent storm surges are expected in Vejle fjord) but to also amass large biomass of kelp (i.e. sukkertang/sugar kelp) from cultivation to be used for organic fertilisers, feed for pigs or food for the locals (circular economy).

246 According to the marine biologist for Vejle Municipality, the mid-fjord is where coastal erosion is the worst and therefore, these wave attenuators (through seaweed, stone reefs, mussel banks, eelgrass plantations) can mitigate the level of erosion (Fjeldsø Christensen, 2021).

Moreover, structures for kelp would need to be designed specifically to be robust enough to withstand a storm and be flexible enough to be lowered to colder depths during heat waves in summer (to avoid kelp from dying during heat waves which are expected to increase in the future). It also needs to be able to cater to allow boats through without compromising its wave attenuating capacity and for the floating buoys to be redesigned as floating art (see Figure 169 and refer to Floating Art Festival in Vejle, in Figure 91) to convey the narrative of what is happening below the sea (i.e. making the invisible visible) and to be accepted by the locals as an "aesthetically pleasing object" that could belong on the fjord (refer to section 1.5.3 Current barriers to seaweed). This type of artistic-structural system is currently non-existent. It is a design challenge that would require collaboration between engineers, marine biologists and artists/architects to design a new multifunctional system that could artistically communicate the invisible kelp below the water through the floating buoys. This intervention would need to visually connect back to what is happening in Kanten/The Edge as a holistic system to tell the story of the role of marine nature in Vejle's green transition and coastal adaptation. The gradual improvement of water clarity due to the numerous strategies mentioned to restore Vejle Fjord would enhance the water clarity of the fjord, which would eventually result in marine lifeforms being visible to the humans in Fjordbyen (i.e. medium time frame). Therefore, working with kelp expands the understanding of an edge to a zone that goes deeper into the land (upstream) and further out into the fjord, as illustrated in Figure 168 below.

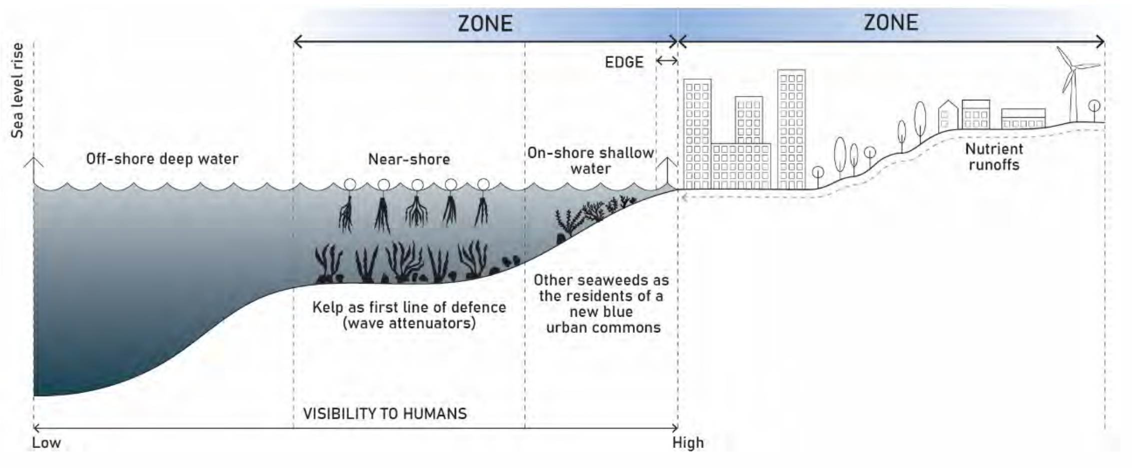
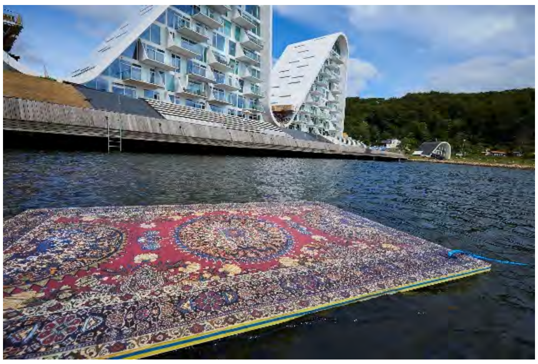


Figure 168. (Top image) Thinking past edge conditions to a zone when considering water and marine lifeforms in coastal adaptation strategy. Kelp (brown macroalgae) is the "invisible" first line of defence against storm surge via wave attenuation (local testing is required to understand various factors that influence the performance of the kelp). In contrast, other seaweeds near the urban shorelines are a visual storytelling element of sea-level rise and the residents of the new urban commons on the waterfront.
(Second-row - Left image) Sukkertang/Sugar kelp grown on lines close to the water's surface, making them visible from above. Image credit: Tim Dencker (n.d.).
(Second-row - Right image) A photo of various seaweeds (macroalgae) visible to the human eye from the shallow waters of Elsehoved Beach in Fyn, Denmark. The photo shows some of the most common forms of seaweed. The green seaweed is called "Sea lettuce (Søsalat)", and the brown seaweed is called "Bladderwrack" (blæretang). The photo was taken by the author in July 2020.
(Bottom-row images) Sugar kelp/Sukkertang is grown on lines in Kalvebod Bølge[247] in Copenhagen harbour. Image credit: Tim Dencker (n.d.).
(Extracted from Kumu Temporal-Projective map – Short and Medium-term node).



247 The sukkertang/sugar kelp is visible from above because the cultivation lines are hung not too far from the surface, and the water clarity in Copenhagen harbour is clearer than other places (due to lack of surrounding agricultural runoffs and urban sewage discharge is well treated in Denmark). However, the mussels grown on these lines in Copenhagen harbour cannot be eaten due to the heavy metals in the water from the industrial activities of the harbour; therefore, they are only used for educational and water filtrating purposes (Hjerl, 2019).

Figure 169. Precedents of floating art installations as potential alternatives to floating buoys used for marine cultivation (currently, these structures serve purely a functional purpose, not artistic). These floating art installations could be designed with more marine themes (avoid terrestrial bias) to convey the story of kelp growing underneath as a way to tackle the climate change issues facing Vejle from a more unified nature-culture perspective.
(Top row images) Image credit: Titled: "Flydende Tæppe" (Flying carpet) as part of Floating Art Festival in Vejle by Tina Helen (2018).
(Bottom row images) Image credit: Titled: "Bihar" (Tomorrow in Basque) in Nervion river in Bilbao, Spain, in September 2021 by Mexican hyperrealist artist Ruben Orozco (West, 2021). The intention of the sculpture that is periodically submerged due to tides is to encourage debate about sustainability and convey the message that people's "actions can sink us or keep us afloat" in the face of climate change (West, 2021).
(Extracted from Kumu S-O-T-A Bilbao Spain and Vejle node).

Fjordbyen scale: In preparation for a blue urban commons

Short to Medium term strategies

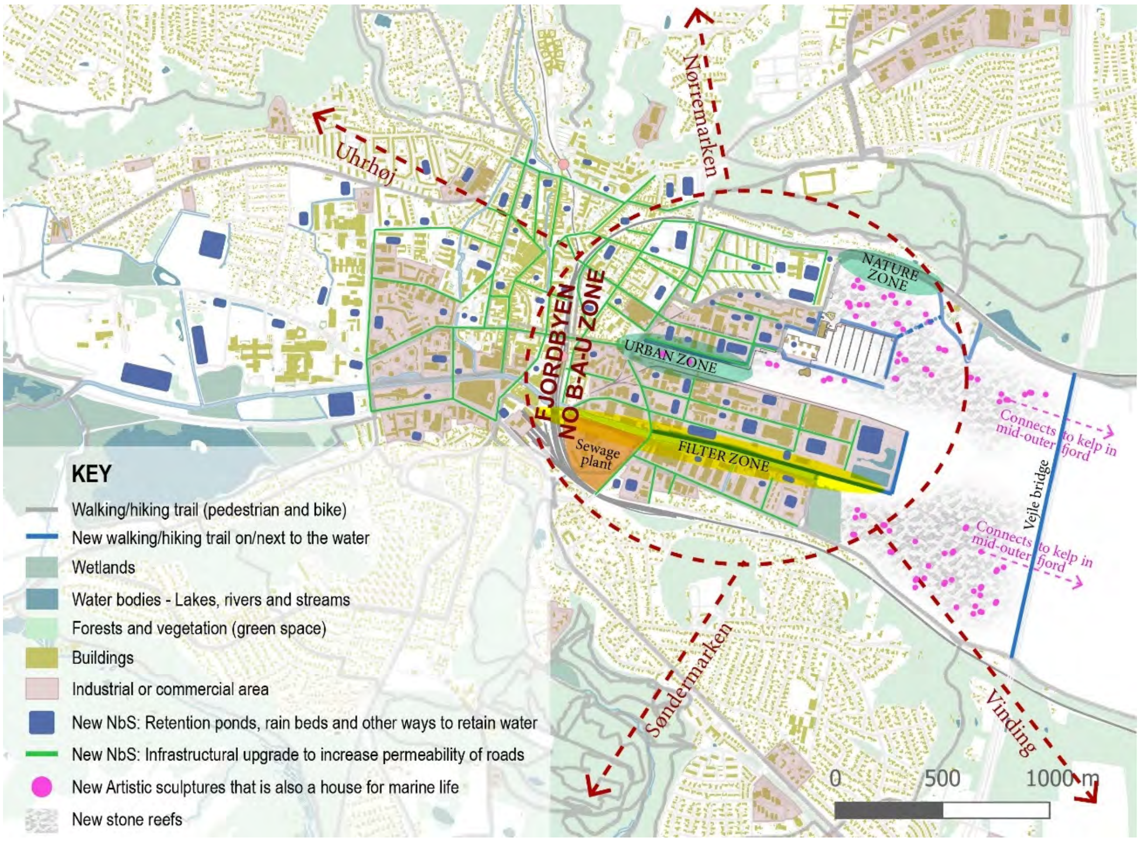
The best features of Kantens/The Edge's four winning entries should be executed in the Urban and the Nature zone that also envelops the entire Fjordbyen as a short-medium term approach (refer back to section 4.1.1). The intention is to gradually erode the current hard-edge conditions and their associated nature-culture divide over time. However, due to Kanten/The Edge competition's limited space for the site, it is difficult to explore alternative options to expand the edge condition to a zone (refer to Figure 109, section 4.1.1). Therefore, the security/protection line is moved from the current urban shoreline from Vejle's Storm surge strategy to the existing railway mound/dyke[248] (refer to Figure 110, section 4.1.1) to free up Fjordbyen for exploration as a bigger buffer zone as an aquatic terrain (see Figure 170). Fjordbyen gradually transforms into a new form of blue urban commons (i.e. invite the agency of the sea).

This new spatial reality entails reintroducing the "sponge" via the proposal by The Membrane's edge conditions that grows and expands with time to increase permeability and spaces to hold excess water in the future (refer to Figure 120, section 4.1.1). For instance, the city's impermeable paving and roofs are retrofitted as a blue-green infrastructure to soak up the excess water (refer to Figure 88, section 3.2.3 New Urban Ground project in NYC). The "sponge/membrane" concept serves multi-purposes depending on whether the condition is dry or wet.

248 The railway mounds to function as a security line (coastal protection), it needs to be retrofitted to ensures that the perforated tunnels (to allow traffic) can be closed in a storm surge event. Refer to section 4.1.1, Figure 110.

As the sea rises, the new blue urban commons gradually open up more access to the water in different parts of Fjordbyen, inviting the marine realm into the urban realm (i.e. multispecies coexistence). For instance, stone reefs (i.e. SuperRev) are reinstated along with artistic initiatives such as "housing for fish" like SUPERFLEX (refer to Figure 94, section 3.2.4) and the current Økolariet[249] in Vejle (i.e. Vejle's Educational science centre located in the city centre) can communicate to the locals the importance of the marine life in addressing climate change, future impacts of sea level rise and helping acknowledge marine life as equal residents of Fjordbyen. The visual and physical proximity to human exposure and interaction is critical to enhancing awareness and literacy (see Figure 170).

Furthermore, to integrate seaweed as part of Urban Seascaping in Fjordbyen, the stone reefs and seascaping elements need to be no deeper than 2-3m (due to visibility) to ensure that the smaller types of seaweed (i.e. refer to Figure 148, section 4.1.3 and Appendix 13) have a chance of surviving in the inner fjords (to ensure access to sunlight, while being visible to humans).



249 Økolariet could move its premises to Fjordbyen playing a stronger role in facilitating and becoming part of Fjordbyen's urban transformation into a blue urban commons. Here, Økolariet can continue to educate the locals about the interconnections between the fjord and the city, humans and nonhumans through a much more immersive spatial experience provided by Kanten/The Edge, NbS, artistic sculptures, seascape gardens and so on. Moreover, the new Økolariet could be built in a way that is adaptable to wetter conditions, showcasing a precedent for new form of building typology suitable for a changing climate. However, there are emerging political pressures and regulations in DK to limit carbon intensive new constructions (only of large buildings) over a 50-year lifetime (Andersen, 2021b).

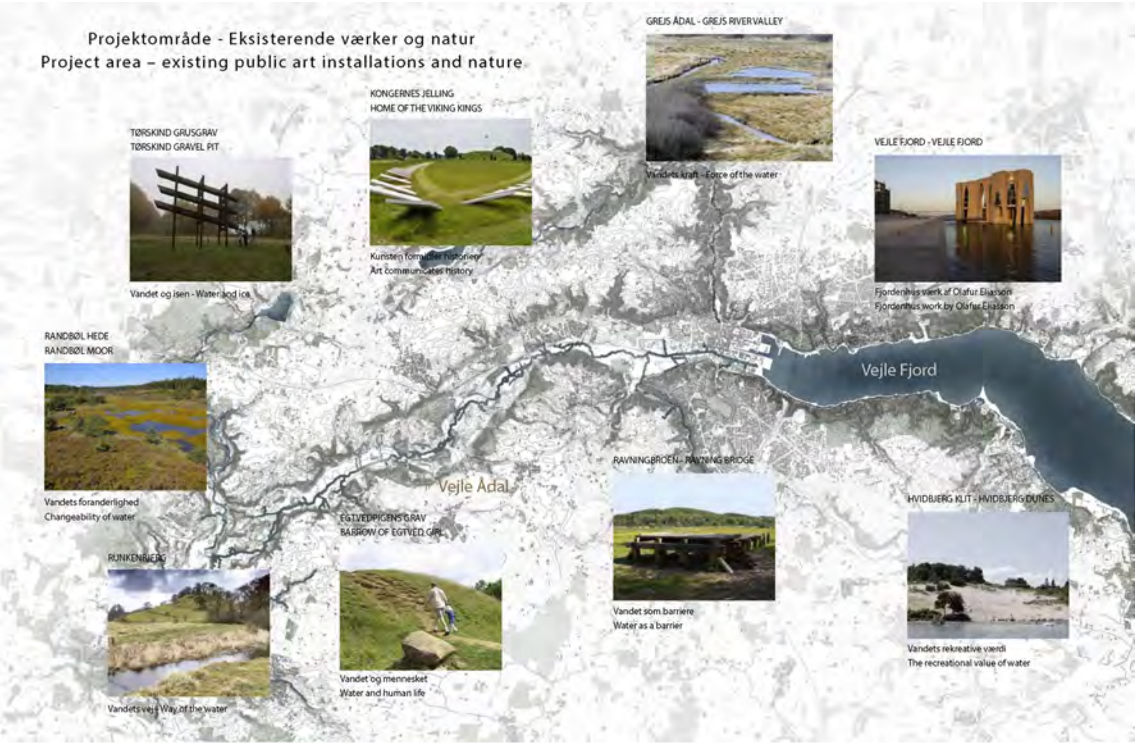


Figure 170. (Top image) Proposal for the transformation of Fjordbyen into a much more aquatic terrain, taking inspiration from Kanten/The Edge winning proposals. There are several proposals for the new Fjordbyen in transition, as shown in the map (refer to the key).
(Middle row image) An example of a projective depiction of an edge condition that allows the seaweed to transition onto Fjordbyen as the sea level rises (depth no more than 3m). Artistic sculptures designed to host marine life are scattered around the inner fjord, visible from above but slowly immersed as the sea level rises, showcasing the imperceptible changes visibly. Image credit: The Membrane team (Josephine Philipsen, Luisa Brando, and Andres Hernandez) and SUPERFLEX.
(Bottom image) Vejle is committed to integrating art as part of the city's identity and storytelling. The report "Invitation Ådalene i Vejle - River valleys of Vejle. Byen, Vandet og Kunsten City, Water and Art" by Vejle Municipality outlines all the art installations and projects that weave through the landscape, using the four main river valleys as inspiration to tell the story of water in Vejle (Vejle Municipality, 2019a). These artistic initiatives are well connected through hiking/walking trails throughout Vejle (Vejle Municipality, 2021b).
(Extracted from Kumu Temporal-Projective map – Short and Medium-term node).

The mouth of the river holds another potential as a last spatial corridor to capture the pollutants from the rivers/streams before it reaches the fjord (see Figure 170). Conveniently, this is the area where Vejle's sewage plant is located (see Figure 170, highlighted in orange). Therefore, the cleaning of the water should not only be extended to human sewage but also agricultural runoff. Thus, this area could be considered the third zone, i.e. "Filter Zone", where nature-based solutions could be expanded[250]. Moreover, NbS can also slow down the water from pushing into the rivers in a storm surge event. The third zone would need to gradually reclaim the edge of some of the existing industrial areas (see yellow fill in Figure 170), which could open up the accessibility of this area. By opening up these areas where the city and the water meet, there is potential to connect them back to the existing network of hiking/walking trails (refer to Figure 144, section 4.1.2) that span further up into the river valleys, forests, wetlands and around Vejle's landscapes (see Figure 170, locations of key public art installations that weave around the river valleys dealing with water as the main theme (Vejle Municipality, 2019a)). The proposal is to connect these existing paths back to the "blue urban nature" of Fjordbyen and to the Vejle Fjord[251] (see the new blue walking/hiking trails in Figure 170 (Vejle Municipality, 2021b)) to connect the story of the water from upstream to downstream. This would enable a bodily way of experiencing and understanding water's networks to tell the story of the role of water in Vejle's coastal adaptation.

Medium to Long term strategies

In the medium to long-term strategies, a sensible retreat plan needs to be in place. This plan needs to account for the unadaptable B-A-U buildings in Fjordbyen that have fulfilled their lifespan (i.e. 50+ years) and which may therefore be demolished (see Figure 171). Moreover, where possible, the existing activities in Fjordbyen are slowly relocated to higher grounds[252] (the start of the degrowth of Fjordbyen). The plots left behind are converted for new purposes – as part of the blue urban commons (i.e. refer to various precedents from section 3.2). The buildings that have yet to serve their lifespan are retrofitted to ensure that the ground floor can withstand inundation of up to 3m. Any new buildings in Fjordbyen must be built in a manner that is adaptable to changing climate, does not compromise marine life, is able to withstand inundation and forces of storm surges, and/or is flexible enough to be relocated (i.e. no B-A-U development zone as shown in Figure 170).

250 Upon site visit to this industrial area that from the mouth of the river to the fjord – see Figure 170 highlighted in yellow), while it was largely inaccessible to the public, but there were few walking paths next to the water that had salt meadows growing in this area with housing bordering the southern side of the water.

251 For instance, a walking paths could be implemented under the Vejle bridge to be able to experience Vejle from the viewpoint of the fjord, and to be able to cross Vejle in a more tactile manner. Since the boundary of Fjordbyen is marked by the Vejle bridge, it could be an interesting way to loop the walking trails from upstream in the river valleys all the way out into the fjord and then loop back up to the river valleys again.

252 While Vejle (and Denmark) do not have an official retreat plan, Vejle municipality is already investing on higher grounds (i.e. Vejle Nord) and is aware that the buildings in the risk zone do not last forever and will eventually need to be dismantled. They also aware that new building technology/typology is required in the future to live in wetter conditions (see Appendix 12).

Figure 171. A photo during Vejle's Floating Art Festival, with the construction of the high-end apartment complex "Bølgen" (The Wave) in the background (the first two waves were completed in 2009 and the rest in 2018). The intention of this image is to be seen in reverse; that is, The Wave apartment complex is in the process of being dismantled as it reached the end of its life around the year 2059-2068+, as part of the urban transformation of Fjordbyen. Image credit: Unknown.
(Extracted from Kumu Temporal-Projective map – Medium and Long-term node).

1500 years after the birth of Vejle – The year 2756

Long term strategies

Planning or thinking about a distant, unpredictable future beyond the average human life seems like a daunting, impossible task. However, our decisions on where we should live have had long-lasting impacts centuries into the future. A glimpse into a possible long-term future is speculated in Kim Stanley Robinson's bestselling sci-fi/cli-fi (climate-fiction) that deals with 15 meters of sea-level rise in New York City in 2140 (Robinson, 2017) (see Figure 172). In this scenario, NYC undergoes significant urban transformation; where it resembles Venice, only the top part of skyscrapers remains, and the coastal ecologies have also adapted to their new environment and redesigned themselves with new species (ibid.).

Figure 172. Kim Stanley Robinson's bestselling fictional book called "New York 2140". The book is well known for critiquing unbridled capitalism, unregulated financial systems, and free-market economies as the main contributor to global warming that led to significant sea level rise. NYC looks like Venice, but only the top of skyscrapers remains, and new ecologies have formed in this new environment. Book cover image credit: Illustrator unknown (Robinson, 2017). (Extracted from Kumu Temporal-Projective map –The connection node between 1256 and 2756).

Based on this fictional scenario, I used SKALGO (n.d.), an online mapping tool, to simulate the maximum SLR level of 10m in Vejle (5m short of the New York 2140 scenario), as shown in Figure 173. It shows that the entire river valley will be inundated (the valley has the capacity of up to 21m of SLR before the sea starts to bleed into the hills on top of the valley (refer to Figure 37, section 2.2.3). Therefore, despite the fact that any timeframe beyond 2100 may seem too out of reach to fathom and to make concrete decisions on, what this small mapping exercise indicate is that with regards to issues surrounding future scenarios of SLR/SS, building/developing on top of the river valley where currently existing suburbs exist[253] guarantees from inundation few hundred years into the future (see red dashed outlines in Figure 173 below).

In this scenario of 10m of SLR, the former waterfront and harbourfront area of Fjordbyen would be pushed back 4km back in the river valley (see the yellow dashed outline in Figure 173 below).

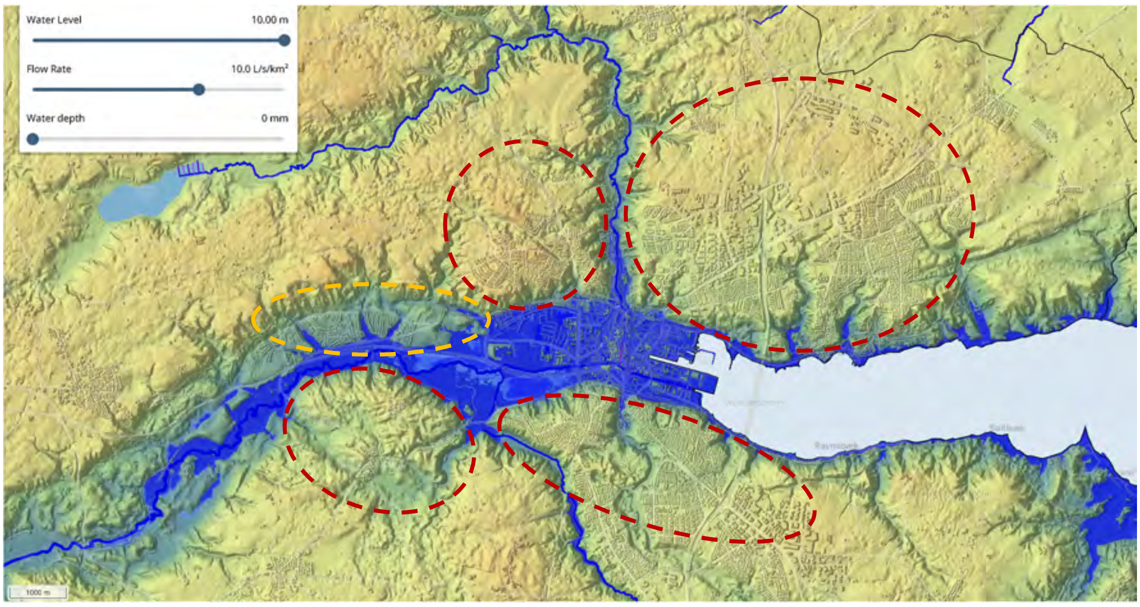


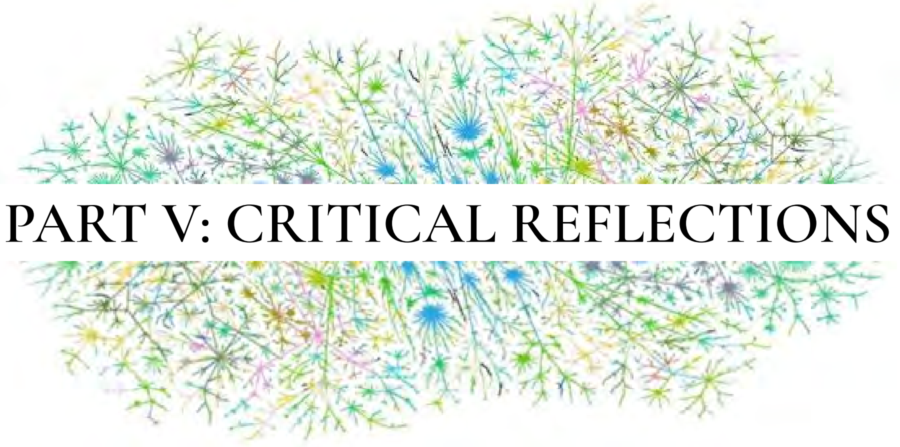
Figure 173. The future scenario of 10m SLR in Vejle, where the entire river valley is inundated (shown in blue). The surrounding suburbs on top of the river valley are safe up to 21m of SLR (red outline), guaranteeing protection from inundation. A potential area for a new harbourfront/waterfront on land would need to be 4km back from the current Fjordbyen (outline in yellow). Map credit: SKALGO (n.d.).

253 These suburbs surrounding Vejle's city centre are: Nørremarken, Mølholm, Pedersholm, Høgsholt, Bredballe, Nørre Vilstrup, Søndermark, Højen Skov, Grejsdal, Smørhullet, Rugballe, etc.

Moreover, in the inundated river valley in the distant future, there may be different building typologies (i.e. futuristic and vernacular precedents) that could still exist on the water, such as those shown in Figure 174 below. Or, the inundated river valley could become a marine habitat inhabited by hybrid and new species living in the former buildings that used to exist in the river valley (refer to “wreck biodiversity” (Mallefet et al., 2008)).

Figure 174. (Top image - left) A visualisation of a contemporary city like Vejle underwater that marine life forms in the distant future will inhabit. Image credit: Image superimposed by the author from Vejle Spildevand and from katatonia82 (2021) iStock by Getty images.
(Top image - right) A futuristic concept for a floating city that adapts to sea level rise is proposed for Busan, South Korea. The imagery contains floating buildings with artificial UV lights to grow seaweed, oysters, scallops, clams and mussels below. The project is a collaboration between UN-Habitat (which works on sustainable urban development), the Massachusetts Institute of Technology (MIT), BIG Architects, The Explorers Club etc. (Wright, 2019). Image credit: OCEANIX/BIG-Bjarke Ingels Group (n.d.).
(Bottom image - left) Reconstruction of Bronze Age German stilt houses on Lake Constance, Pfahlbaumuseum Unteruhldingen, Germany. These vernacular buildings are constructed on stilts. Image credit: Rufus46 (2015)
(Bottom image - right) Typical forms of houseboats on the canals of Amsterdam. Image credit: AmsterdamWonderland (2016). (Extracted from Kumu Temporal-Projective map – Long-term node).

*NB: For conclusions for Part IV, refer to Part V, section 5.2: *Key learnings from the Kumu mapping analysis and* projection of Kanten/The Edge .



PART V: CRITICAL REFLECTIONS

Introduction to Part V

Part V of the monograph departs from a critical reflection and discussion of the main themes and learnings that arose during the time I conducted the research presented in this monograph. Thus, the chapter revisits the initial research questions and asks whether a satisfactory answer can be said to have been reached. Moreover, the chapter discusses the potentials and shortfalls of Urban Seascaping as a critical proposition and methodological mapping framework to assess and discuss Denmark's current coastal urban development models. Moreover, the learnings from Kanten/The Edge competition are also discussed for its future potentials and shortfalls, especially regarding seaweed as a marine nature-based solution. The chapter also indicates future avenues not explored in this research that would be critical for contributing toward the emerging practices of blue urbanism, coastal urbanism and marine landscape architecture. Finally, I summarise some key findings and reflections that are generalised for broader application.

5.1 Urban Seascaping as a research contribution

In this dissertation, Urban Seascaping (USS) has served as a working hypothesis through which I could answer the research questions. The design principles were developed with an intent to depart from the current nature-culture divide, both perceptually and physically in coastal urban environments, territorial biases and a dominant hard approach to coastal development that constantly excludes and degrades the marine environment. Fundamentally, the research presented here is part of an ongoing discussion to question the current adverse relationship between some of the most powerful forces in the world, the market-driven urban development models and the rising sea.

In this regard, the research on Urban Seascaping presents an "original" contribution towards the paradigm shift that is urgently needed in the transformation of future urban development. This also includes a new view of the phenomenon of sea-level rise and its marine life (i.e. seaweed) as a resident and an actor, which the project suggests can play a key part in coastal cities and their blue-green transitions. Therefore, USS attempts to cultivate a world that allows us to co-exist in ways that are just and livable for more-than-human entities, such as seaweed and other marine species. Ultimately, this is achieved through the acknowledgement of their intrinsic values and the ongoing effort to grant them a space that may foster a better meeting place in the contested coastal zone. As such, USS constitutes a novel spatial design practice that may culminate in an urban blue commons – the success of which will be determined by the citizens of the terrestrial and the marine world.

Furthermore, the research has been centred around an ambition to use design as a method (i.e. Research-through-design), which contributed to new context-specific knowledge in Vejle, in which certain aspects of the findings were transferred to a level of general validity and broader impact.

In the following Table 4, I outline the three main contributions that the present research on Urban Seascaping has sought to produce:

Research Questions (RQ) & Corresponding Hypothesis	Research contribution(s)
Main RQ: *How can coastal cities of Denmark integrate the sea and its lifeforms to contribute towards re-envisioning urban development in light of sea-level rise and frequent storm surges?*	The act of bringing forth the forgotten and unexplored actor of seaweed into the urban realm and coastal adaptation strategies, especially as a marine nature-based solution, constitutes one of the primary innovations of the PhD. In this context, the project suggests that seaweed be conceived of as a representative of the marine realm and as a rightful resident in catalysing the transformation of the current waterfronts into a new form of urban blue commons. This means taking into consideration both seaweed's instrumental and intrinsic values, such as its various ecosystem services, in particular the ability to contribute towards coastal protection in the form of floating kelp farms in the deeper parts of the sea while closer to the urban shoreline, as a key actor in the creation of projects like Kanten/The Edge design competition, an urban landscape approach to rethinking the current edge conditions. The findings have shown

Hypothesis: *Urban Seascaping with seaweed – the potential of "seascaping" with seaweed in coastal cities as a response to alternative urban development and coastal adaptation.*	certain design parameters for the two major interconnected zones in the fjord where seaweed can be implemented (in Vejle), the shallows, and the deeper waters as a floating kelp system. Moreover, the findings from Kanten/The Edge competition entries, while focussing on seaweed, arrived at a conclusion about the need to expand the conventional notion of a fixed, singular and territorially-biased view of a site to one that identifies multiple scales, reciprocal and nonreciprocal relations with the intersection between different territories that all contribute towards urban spatial networks. Furthermore, dealing with the real-world issues of sea level rise and increasing storm surges is directed to the need to work with long-term time scales. **Generalisable outcomes:** The four main Urban Seascaping propositions to guide future coastal adaptation strategies with marine nature-based solutions (i.e. seaweed) and an alternative to the current B-A-U urban development models in coastal cities. It is a small contribution to the emerging practices of blue urbanism, coastal urbanism and marine landscape architecture.
Sub RQ1: *How can design research methods and practice from the spatial design disciplines of LUDP contribute to the changing spatial boundary between city and sea, human and nonhuman, due to climate change?* **Hypothesis:** *The projective (speculative) quality of research-through-design as a methodology for knowledge production of certain design parameters and principles that can arrive at new ideas (for the future)*	There is a research and practice gap in coastal adaptation projects that integrate nature-based solutions, which has largely been the domain of engineers and biologists. Therefore, the projective element of design could offer unique insights into an imaginative possible solution that does not exist yet, especially given the need for sustainable urban landscapes to be projected by design first. Design research has the task of evaluating the projections' "preferability" and then reflecting on their transformative capacity (Prominski and Seggern, 2019, p. 44). Moreover, the projection of different future scenarios communicated by drawings, models or digital media can play a key role in the ability to collaborate with other disciplines and actors through a shared legible visual medium. Hence, the contribution of the research-through-design methodology lies in its capacity to synthesise various future opportunities for socio-spatial development through the act of designing. Transformational research like research-through-design is an appropriate and productive approach towards tackling issues of green transition through the synthesis of different knowledge towards a holistic realisable spatial outcome (which can then be analysed further for its capacity to catalyse societal transformation). Furthermore, since it can be argued that there is no untouched and "undesigned" nature left in the Anthropocene, designers have a proactive role in embracing the possibility of design as a way to engage with the nature-culture entanglements. Kanten/The Edge design competition winning entries were an example of this process. It was a testing ground for new knowledge and solutions in a "real-world" context to facilitate the transferability of solutions to other contexts in Denmark. The role of designers (as demonstrated in the winning entries) in the competition became one of synthesising complex transdisciplinary knowledge across various scales and timeframes, pushing the usual boundary of what designers (i.e. landscape architects, urban designers and architects) are increasingly asked to do. This meant that designers

	had to engage with the ecosystem services of coastal ecosystems, different nonhuman perspectives and how Kanten/The Edge could bring forth these entanglements into the aesthetic, atmospheric and spatial realm, especially while addressing the broader issues of climate change and green transition via mitigation and adaptation.
Sub RQ2: *What ways of thinking and doing (i.e. world views, representational and analytical tools) can help the spatial design disciplines of LUDP address the aforementioned research questions? (i.e. RQ and SRQ1)* **Hypothesis:** *Hybrid mapping methods that synthesise transdisciplinary knowledge and increasing complexities while engaging with various visual mediums for analysis and curation.*	The starting point for the investigation into hybrid forms of mapping was due to the need for multiscalar, temporal and projective engagement needed to design large-scale relational spatial nexus of the landscape-seascape continuum in Vejle. The search for suitable methods and tools for the challenges associated with this issue came about with an online network mapping tool called Kumu, which was an apt medium to accumulate, connect, synthesise, assess and curate the different transdisciplinary knowledge and data associated with investigating how to "urban seascape with seaweed" in Vejle (using Kanten/The Edge design competition entries as data). The Kumu map was re-designed and repurposed from its original purpose as a stakeholder relational mapping tool to incorporate a spatial element by embedding territorial mappings, animated GIFs, drawings, sections, photos, videos etc., into a "node" within a larger network map. This meant Kumu maps could operate as a "master map" (i.e. maps within maps) to show the interconnection between visual mediums/findings and interactive for the user to engage with online (i.e. it is an activity-inducing mapp*ing* tool). Kumu is an emerging type of new hybrid form of mapping that is created for this research to highlight the need for accommodating the increasing complexities and entanglements that characterise urban developments in the Anthropocene. Thus, the methodological contribution of the research lies in its demonstration that the role of network mapping can play in multiscalar contextual deep site analysis and a temporal way of curating future projections and mapping complexities through multi-modal relational understanding. **Generalisable outcomes:** The mapping process of a Multiscalar network map, Temporal-projective map and State-of-the-art map in Kumu.

Table 4. An overview of the research questions, the initial hypothesis and the overall research contributions of Urban Seascaping. The methods used to attain the outcomes are: Literature review, Case study, Expert interviews, Fieldwork (i.e. site visits, workshops and meetings) and Research-through-design via mapping.

5.1.1 Seaweed as a catalyst of urban transformation in the age of the Capitalocene-Anthropocene

There is a paradoxical aspect to the aesthetics of seaweed. On the one hand, I have spoken to several marine biologists in Denmark who pursued their careers specialising in seaweed primarily due to their beauty (Krause-Jensen, 2022) (see the Victorian women's dry pressing of seaweed, as shown in Figure 19). On the other hand, there is this negative public perception of macroalgae as a weed – i.e. something that is ugly, smelly and slimy that you want to avoid while swimming (Krause-Jensen, 2022). It is hard to be enchanted by something that seems worthless, uninteresting, unknown, invisible and even disgusting. For the (Danish) public, there is generally a lack of interest and awareness in seaweed (Hedrup, 2021; Krause-Jensen, 2022), but also, in practice and research in the LUDP disciplines (unlike marine biology), seaweed is seldomly mentioned as a marine "nature" that could be implemented as a part of waterfront/harbourfront development and coastal adaptation (i.e. nature-based solutions) in Denmark and abroad. However, this is changing among groups that are aware and collaborating more with the themes of blue biodiversity with marine biologists (Larsen et al., 2021).

Conceptions of nature since the Golden Age period of Danish history favoured a particular aesthetic of nature – the sublime, "untouched" nature in the wilderness or the neat, manicured visions of the well-kept terrestrial pastoral landscape. These ideal visions of nature have persisted in current times, as, for instance, is reflected in the negative reaction to "nature" that looks unkept and unmanaged, such as the reaction towards beach wrack, the smelly and rotting beach matter that also plays an important ecological function for the insects and biodiversity and even has a role in mitigating coastal erosion (Innocenti, Feagin and Huff, 2018; Robbe et al., 2021). The learnings from this research indicated the difficulty in departing from the influential romantic aesthetic ideals of nature and how it could be a barrier to accepting the need for alternative aesthetics or even "unkept" marine nature in coastal urban areas (which is more difficult to control). For instance, in correspondence with various marine biologists, certain people found the floating buoys on Vejle fjord (which hosts mussels and seaweed for cultivation) ugly and an eyesore to the "unspoiled" view of the water. The irony here is that Vejle's fjord has been subject to ocean sprawl due to urban development and environmental degradation due to agriculture, which does not seem to cause the same kind of resistance. It highlights people's preoccupation with the sea *merely* as a view only for recreational pleasure, which is currently a marketable and profitable commodity.

Furthermore, there is also resistance to accepting this "new type of marine nature" at the waterfront due to the dominant imagery of hard-edged concrete bulkheads in most coastal cities as the norm, indicated by the remarks from some of the judges during the Kanten/The Edge design competition deliberation; "there is too much [marine] nature; it looks like some nature park" (in reference to the first place winning project).

There are also other resistances to cultivating seaweed at a larger scale, for instance, economic factors, where manual labour of harvesting seaweed is expensive in Denmark, and the market demand is too small (Hornbek Nielsen, 2020; Boderskov, 2021). It is also difficult to attain municipal permission to have large-scale interventions on the water in Denmark (Boderskov 2021). These regulatory and economic hurdles to cultivating seaweed on a larger scale are beyond the Kanten/The Edge scale and outside the domains of the LUDP disciplines. Furthermore, the research indicated that there seem to be biases in the distribution of funds towards large grey infrastructure, which consumes large amounts of energy, time and resources. Some examples of grey infrastructural projects covered in this research were hyper large-scale land reclamation projects and additional transport projects costing billions of kroners, while projects to revive Vejle fjord, a "blue infrastructure", get meagre short-term funding in comparison. It may sound simplistic, but there is still a tendency to prioritise and value more economic growth-inducing initiatives despite the need to radically reduce emissions (or increase carbon-sequestering initiatives). However, how many more billions, if not trillions of Kroners, would the coastal cities need to spend on coastal defence, infrastructural upgrades and property damage in the future due to climate change-related issues? How expensive is a "point of no return" in the degradation of coastal waters? Perhaps, there may be beneficial potential in assigning the fjord with a utilitarian value in the Capitalocene, as a "blue infrastructure", as a source for meeting some of the carbon sequestration targets, a source for sustainable forms of food, feed and even fuel while providing levels of coastal protection for storm surge and mitigating coastal erosion.

So, the question remains, are these "barriers" too big for Urban Seascaping with seaweed? These barriers do not seem so big in light of global, national and regional deadlines and goals such as the Paris Climate goals, IPCC targets, the EU directives on improving biodiversity and Vejle Municipality's goal of increasing wetlands in the future. Therefore, I explored in this research one of the steps towards bridging the gap between city and sea, human and nonhuman, from a spatial intervention as one of the many steps toward enabling a different way of thinking about seaweed and marine life forms – by including them into the everyday experience of living in a coastal city. Projects like Kanten/The Edge could contribute towards the beginning of what constitutes an urban coastal "landscape/seascape" (urban ecology), as these projects are still in the early stages of acceptance and implementation[254]. Thus, the implementation of Kanten/The Edge in the next few years would open more possibilities for research that uncover insights about how the public and marine life forms will accept them[255] and understand the true potentials and shortfalls of these initiatives, which can then be scaled up (however, it is not a straightforward task of being able to "measure" the actual impacts – be it perceptual or physiological).

Moreover, there are many other ways to address the integration of seaweed as a key actor in future ecologies in urban development that needs to run parallel to a spatial design approach. For instance, to help change the current negative and illiterate understanding of (urban) seaweed, educational and community-based initiatives that help create a culture around seaweed, raise awareness and influence policy change are paramount (such as the continuing efforts by Vejle Municipality/Sund Vejle Fjord, Havhøst, Marine Education Centres, etc.). Much of the research and educational initiatives by organisations like these indicate the importance of direct exposure to the marine world to aid in better ocean literacy, interest and care. Therefore, how these educational and cultural "services" are better integrated and hosted in the waterfront areas in

254 Many of these blue projects are unrealised and remain as beautiful speculative drawings and illustrations. For instance, the speculative works for the "Rising Current" in NYC, Coastal Bight, EDIT studios in Norway, and some of the Realdania pilot projects, to name a few.

255 For "unkept" and "uncontrolled" marine aesthetics currently, to be accepted as part of the waterfront identity, it might take time to be accepted by the public as the new "normal" on the waterfront.

transformation (as part of the blue urban commons) is also a task that the spatial design disciplines can also assist with.

Finally, my approach throughout the research has been to use seaweed as a representative – as a point of departure and a lens to address the immense transdisciplinary complexities. Focussing on seaweed gave me a specific lens to navigate through this research that otherwise could have ended in another direction. For instance, working with seaweed allowed the site of intervention to go upstream (to tackle the sources of pollution) to the deeper sea (mid-outer fjords for the implementation of floating kelps). That being said, I am, of course, not proposing that seaweed is the most important representative/actor, as seaweed is only a small part of the puzzle in this myriad of complex entities that make up the coastal ecosystem, nor is it the saving grace to climate protection/adaptation. There are bigger systemic issues that need to be addressed, and thus seaweeds should not be used as a way to detract attention from the real sources of the issues. Moreover, by romanticising them, they can also become subjects of greenwashing. Nevertheless, seaweed is unique from other coastal vegetation because of its potential to impact various parts of culture and presents an original contribution to research by consciously integrating them through a spatial design.

5.2 Key learnings from the Kumu mapping analysis and projection of Kanten/The Edge

The learnings from Kanten/The Edge competition helped answer the main research question by offering examples of what nature-based coastal protection models might look like in practice. The findings revealed the potential role of the spatial design disciplines in aiding the blue-green transition towards a new reality with water in the future for coastal cities like Vejle (addressing SRQ1). The winning entries revealed different approaches with unique strengths and weaknesses in creatively integrating the marine realm into the urban realm (addressing RQ). In the following, I reflect critically on the key learnings from Kanten/The Edge competition, encompassing the three phases of involvement from Figure 115.

5.2.1 "Beyond the edge" - Deconstructing the conventional notion of a site

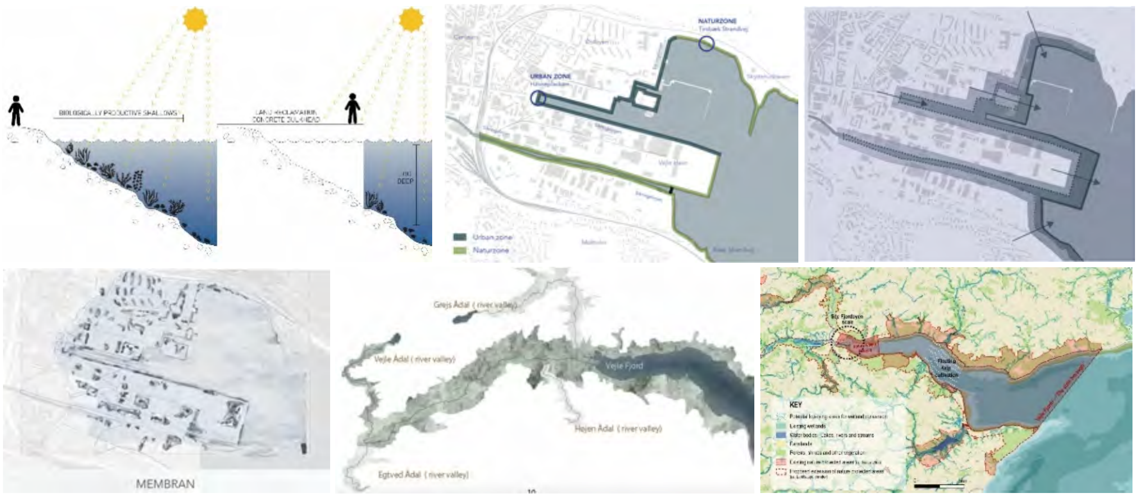
Reflecting on Kanten/The Edge competition brief, the judging process and the winning entries, a central theme kept repeating itself throughout, namely the importance of going beyond the edge to a zone. The issue of scale is key to the definition and how designers define the geographic and spatial extent of a site and understand the context of their work (Kahn and Burns, 2021). For instance, the multi-scalar mapping study revealed that the coastal urban sites in the land-sea continuum partake in many differently scaled networks simultaneously and at different timeframes. Therefore, engaging as a singular and limited understanding of a site obscures and simplifies the reality of the entangled complex spatial interrelations (Kahn and Burns, 2021). Departing from the definition of what constitutes a site by Kahn and Burns (2021), they argue that there are three distinct viewpoints and territories. First is called the "area of control", which designers are most familiar with as "the site", defined by often linear lines of property, assigning the legal boundaries in which designers can exercise the most agency. Second, the areas outside the control are called the "area of influence", which includes the surrounding forces that act on the site beyond the assigned plot. The last is called the "area of effect", the areas impacted by the design action/intervention (ibid.). Kahn and Burns (2021) argue that while all three areas can exist within the domain of design concerns, the "area of influence" and "area of effect" conventionally lie outside of direct design control but situate design actions in relation to wider processes. The research findings reinforce the view that these three areas overlap, despite their varying geographies and temporalities when working with water networks.

The research, therefore, argues that there is a need to engage beyond the "area of control" (as defined by the two zones in Kanten/The Edge brief) to include the "area of influence". This is due to the current dependence on improving the current poor ecological condition of the fjord when considering marine NbS. Going beyond the current notion of a site means acknowledging water's networks, including wetlands next to rivers and protected forests near the coast (Natura2000 area) that play an important role in filtering agricultural runoffs[256]. Moreover, the need to think from a watershed/catchment scale to limit the sources of pollutants that travel through these water

256 For coastal cities where the source of water pollution is due to untreated sewage, then the solutions do not need to include the watershed. Nevertheless, the watershed has a role in determining flood defence from cloudburst events.

networks crisscrossing artificial legislative borders challenges the notion of intra-municipal to inter-municipal collaboration. These upstream-downstream networks emphasise that the proposal of Kanten/The Edge do not exist in isolation but is dependent on the success of these other nature restoration projects (such as Sund Vejle Fjord), which mitigate water pollution. This means that the "area of control" (site) expands to include Vejle Fjord as a holistic entity[257], including its connection to the river valleys (refer to Figure 175 and Figure 168).

Furthermore, the need to expand the "area of control" (site) is supported by the need for a larger-scale intervention when addressing more complex and time-pressing issues like climate change and meeting climate goals[258]. To be able to make a significant impact on the carbon sequestration and water filtration capacity of NbS, especially when considering seaweed (kelp) as a soft approach to coastal protection via wave attenuation (and coastal erosion mitigation), requires engaging with the mid-outer fjord (see Figure 175 and Figure 168). While there is an importance in the edge conditions to demonstrate how waterfront/harbourfront development can integrate marine nature as part of the spatial and aesthetic experience of a coastal city, it also needs to go beyond an aesthetic approach to ensure that it contributes more significantly to improving the conditions of the Fjord towards a more equitable multispecies coexistence. Providing more space beyond the edge for water in these contested zones opens up more possibilities to envision how to live not just by the water but *with* the water in the future.



257 The city architect of Vejle reiterated that Vejle is not just the city centre next to the water, but it also consists of many clusters of suburbs on the hills and in the hinterlands. Therefore, there are plans to develop and invest in these higher areas as the bottom of the river valley becomes more vulnerable (refer to Table 16 Appendix 12).

258 Vejle Municipality is currently working on how we can reduce CO_2 emissions. By 2030, Vejle must have reduced its emissions by 70%. Kanten/The Edge must be considered as part of this vision (Vejle Municipality, 2020a).

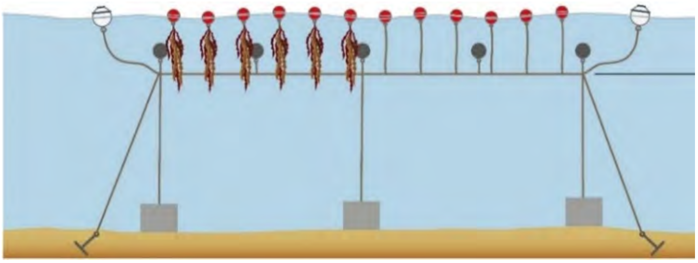


Figure 175. (Top Left to Bottom Right) A progression of how Kanten/The Edge expands out, starting from the importance of the shallows in addressing the need for access to sunlight for seaweed, which is impeded due to various anthropogenic activities. Kanten/The Edge site represents two edge conditions (urban and nature) and sees a "zone" as an area that expands out from the edge in the near vicinity. While the winning entry expanded this notion of a zone to include the entire Fjordbyen (The Membrane), the zone also should encompass the four major river valleys that all join and connects to Vejle Fjord. Furthermore, when considering seaweed as part of the coastal protection strategy, the site (area of control) expands to a mid-outer fjord area where kelp can be grown. Finally, in order for marine NbS to be successful, the main source of pollution needs to be addressed within the watershed/catchment area.
Image credit: Vejle Municipality, Teis Boderskov and Team Membrane: Josephine Philipsen, Luisa Brando, and Andres Hernandez.

The notion of a site is also relevant to notions of ownership and responsibilities, its arbitrariness challenged by the fluid medium of water. For instance, a fixed understanding of boundaries currently excludes farmers' responsibilities for the degradation of the fjord, which can be considered a common "good". Moreover, issues of sea level rise and storm surge through Vejle fjord (and its ecological degradation) concern not only Vejle Municipality but also its interconnected surrounding municipalities. This meant the responsibility of financing and needed regulations for decision-making needed to be shared, requiring collaboration beyond land borders. The numerous property lines that demarcate private ownership of lands that all face the same fate from increasing risks from water (and coastal erosion), therefore, require a unanimous, collective and holistic decision on a remedial solution.

Lastly, the 90-degree concrete hard edges delineate the boundary where the city stops and the water begins is being challenged by future SLR/SS. Climate phenomena are not only putting in question the shifting boundaries between the city and the sea but also whom these boundaries are serving. Should the meeting place between the city and the sea in the form of waterfront and harbourfront remain largely inaccessible and the seaview privatised for the privileged few? And if this is the continual urban development model into the future (i.e. the increasing size of ports and high-rise, high-end apartments), should public funds be used to protect the interest of the few in these risk areas in the future?

5.2.2 The value of transdisciplinary collaboration

The judging committee consisted of those with different priorities and values from different sectors in Denmark (see Appendix 11D for the list of judging committees). While they all expressed concern with the increasing negative impacts of climate change and thus issues with water, they all had different priorities in which aspects they deemed more important. For instance, one of the judges prioritised branding Vejle as a tourist attraction, with concerns for economic growth. Some expressed their desire that the designs show stronger homage to the industry of Vejle's harbourfront. Through my involvement with the judging process, I gathered that it was perhaps also a learning experience for the judges[259] during the deliberation process – a chance to be exposed to a different way of thinking about waterfront development and coastal protection. The professional judges (the city architect of Vejle and a professor from Aarhus Architecture School) who took on the role of leading and guiding the deliberation process ensured that the winning entries satisfied the competition brief and not be deterred by the individual subjective preference of each judge. In hindsight, the professional judges ensured that the typical B-A-U projects that did not comply with the brief from being selected as a winner (while open discussion as to why certain proposals did not comply was encouraged) (refer to section 4.1.1, Figure 142). Even as a researcher in the field of LUDP working in this transdisciplinary context, the exposure to marine biologists through Kanten/The Edge competition was a huge eye-opener in many respects. The experience solidified the importance of designers working with marine biologists when engaging with the marine realm, who has been working with marine environments much longer than the LUDP disciplines. I realised how, conventionally, architects do not integrate and work with the marine environment, which was demonstrated by the common mistakes displayed by the unsuccessful Kanten/The Edge competition entries (as indicated in section 4.1.1).

The judging process of Kanten/The Edge reflected the complexity of representing a diverse set of interests (i.e. political, economic, ecological, social, and cultural). Moreover, the involvement of the two marine biologists[260] was particularly crucial, as they guided the competition to ensure that ecological values were at the forefront of the design solutions and influenced the final outcome of the winning entries by eliminating proposals that would not work from an ecological perspective. Therefore, in order to successfully engage in nature-based solutions, transdisciplinary efforts from various actors were necessary, in particular, the role of the marine biologist in determining more successful design parameters for integrating marine life. The interviews with Kanten/The Edge winners revealed that collaboration with marine biologists is difficult, as few established networks exist. Moreover, it is not common for these two disciplines to work together towards a common spatial, design and ecological outcome making Kanten/The Edge a state-of-the-art competition by bringing artists, landscape architects and marine biologists under one roof.

259 One of the judges approached me to ask me further about whether the nature-based solution had the potential to give Vejle a different appeal compared to other coastal cities in Denmark.

260 The first marine biologist was involved in making the inspiration video providing more detailed context-based knowledge on Vejle Fjord, while the other marine biologist as an advisor to the judges.

5.2.3 The invisible actors

COVID-19 played an important role in receiving more resolved and sophisticated entries, as all top three winning teams had compromised workloads during COVID-19, resulting in working on the competition for several months, a rare opportunity to dedicate their full attention to the competition. The entries indicated that dealing with these complex transdisciplinary issues outlined in the competition brief required a decent amount of time invested, unlike conventional open competition projects done in haste by architecture companies[261] due to the limited budget. It can result in superficial entries, emphasising impressionable visualisations rather than more daring and resolved proposals. The interview with all the winners also revealed their determination to win (partly due to the loss of work), but they were also able to think deeply about the project with spare time on their side. Their written and visual outputs demonstrated the time and thought spent on the winning entrants' proposals which were noted during the deliberation meetings with the judges. One of the entrants also pointed out that these "larger-than-courtyard size" coastal adaptation projects rarely involve landscape architects (usually only involving coastal engineers or marine biologists). Thus, Kanten/The Edge provided a unique opportunity that piqued their interest to participate.

However, the competition project did not involve citizens[262] or anthropologists who could have contributed to discussions around the changing narratives and socio-cultural ideologies required at the urban shorelines. Furthermore, it could have also been interesting to include discussions on looking at Kanten/The Edge from the marine life's perspective (i.e. the missing actors), which only the SUPERFLEX/Baldios team attempted to do[263]. Furthermore, making the invisible seaweed (and other underwater marine life forms) visible and other imperceptible phenomena like sea level rise, which happens incrementally over a long period of time, became one of the major concerns for Urban Seascaping (as a proposition). Therefore, initiatives that help make these seemingly invisible things visible to the average citizen play an important role in raising awareness. It is difficult to show concern for something that does not seem urgent or perceptible and make it visible. Therefore, the research reinforces the role of creative disciplines (answering SRQ1) by providing space for people to be able to see and interact with the marine world.

My experience with workshops involving the implementation of (marine) nature-based solutions to improve biodiversity, water quality, coastal erosion, and carbon sequestration fell short of engaging at a deeper level when addressing the agricultural industry's impact in Denmark. This impact does not only concern the agricultural industry's sizable carbon footprint but also its

261 This is based on my professional experience working in architecture firms in three different countries over a span of seven years.

262 However, Vejle has been proactive in involving citizens in the discussion of coastal adaptation through its many other engagements, such as workshops, events and online platforms.

263 This entry by SUPERFLEX/Baldios would have been overlooked if it was not for the artist (advisor) pushing forth the merits of this project (both philosophically and aesthetically). Therefore, the involvement of artists as advisors to the judges also played a role in selecting the winning entries that departed from B-A-U proposals. This entry would have easily been overlooked as too "radical" in its design form by some of the judges to be selected as a finalist.

significant contribution to the degradation of Danish water bodies that inhibits the implementation of NbS (refer to Figure 13 in section 1.5). As shown in my research, it is clear that this is one of the biggest contributors to water pollution in Denmark and is something that marine biologists have been battling with the farmers for several decades (Organo Quintana, 2020; Fjeldsø Christensen, 2021; Hedrup, 2021). It is a complex ongoing issue that does not seem to be resolved anytime soon (despite efforts from Vejle Municipality). The ethical implications of excessive meat consumption and production in Denmark are controversial and intertwined with economic benefits and cultural identity, making it challenging to address the problem (Levitt, 2020; Perez-Cueto, 2021). However, this is not just an issue in Denmark – but a global problem in developed countries with excessive agricultural product consumption, resulting in the exponential use of artificial fertilisers as part of the "Great Acceleration" (Steffen et al., 2015) – an exponential increase in the use of resources and degradation of ecosystems since the middle of the last century. Coastal cities like Vejle are at the mouth of the river where the pollutants are expelled, thus making the coastal water bodies next to the cities a challenging environment to implement NbS (such as Kanten/The Edge projects). Before starting my research, I had no idea that the research would have such a big focus on poor water quality due to the Danish agricultural activity. There is growing pressure to implement NbS from many different sources (i.e. national level, EU level) to revive salt marshes and eelgrass as part of coastal resilience. However, the caveat is that the impacts of NbS will be less effective, laborious and costly unless water quality is sufficiently addressed and resolved.

Poor water quality thus has implications for Urban Seascaping. Floating particles from fertiliser runoff render the Danish coastal waters more opaque (and cause more harmful algal blooms), meaning that the world under the water becomes literally invisible (see Figure 24, section 1.5.3 of Vejle's algae blooms). I tried to address this water quality issue by exploring the potential of large-scale NbS via a floating kelp system in Vejle Fjord. The kelp could provide various benefits along with the potential for organic fertiliser (less damaging than artificial ones) while absorbing excess nutrients (while also providing wave attenuation). However, under the current economic model in Denmark, seaweed as organic fertiliser would be too costly to be economically feasible (i.e. high labour cost and low market demand – contrary to South Korea with thriving seaweed farms as shown in Figure 176) (Hornbek Nielsen, 2020). These findings indicate that even in cases where environmentally sound solutions are present, such solutions will not see the light of day unless they have profit-generating capabilities or are heavily subsidised by the state. This means that these green solutions have difficulty being implemented. It is with the hope that as the benefits of seaweed become more well-known by the public and private stakeholders through initiatives like Kanten/The Edge (along with education and regulation) that could aid in cleaning up the waters of coastal bodies in Denmark, both at the source of pollution on land and in the water.

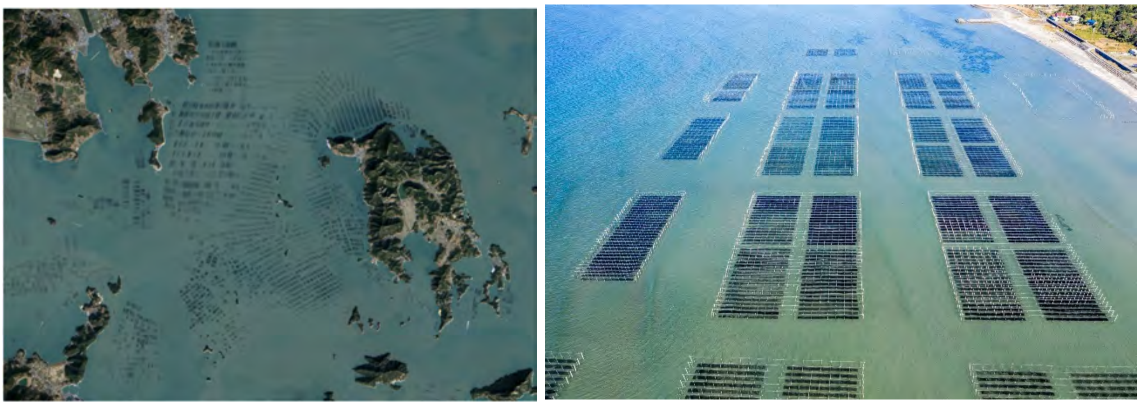


Figure 176. The dark squares that make up the checkerboard pattern in this image are large-scale seaweed farms viewed from a satellite image. Along the south coast of South Korea, with a thriving aquaculture industry, seaweed is often grown on ropes, which are held near the surface with buoys, an example of a "production landscape". Image credit: NASA Earth Observatory image by Jesse Allen on January 31, 2014 (NASA earth observatory, 2015) and LeafScore (Hollow, 2021).

5.2.4 After Retreat: New Blue Urban Commons

[S]patial design disciplines understand space as a relational structure, by going beyond dualisms such as city – country, natural – artificial and placing the focus on the relations between humans and things and their dynamics.

Sigrun Langer, *Mapping as a navigational strategy* (Langner, 2019, p.51).

Managed retreat and stopping development in risk zones ("tilbagetrækning" in Danish) had not been officially presented as a viable strategy. Despite the best intentions of the individual municipal public servants, it is not a national strategy backed by the Danish parliament, most likely because it would constitute a highly controversial topic. Politicians also have limited expertise on this subject. Therefore, more time and effort are required to convincingly present a sound retreat plan of certain risk areas that would need to be relocated in the long term and regulations made to stop development in critical areas (and not just get developers to pay for the sea wall while doing B-A-U). There are many complex reasons behind the delay of no development plan in risk zones and a viable retreat plan for the long term in Denmark. Understanding the various factors will require further detailed examination. Nevertheless, in the absence of these regulations and official strategies, urban development will continue in the risk zones, and if they are continually designed in a B-A-U manner, these areas will be costly to protect and relocate in the future. Moreover, it will continue to perpetuate a sense of denial about the impending threats to climate change and delay the need for more radical changes[264] sorely needed in these risk areas. Additionally, the current "Storm surge Strategy" for Vejle (i.e. Stormflod Strategi) that passed in December 2020 is based on predicted future scenarios of SLR and SS with no mention of a retreat[265] plan (refer to Figure 114 in section 4.1.1). However, given the current global inertia in meeting the IPCC goals/Paris Agreements in 2030 and 2050, these strategic documents could underestimate the future impacts of SLR/SS. Unless Vejle wants to keep increasing its elevation (bulkheads) and install bigger pumps (which is an option), could Vejle make use of the unexplored opportunities for urban transformation through a crisis of SLR/SS? (i.e. new uses, new habitats, new financial models, new building models, new ways of living). Furthermore, having a long-term retreat plan has implications for Urban Seascaping. For instance, if the most vulnerable areas at the waterfront are relocated to safer grounds, these risk areas can be available for urban transformation – in this case, a form of new blue urban commons[266], as explored in the projective Kumu mapping in section 4.2.2. This raises the question of who should occupy the waterfront in the face of rising sea and raging storms in the future. Are blue commons a necessity that should be publicly owned and accessible to humans, and the land reclaimed risk areas be returned to nonhumans in the future?

Ultimately, in the absence of a sensible long-term retreat plan, Vejle's municipality's Storm surge strategy also reverts to the conventional approach of asking how high the storm surge protection levels should be (refer to section 3.1 on dominant practices). Rather, the question should also be about the different ways to coexist *with* the sea, opening up more alternative design possibilities such as those indicated by the Urban Seascaping propositions.

264 Including the extra time required to experiment and monitor the impact of these radical solutions.

265 Also missing from the report is the designation of "no development zones" (i.e. degrowth of Fjordbyen), no allocation of B-A-U developments in the risk zones or future plans to retrofit existing buildings to be able to handle frequent inundation. Moreover, the long-term strategy outlined in the report only reaches up to the year 2070 and is very vague and indefinite in its future plans.

266 Vejle on the East coast in East Jutland is different to other coastal cities with stronger tidal differences and waves with much more dangerous and deeper currents. Therefore, it provides an opportunity for designing spaces that allow safer access to water for the citizens. The transferability of Kanten/The Edge competition findings would be appropriate for similar contexts in Denmark (especially the fjord-based coast cities of East Jutland, Sjælland and Fyn).

5.3 Shortfalls of Urban Seascaping

[M]any landscape architectural assignments have to respond to a higher degree of unpredictability and thus need other types of design directives… However to study design directives for entirely new conditions, rigorous research through design is required to explore the breadth of future design possibilities beyond the precedents. Apart from that, designers in practice are increasingly urged to legitimize their design decisions towards a critical public. This requires conscientious designing and rigorous testing of design alternatives.

Sanda Lenzholzer, Steffen Nijhuis and João Antunes Granadeiro Cortesão, *Research Through Design in Landscape Architecture: a first State of the Art*
(Lenzholzer, Nijhuis and Cortesão, 2018, p.2).

Urban Seascaping encompasses many aspects covered in this research, be it from an epistemological perspective, a critical stance against the status quo of urban development in coastal cities, or a proposition to guide the mappings as a curatorial and analytical tool. However, it runs the danger of simultaneously encompassing everything and thus not being specific enough to distinguish anything. In the process of the research, I found it difficult to balance between the act of giving room for my conceptual propositions to be general enough to be applied in different contexts whilst also not being too broad, meaning that it might fail to offer concrete prescriptions in particular cases, making little less than a reductive to-do checklist. That being said, suggesting some generalisable "solutions" from a specific case study finding is an immense undertaking, and I am certain that Urban Seascaping has not escaped the pitfalls of these all too familiar shortcomings. However, I also recognise the importance of having an initial framework for thinking and doing, such as Urban Seascaping, that at least attempts to encompass a higher degree of unpredictability, complexity and plurality when dealing with the issues around climate change and more-than-human entanglements with urban development. I argue that USS has served its purpose in this research for the context of Vejle (East Jutland), but by no means universally applicable. Moreover, Urban Seascaping is by no means perfect or finished. It is an ongoing process contributing to the emerging fields of Blue urbanism (Beatley, 2014), Coastal Urbanism (Segal and Drake, 2021), Marine landscape architecture (Sørensen, 2020), and other urban landscape practices.

All the while, in the current age of information, which is characterised by increasing complexity, the relationships that Urban Seascaping seeks to map need to be communicated in a manner that people (i.e. different stakeholders) can relate to and easily understand without oversimplification. It is the biggest challenge of our times as researchers in the field of "green transition" to work with immense transdisciplinary complexity while being able to disseminate that knowledge to the wider community. I tried to ensure that the research was as clear and transparent as possible in navigating through the complexities and addressing the reasons why Urban Seascaping took the form it did as *one* approach to moving past B-A-U practices. In the future, these overwhelming complexities may become more sophisticated, familiar or easy to navigate. At such a moment, the proposition of Urban Seascaping may no longer serve its purpose as an *alternative* way to think differently but constitute the B-A-U urban developments at the coast. Furthermore, I had concerns about whether USS is the most appropriate term or perhaps the term has run out of steam throughout this research. My limited capacity to engage with the more "enchanting[267]" narratives, such as the Māori people's model of stewardship/guardianship, to represent the more-than-humans as a human ambassador and how this type of model could influence spatial design outcomes. Issues surrounding ethics and legal frameworks (i.e. Right to Nature) are incredibly complex, and thus, the ethical components of the Urban Seascaping proposition are not without weaknesses and fallacies. It is a task that would benefit from collaborations with lawyers (planners), local communities, philosophers and social scientists. Inputs from these disciplines would also have influenced this research in another direction, different from my close workings with marine biologists.

Moreover, collaborating with marine biologists was challenging to integrate knowledge that was radically new to me. Working with high levels of disciplinary entanglements made it challenging to regulate the different levels of complexity sufficiently enough to be relevant for this research. For instance, how much transdisciplinary knowledge needs to be synthesised? At what point does the complexity become an unnecessary level of depth that is irrelevant to stakeholders? (such as practitioners or municipal members[268]). Therefore, it is important to stress that the intention of the Kumu mapping tool is not for stakeholders to create a replica of their corresponding context but as a way to be aware of these complexities at play and as a tool to think with when making decisions when considering marine realm into the development of the coast.

5.3.1 Shortfalls of Kumu Mapping

> *Gilles Deleuze and Felix Guattari declare: 'Make a map not a tracing!'. . . What distinguishes the map from the tracing is that it is entirely oriented toward an experimentation in contact with the real... The map has to do with performance, whereas the tracing always involves an 'alleged competence.'*
>
> Gilles Deleuze and Felix Guattari in James Corner, *Agency of Mapping; Speculation, Critique and Invention*
> (Corner, 2011, p.213).

267 In reference to the statement by Jane Bennett (2001), "it is hard to love a disenchanted world".

268 It would be unrealistic to expect municipalities or practitioners to repeat the level of depth I explored in this research – even the multi-scalar site analysis.

The spatial mappings for Urban Seascaping could have done more to portray the marine realm with less focus on terrestrial depictions. This imbalance is due to the abundance of land-based GIS data (itself an example of terrestrial bias) but comparatively very little data on water, making it difficult to represent it on the map. Therefore, I also struggled to depart from depicting the boundary between city and sea as a line and water as an abstract flat plane with a limited portrayal of what is underneath the surface of the sea. Moreover, the findings indicated that Vejle fjord is largely a dark, murky, empty and muddy desert (refer to Figure 8, section 1.4.1) (Fjeldsø Christensen, 2021). The dilemma was whether to represent in a section to show the majority of the fjord that is uniformly lifeless and dark or whether the screenshots of the video provided by the Sund Vejle Fjord project would suffice. On the contrary, for future potential projections of implementing marine nature-based solutions in Vejle, I was hesitant to represent seaweed in a manner that could be too aesthetically pleasing[269] (refer to see Figure 170, section 4.2.2) and risk romanticising marine nature and mislead the public's expectations. I also struggled with my lack of visualisation skills to achieve this "balance" successfully - the balancing act between doing it justice to represent marine life (i.e. seaweed) accurately and imaginatively as possible while avoiding depictions of overt romanticisation that is radically different from the dire condition it is in now.

Furthermore, I re-used some of the maps available from various sources without recreating/reappropriating[270] them, reinstating some of the maps I critiqued for their limitations in section 2.2.2. I also wanted to ensure that these maps are somewhat "legible" for practitioners and municipal members by keeping it an incremental step forward development rather than something more radical or exemplary. Regardless, more boundaries could have been pushed with the spatial visualisations and the maps that could have departed from the current normative practices[271] (i.e. "Make a map, not a tracing!"). Other visual explorations I did not explore further were the use of films (audio-visual), 3D modelling/renderings and collages (i.e. dry seaweed pressings that I did in Figure 19, section 1.5.2). These methods could have reaped a different outlook that might aid the analysis and help visualise more imaginative visions of the constantly changing marine world. Also, since collaborative and transdisciplinary forms of mapping are emerging and evolving (such as Kumu mapping, the Feral atlas or qualitative GIS), there may be more possibilities for LUDP practitioners to engage with many different mediums of mapping in the future. Thus, in the end, the Kumu mapping contribution focussed more on the curatorial and organisational aspects of the interconnections between scale, time frames and S-O-T-A projects around the world rather than challenging the spatial mapping/visualisations itself. However, curating these networks was a double-edged sword in that while I used Kumu to structure the

269 Danish marine nature is not as visually enticing to humans compared to the tropics; therefore, I suspect it would require certain levels of sensitivity to pay attention and appreciate less fantastical forms of marine nature. However, the before and after depictions of going from a marine dead zone to a flourishing bed of mussels, seaweed and eelgrass could enable people to appreciate that life below the sea can also flourish with interventions such as stone reefs.

270 Many of the spatial mappings were reused from existing data available from GIS and other sources rather than spending time to make them look more "aesthetically" unified. I made this decision because I thought that telling the overall story and the interconnections was more effective than recreating what had already been done.

271 Nevertheless, I did engage in some attempts to incorporate different ways of depicting the water and the marine life forms, as shown in depicting the water bodies as blood vessels in Figure 38.

entangled mesh, it can still risk being too complex for some users, limiting its full potential for a wider audience. Ultimately, Kumu served more useful as a research tool/method for me and as the sole navigator to disseminate findings rather than a universal tool. Furthermore, I did not make full use of Kumu's analytical capacities as software[272] due to my limited skills (coding).

Moreover, translating the interactive nature of Kumu and reducing its complexities into a static A4 format was also limiting and reductive. However, working across scales, timeframes and disciplines with the mapping helped me understand how these interconnections worked and uncover hidden aspects that led to new queries. The Kumu map is essentially an exercise in deciphering the complexity of a relational structure between maps but, most importantly, to enable a complex cartographic conversation.

272 For instance, the Kumu nodes can be free-flowing, thus, by assigning certain parameters, the nodes can move and cluster around in different categories. The sizes of the nodes can also change based on certain parameters (i.e. popularity of connections), and Kumu can reveal, track and analyse different capacities of nodes, depending on the parameters. It can be used to run fairly complex analyses (Kumu INC, 2011).

5.4 Future research avenues

In this penultimate section, I briefly address some of the viable research avenues and unexplored research gaps I chose not to cover in my research.

5.4.1 Potential role of local 1:1 scale implementation and adaptive architecture

One of the main limitations of this research is that the main framework, i.e. that of Urban Seascaping, has mainly been explored through projective works, especially by exploring the entries for Kanten/The Edge design competition. There is a limit to understanding the actual real-world impact of these interventions. This analysis considered the ecological, sociological, cultural and economic impacts of the projects, especially on a local level. Fortunately, Vejle Municipality has plans to follow up the winning entries from the competition into a 1:1 scale-built project[273]. In turn, a physically built Kanten/The Edge proposal would open up the scope for investigating more measurable and tangible impacts, for instance, the capacity for nature-based solutions (NbS) to provide effective coastal protection and enhance biodiversity. What type of marine nature might return and live in the new Kanten/The Edge? The 1:1 built project could provide grounds for understanding the public's (residents and tourists) response to these new blue urban commons, as public opinion was not included during the deliberation process. Furthermore, any unintended consequences or unexpected shortfalls would be important to understand to ensure what works in the local Vejle inner fjord context.

Moreover, a potential larger-scale NbS could be tested further out in the mid to outer Vejle fjord, such as the floating kelp system, to understand the impacts of water filtration, wave attenuation, mitigating coastal erosion and as a sustainable source of food, fuel and feed. A 1:1 scale is one of the most realistic ways to test how different forms of integrating seaweed could impact the way residents view the fjord as a new form of a seascape or whether it will be dismissed as an eye sore (refer to section 1.5.3). Nevertheless, the emphasis here is to ensure that these efforts from Kanten/The Edge competition go beyond the projective realm to the next phase of a realised project to understand the context-sensitive real-world implications of such interventions.

While the majority of this research has been focussing on larger-scale landscape-seascape potentials of urban transformation at the coast, there is ample scope to study the different types of adaptive buildings that could safely occupy the risk zones[274]. For instance, there are existing examples of innovative ways to occupy the waterfront, such as temporary structures that could easily be dismantled and moved to a safer location (refer to Figure 58) that is not destructive nor obtrusive to the marine life below. Individual buildings' role is important to provide indoor space

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273 Vejle Municipality currently plans to finish the construction of Kanten/The Edge's Nature zone around 2024/2025, which is beyond the timeframe of this research.

274 For instance, ground floors and basements of buildings can be repurposed for car parking structures that can withstand flooding with relatively minor damage, while the more valuable shopping or commercial functions can be placed above the flood level (while residential areas in the risk zones are relocated). For e.g. in the Netherlands, underground parking areas double as water storage to hold excess water during flood events (Pilkey, Pilkey-Jarvis and Pilkey, 2016).

to host various activities at the waterfront in colder and wet climates like Denmark, where outdoor public spaces are seldom occupied during colder months resulting in dead, unused, unlively areas. Therefore, the role of adaptive and resilient architecture that can host various activities (i.e. marine education centres) will enhance the livelihood of the waterfront area to bring people into these areas where Kanten/The Edge projects are to be implemented. Furthermore, multispecies coexistence indicates the idea of cohabitation and bringing together the current nature-culture divide at the coast, albeit in a more symbiotic way. In that regard, it would be important that these buildings do not resort to the status quo of unsuitable, unsustainable and unadaptable buildings criticised in Part III.

5.4.2 Informative tools and imaginative visions

Multispecies justice demands thinking in legal and political frameworks, but also in cultural ones, and especially in terms of narrative. What stories do particular communities tell about their own origins and futures and about their relationship to other communities and species is often a crucial means of establishing and perpetuating scenarios of justice and injustice. Fictional story worlds, in addition, offer the possibility of playing out the implications of different kinds of design and planning in the context of polyphony of voices and divergent plot lines. This has, of course, always been one of the functions of the novel, and especially of novels in the genre of science (or speculative) fiction, which uses the device of futuristic or alternative worlds to explore the consequences of individual and collective decision making.

Ursula Heise, *Mapping Urban Nature and Multispecies Storyworlds in Design with Nature Now* (Heise, 2019, p.79).

During COVID-19 lockdowns, much of the research dissemination, collaboration, fieldwork and data collection process went digital and online. Stumbling upon online digital tools like Kumu (or other online maps like the Feral Atlas in section 2.2.4) was, therefore, of no coincidence. However, Kumu is not originally designed for the LUDP spatial design practice, so there is a potential research scope in developing software and programs specifically for the spatial design disciplines that can assist in representing, curating and helping with analysis of the increasing engagement of multi-scalar, temporal and transdisciplinary complexities. Thus, there may be future potential for improving collaboration with engineers (simulation programs), geographers (GIS), and designers (spatial-visual representations) to explore hybrid programs that can help us better predict, understand and communicate nature-based proposals[275] as a *design* tool (i.e. how can designers know that their design proposals will work in that specific context from a marine perspective? How can designers better engage with the spaces under the surface of the water?) According to Orff (2016), there is an "emphasis on the need for iterative modelling, testing and refinement and stressed the need for informed design decisions and collaborative conversations with residents, scientists and city planners alike to achieve successful outcomes" for the future. These different "tools" could also extend to, different immersive mediums such as films (Troiani and Kahn, 2016), virtual reality (Wallis and Ross, 2021), photography (Hjortshøj, 2021), eco-art (Christensen-Scheel, 2020) and even scuba diving as a method (Sørensen, 2020).

Furthermore, the role of new "tools" does not stop at technological inventions and software. New narratives also are tools to design with. For instance, there is emerging scholarship around the role of science fiction (and cli-fi, see Figure 172) as a way to generate future narratives and design projections (Letkemann, 2022, pp.25–60). Moreover, participatory design methods are used to derive engagement and more inclusive design practices and, thus, outcomes (Letkemann and Laplace, 2022). Also, there is scope to take on a much more theoretical approach by examining Bruno Latour's Actor-Network Theory (Latour, 2007; Yaneva, 2022) or James Gibson's Affordance Theory (Gibson, 1979b) to provide a deeper engagement with questions such as how is seaweed an actor? What is its intrinsic agency? What is the affordance of the sea/seaweed?

5.4.3 Changing ecologies and cultural heritage

Another emerging discussion is the project of rethinking the idea of "ecological novelty" to one that acknowledges the constant flux and entwined human and nonhuman elements and processes that characterise all environments today (Orff, 2016; Lemoine and Svenning, 2022). Robinson (2017, p.356) supports this view by stating that "caring for the planet… does not mean restoring a lost purity but accepting hybrid ecologies". As climatic conditions change, the potential of hybrid species as part of NbS in the future is largely unexplored in design research. This is particularly relevant as the future climatic change would lead to the extinction of some existing species unable to withstand the heat, or due to rising sea levels, forests near the coast would not survive the saltwater intrusion. There may be potential to compensate for the "lost" nature (i.e. the beech forests) with new coastal nature (i.e. seaweed) that, with time, could become the new normal for that area. For instance, it may be inevitable for the arrival of foreign species of seaweed as kelp is already moving up to colder waters (refer to section 1.5.1). Therefore, there may be scope for researchers to look into potential hybrid/new species[276] as part of the urban landscape/seascape

275 Without proper simulation modeling it would be difficult to know as designers how dense or how much space is required to effectively implement the nature-based solution. These factors are dependent on the local conditions (salinity, water current speed, the strength of storm surges, tides, bathymetry, etc.). The size may differ between several hundred meters to several kilometers.

276 This view of hybrid ecologies has also been supported by Vejle Municipality in Kanten/The Edge competition brief, where it acknowledges the future reality of being able to host new animals and plants than those we see today through innovative landscape-seascape proposals (Vejle Municipality, 2020a).

approach that could be better suited to withstand climatic changes in the future, compensate for the loss of terrestrial forests due to SLR to also contribute towards improving biodiversity.

Moreover, fixed notions of what constitutes "cultural heritage[277]" today (i.e. commonly associated with a monument, a building, a garden or an urban environment) that is worthy of protection from future sea level rise and storm surges rather than retreat/relocation are worthy of discussion. In recent years, due to the uncertainty of future scenarios as a result of ongoing climate change, there has been a paradigm shift in the understanding and management of cultural heritage in cities and landscapes to one that does *not* normatively render cultural heritage to be based on a specific and singular point in time that must be maintained in an ideal and "original" state for a long period of time, to preserve national storytelling or posterity (Riesto and Stenbro, 2021). Furthermore, globally speaking, the term cultural heritage has undergone considerable changes in recent decades to widen the scope and scale to include a more holistic understanding of heritage, such as immaterial aspects led by more participatory practices involving the local community and interrelational thinking about historical development (Vecco, 2010; Janssen et al., 2017). Moreover, UNESCO (2022) has recognised the importance of "intangible cultural heritage" that "does not end at monuments and collections of objects. It also includes traditions or living expressions inherited from our ancestors and passed on to our descendants, such as oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe or the knowledge and skills to produce traditional crafts" (UNESCO, 2022) (also refer to (UNESCO, 2022)). Therefore, there is scope to consider immaterial values and practices[278] of cultural heritage that entire communities/towns could carry with them when relocating to a new area due to SLR/SS/coastal erosion, departing from the dominant fixed notions of buildings of a certain period must be conserved, frozen in time (i.e. it may not be possible nor sensible to save all "historical" buildings by moving it back like the "Rubjerg Knude" lighthouse from Part III Figure 52).

277 The current understanding of "cultural heritage" only as physical "artefacts, monuments, a group of buildings and sites, museums that have a diversity of values including symbolic, historic, artistic, aesthetic, ethnological or anthropological, scientific and social significance" may be a limited view of what constitutes heritage (UNESCO, 2020).

278 From the perspective of seaweed, the practice of seaweeding by Victorian women in Great Britain (refer to section 1.5.2, Figure 19 could be considered under this category).

5.5 Conclusion – A summary of findings

One thing is clear; we are edging towards an irreversible change in the biosphere that will put into question the very fabric upon which we depend. Urban Seascaping explored what it meant to depart from business-as-usual urban development practices and paradigms at the coast by integrating marine life forms without romanticising or reverting to the past. While being wary of greenwashing, this research explores the role of the spatial design disciplines to re-conceive, re-orientate and re-design our relationship with the more-than-human agencies in the future.

In this final subsection, I present a summary of the key findings and learnings from the past three years, with two main contributions, Urban Seascaping as an ethical and critical proposition as well as an analytical and curatorial tool that engages with various complexities, entanglements and relations in the Anthropocene. Thus, Urban Seascaping with seaweed contributes towards addressing the climate crisis to contribute towards the ongoing paradigm shift that is urgently needed in coastal cities to re-envision what it truly means to live not just by sea but *with* the sea.

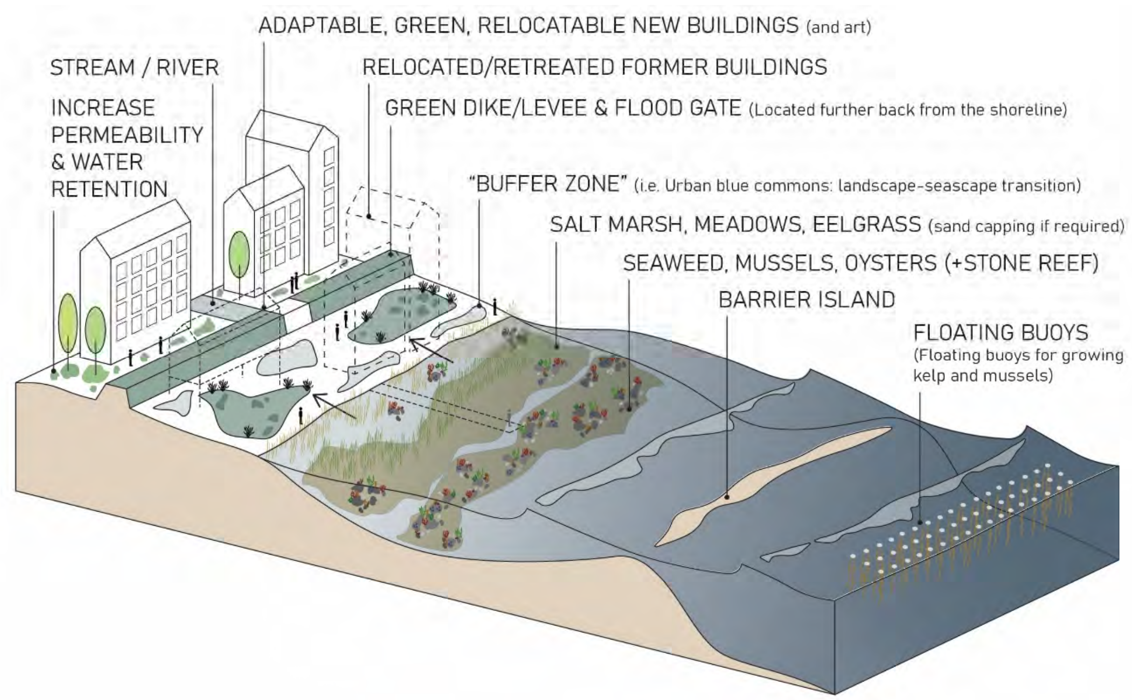


Figure 177. The research (Part III) has explored various coastal adaptation strategies, concluding that there are benefits to the hybrid approach of combining both hard and soft approaches. The illustration is not to inform final design-specific solutions but an illustration of general principles of the Hybrid Approach developed for this research. Redrawn and redesigned diagram by Soo Ryu and Agnes Varmund (based on Sutton-Grier et al. (2015)).

5.5.1 Urban Seascaping as a critical proposition

In this final subsection, the key, prescriptive, and generalised learnings of the research will be presented, following the structure of the four critical propositions of Urban Seascaping to urban transformation as an answer to the main research question:

1. **Multispecies coexistence (with seaweed):** *Design coastal cities not just for humans but also for better cohabitation with the marine actors*

   - **Proactive integration, restoration and protection of coastal ecosystems** are needed so that they can cohabit in the waters of coastal cities. For instance, providing habitat-friendly conditions, such as reinstating stone reefs into the sea bed for marine habitats (i.e. seaweed). However, integrating the marine world means also going beyond their instrumental benefits and acknowledging their right to exist in these coastal zones as part of multispecies coexistence. In urban planning terms, it would ensure that their habitat is (legally) protected from the land reclamation process.
     Examples: Sund Vejle Fjord project, SUPERFLEX's house for fish, SuperRev, Kanten/The Edge winning entries, the sixth borough (extending the MPAs/Natura2000 areas to the water) etc.

   - Plan for long-term strategies (more than a few decades) for coastal urban development that can adapt to time and changing conditions (i.e. designed for inundation) for human and nonhuman coexistence. For instance, design adaptable infrastructures in the coastal shorelines' critical zone (i.e. inundation risk area) that could better facilitate the meeting ground between land and sea, human and nonhuman. These new structures need to be safe for humans and beneficial to marine life forms in material choice and design. When the current structures are inundated due to sea level rise, will the seaweed inhabit it as a new home? This means **considering the (marine) nonhuman actors as clients when designing/developing waterfront/harbourfront areas.**
     Examples: Oystertecture, Bight Coastal Urbanism, New Urban Ground, Kanten/The Edge winning entries, SUPERFLEX's house for fish, Wreck biodiversity, etc.

   - Initiatives at the waterfront/harbourfront areas need to provide space that initiates and supports **local educational and sociocultural practices** that engage individuals' and coastal communities' lived experiences and identities. Co-existence involves learning about the watery neighbour below to **enhance ocean literacy**.
     Examples: Havhøst Sea garden Associations, Marine Education Centre in Malmo, Goat Island Marine Education Centre, Glydensteen Lagoon etc.

   - **Departing from the notion of the sea only as a view** to gaze at, which can encourage B-A-U developments and NIMBY mentality at the waterfront, perpetuates dualistic conceptions of nature-culture while hindering more meaningful engagement and relationship with the sea.
     Examples: Blue urbanism, Oystertecture, House for a fish, Wreck biodiversity, Floating kelp farms, SuperRev, Archipelagic thinking, Maori legal personhood, etc.

   - Multispecies urbanism as an **emerging spatial practice** that is a critical part of the **waterfront/harbourfront development model** in the age of the Anthropocene.
     Examples: Blue urbanism, Coastal Urbanism, Marine landscape architecture, etc.

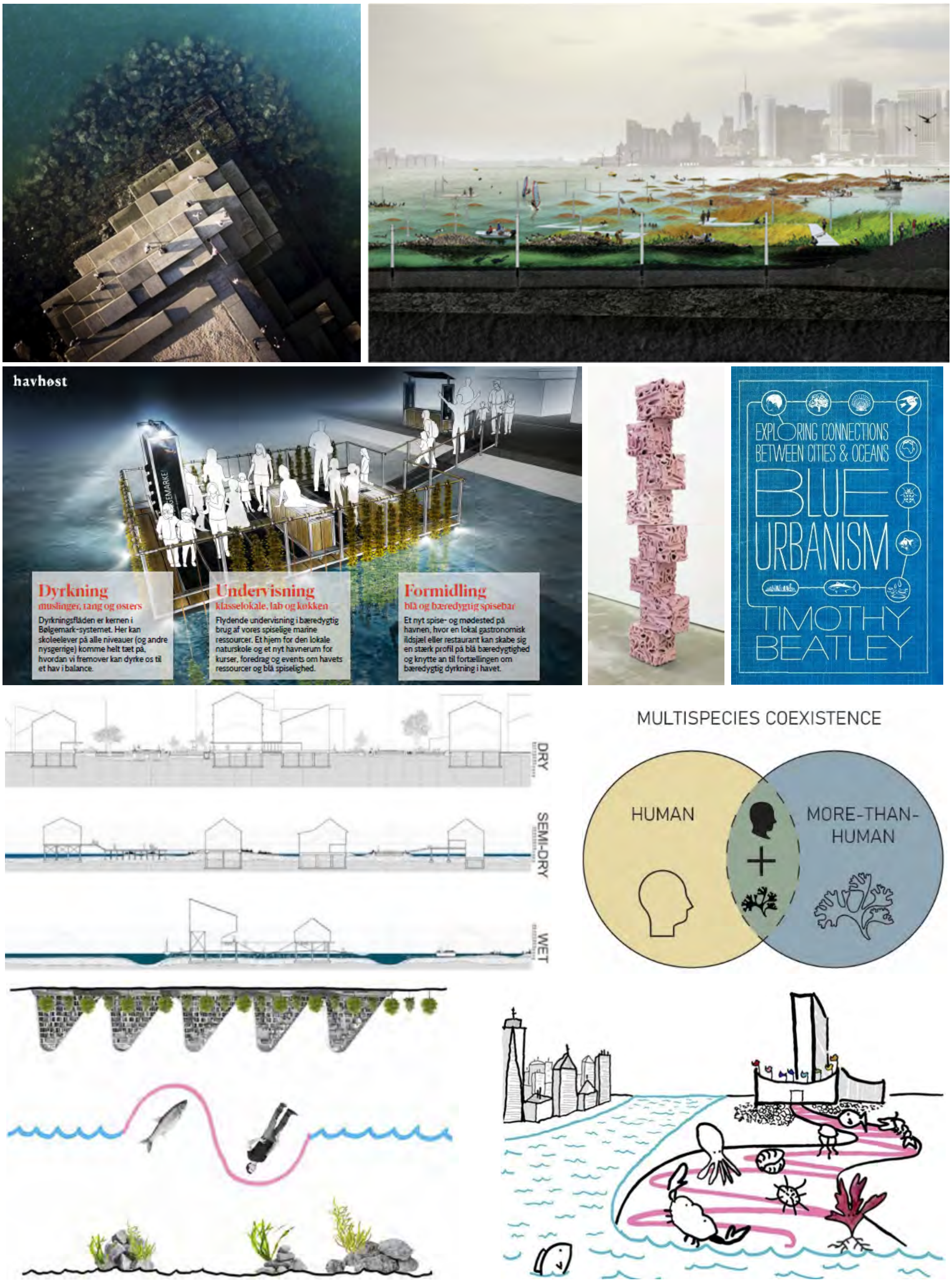


Figure 178. An amalgamation of some of the projects mentioned in this research that is relevant in representing the first Urban Seascaping proposition. Image credit: (Starting from the top left image to the bottom right) Architecture Workshop, Scape Studio, Havhøst, SUPERFLEX, Timothy Beatley, DLand Studio and Rafi Segal, and SUPERFLEX. The drawing of "Interspecies Assembly" by SUPERFLEX (bottom right row) has been superimposed with red seaweed (the missing actor) by the author.

2. **Invite the agency of the (rising) sea** *into coastal cities as a driver in urban transformation.*

- Identify high-risk waterfront/harbourfront areas that can transform into **new blue urban commons** by inviting the agency of the rising sea. This means accepting the future reality of living with more presence of water and providing a better meeting place between the city and the water.
  Examples: Gyldensteen Strand lagoon, Architecture Workshop NZ, Kanten/The Edge winning entries, etc.

- **Recognition of water as a living entity** – Recognise alternative intrinsic value-orientated narratives of water as a connector and a living entity. Moreover, granting the water bodies legal representation as a critical part of a coastal city as one way to live *with* water in light of sea-level rise. Moreover, being conscious of terrestrial bias where the marine realm is made secondary due to a stronger lobby of land-based priorities or marine nature used to greenwash the acceptance of B-A-U practices.
  Examples: The Sixth Borough concept, Archipelagic thinking, Maori legal personhood, Marine Protection areas etc.

- **Water as a design actor** provides a space to experience and engage with the sea in a tactile and artistic way for the residents by using the water as the main design driver. *Examples: "On Water" art installation bridge, Gyldensteen Strand lagoon, Kanten/The Edge winning entries, etc.*

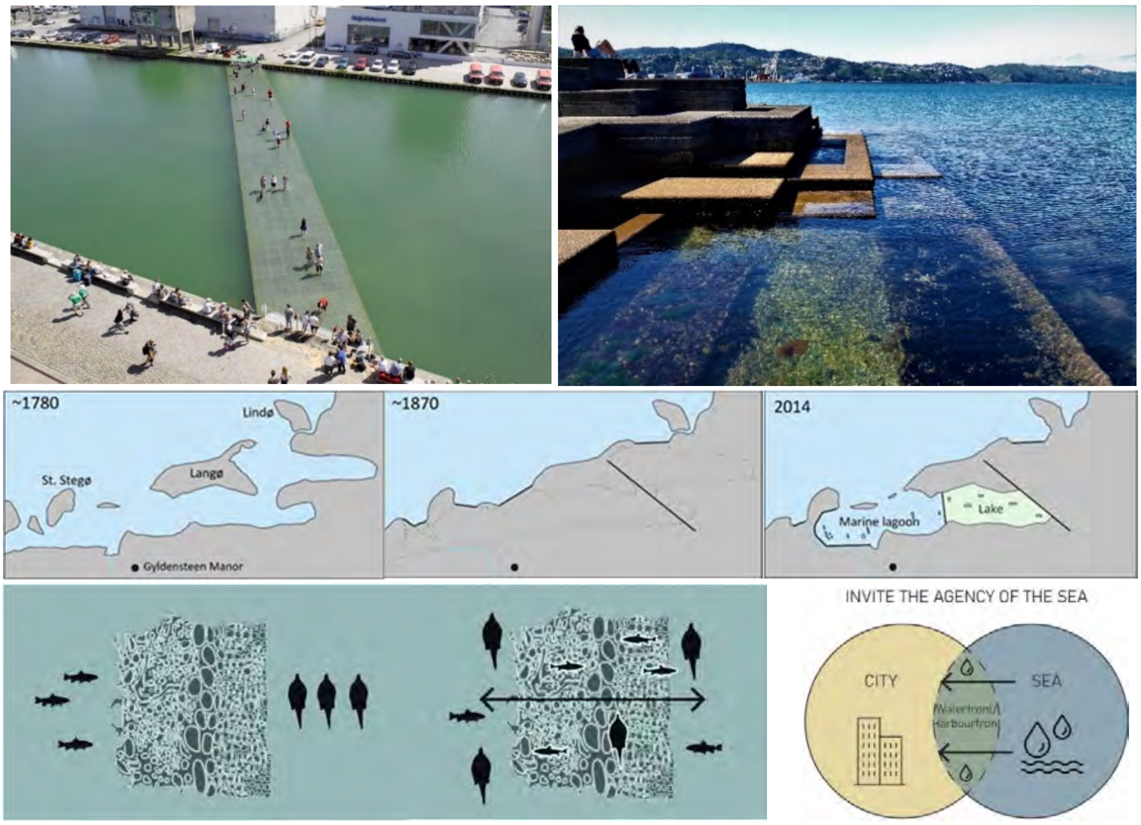


Figure 179. An amalgamation of some of the projects mentioned in this research that is relevant in representing the second Urban Seascaping proposition.
Image credit: (Starting from the top left image to the bottom right) Ayşe Erkmen, Architecture Workshop, The Membrane (Josephine Philipsen, Luisa Brando and Andres Hernandez).

3. **Beyond the edge (to a zone):** *Shift our thinking of the coast as an edge to a zone.*

   - Depart from the current view of the water as a threat by going beyond the traditional defence-driven approach to coastal protection to **include coastal ecosystems**. For instance, there are possibilities of seaweed (kelp) as a **marine nature-based solution** as the first line of defence against storm surges by wave attenuation, along with many other benefits to humans and nonhumans (i.e. ecosystem services).
     Examples: Natural kelp forests, floating kelp system, Blue dunes, Multigenerational City in Ulsteinvik, Oyster-tecture, New Urban Ground, etc.

   - Assign a bigger area of focus (from an edge to a zone). Nature-based solutions require **a large-scale intervention** (not just a "blue line"), and the marine world requires inter-relational systems thinking of space and boundaries. The conventional idea of a "site" changes when dealing with water issues.
     Examples: Sund Vejle fjord, Blue dunes, Bight Coastal Urbanism, Gyldensteen Strand lagoon, New Urban Ground, Multigenerational City in Ulsteinvik, etc.

   - The potential interventions at the coast need to be coupled with other initiatives that acknowledge the **upstream-downstream connection**, such as wetland restoration and **urban blue-green infrastructure** (i.e. increasing permeability and water retention).
     Examples: New Urban Ground, Bight Coastal Urbanism, Vejle Municipality's wetland restoration project, Sund Vejle Fjord, etc.

   - **Rethinking ocean sprawl** as a form of urban development in light of the sea-level rise and storm surge. The need to assign **no build areas** in risk areas (or only adaptable buildings in the risk zones) in the future or **relocate critical areas** over the **long term** and find new future uses while **redeveloping areas on higher grounds**.
     Examples: Bight Coastal Urbanism, Gyldensteen Strand lagoon, Kanten/The Edge winning entries,

   - **The new urban blue commons** need to understand the networks and processes from a holistic point of view that acknowledges the ecological connection between the urban realm and the sea.
     Examples: Multigenerational City in Ulsteinvik, New Urban Ground, Kanten/The Edge etc.

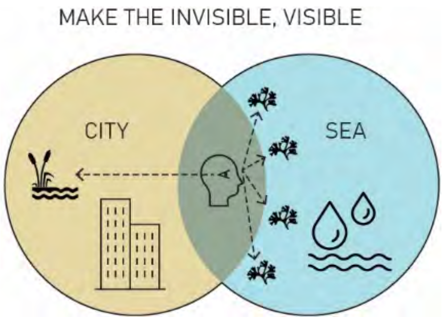
Figure 180. An amalgamation of the projects mentioned in this research is relevant in representing the third Urban Seascaping proposition. Image credit: DLand Studio and Rafi Segal, Floating kelp system by Teis Boderskov, WXY Architecture + Urban Design, West 8 and Edit Landscape Architects.

4. **Make the invisible-visible**: *Bring the invisible life under the sea into the visible urban realm*

- There is a need for an innovative coastal landscape-seascape architecture that integrates marine lifeforms (such as seaweed) in **a visible, tactile, safe, functional, accessible, restorative, thought-provoking and artistic manner**. The purpose is to provide a better **meeting place between the city and sea, humans and nonhumans**, to enhance the presence and awareness of the marine realm.
  Examples: Kanten/The Edge design competition winning entries, Multigenerational City in Ulsteinvik, Underwater/marine art installations, etc.

- Waterfront/harbourfront developments tend to forget to integrate the surrounding marine ecosystems. Therefore, making the invisible visible means **including these "forgotten" marine actors** back on the coast and **making their roles (i.e. ecosystem services) visible to humans** (not only from an aesthetic sense but also from a socio-cultural and educational way).
  Examples: Havhøst sea garden associations, Marine education centres, Kanten/The winning entries,

- Ensuring that the **water clarity is good enough not to hinder the growth of** marine life forms to prevent them from being literally invisible. Therefore, initiatives that clean up the sources of water pollution before it reaches the sea is paramount (i.e. looking into the watershed scale). Moreover, due to climate change, certain coastal ecosystems (such as young eelgrass beds) would require **human interventions** such as structural support to help them resist stronger storms. These **artificial structures** could also help make these coastal ecosystems **visible through artistic and educational interventions**.
  Examples: Sund Vejle Fjord, Gyldensteen Lagoon, Havhøst, SuperRev, Kanten/The Edge winning entries, etc.



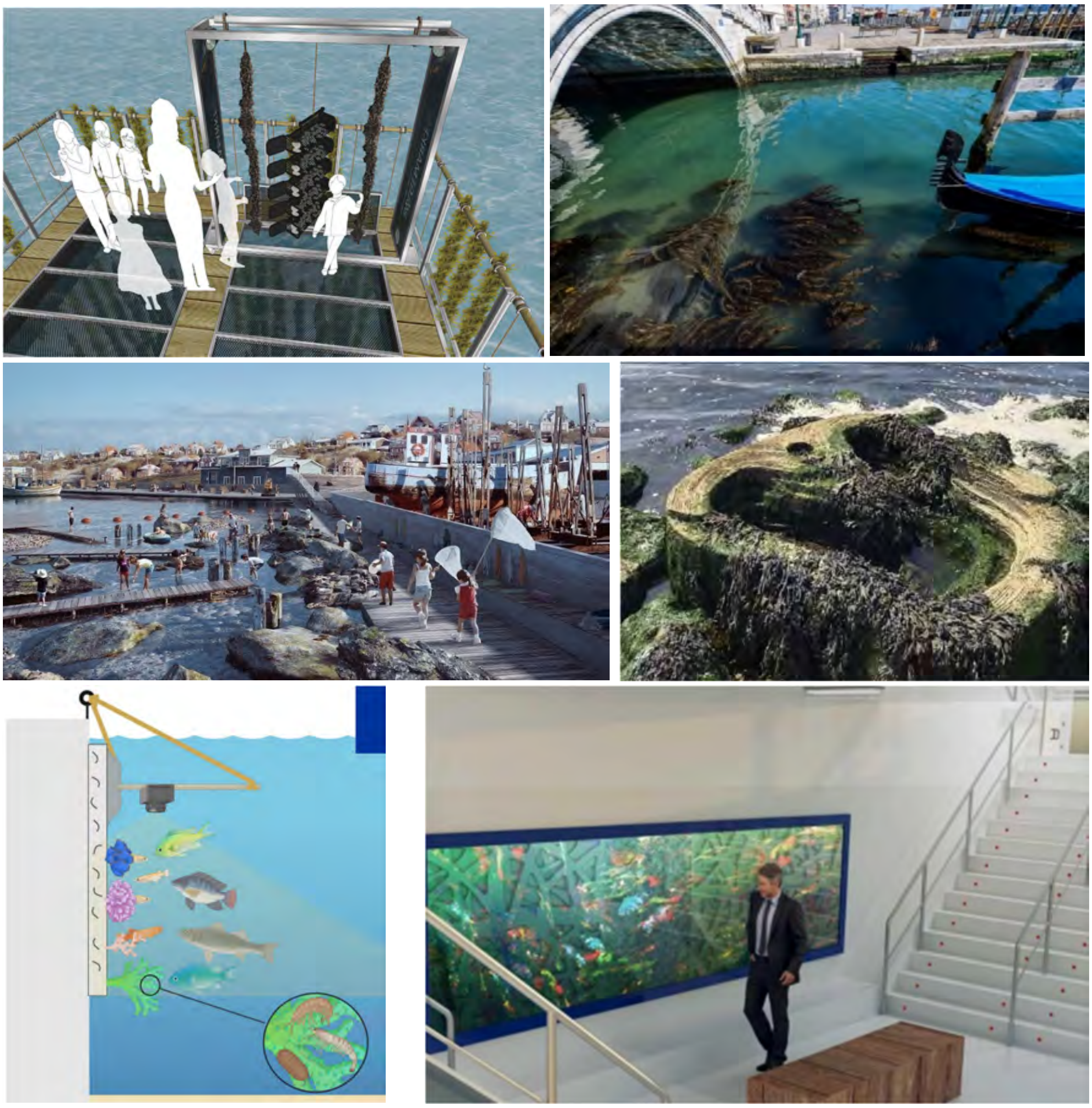


Figure 181. An amalgamation of the projects mentioned in this research is relevant in representing the fourth Urban Seascaping proposition. Image credit: On the Edge of the Utopia (Karen Gamborg Knudsen and Kasper Magnussen), Sund Vejle Fjord, SuperRev by SUPERFLEX, Havhøst, Venice canal by Andrea Pattaro/AFP via Getty Images (Brunton, 2020), The Knot by Tredje Natur (n.d.), ECOncrete, Living Ports Project in Vigo by Jon Svendsen (2022).

5.5.2 Urban Seascaping as an analytical and curatorial tool

Urban Seascaping is an approach to coastal adaptation and urban development. The different maps were created as an outcome of synthesising a transdisciplinary body of knowledge into a hybrid format that might aid informed design parameters, leading to future projections. Thus, Urban Seascaping – in addition to its ethical and critical dimensions – also presents itself as an analytical and curatorial tool to think and work within the LUDP disciplines (as a response to answering sub-research questions one and two). Here are some of the key prescriptive learnings from the mapping explorations:

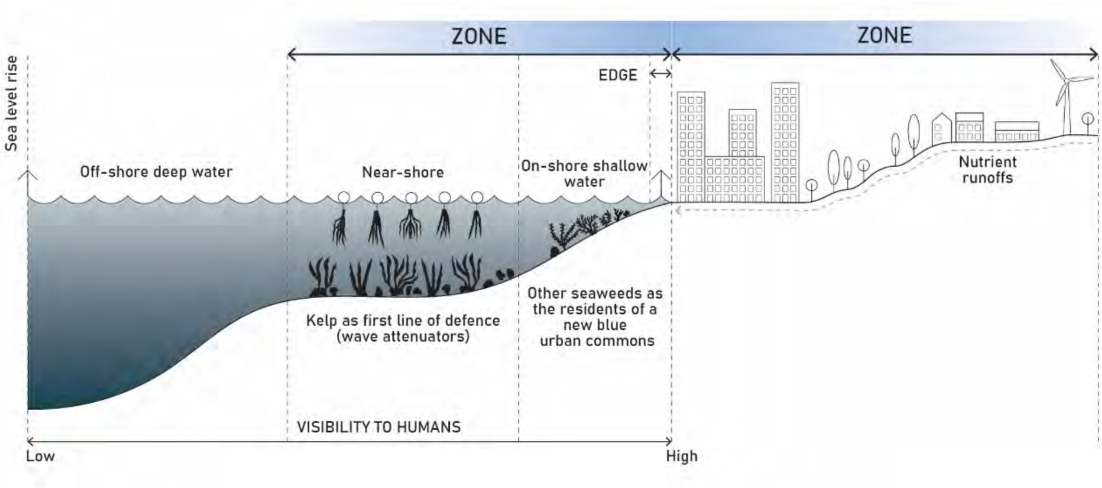
1. ***Multiscalar mapping:*** *Engage with multi-scalar networks when working with the marine realm in coastal cities*

    - Working with water challenges the conventional notion of a site with fixed boundaries to a multiscalar condition. The water connects and impacts the site from global to local, macro to micro, extending further into the landscape and out into the sea. Therefore, when dealing with an "edge" condition in urban shorelines, there is a need to ensure macro and micro-scale interventions are running in parallel (that is dependent on the local context).
    Examples: For Vejle's Kanten/The Edge project, due to the dire ecological condition of the fjord, projects such as Sund Vejle Fjord needed to be running in parallel to ensure the success of Kanten's/The Edge's NbS (i.e. large-scale interventions to re-establish stone reefs and mussel beds).

    - In particular, working with the watershed/catchment scale becomes paramount when dealing with water pollution, as the excess nutrient gets transported and expelled into the sea from the catchment areas.
    Example: The upstream wetland restoration to capture more agricultural runoffs before it reaches the inner fjord.

    - The multiscalar networks also need to be envisioned from the perspective of water (i.e. water-based scales - global to local waters) and its connection to other water bodies
    Example: The need to conceive the water body in its entirety, such as the Vejle fjord with its interconnection to the rivers and watersheds (relational thinking).

    - While understanding the local ecosystem (i.e. food chain) might seem less distinguishable on a spatial scale, it is important to understand the food chain and its relation to the water cycles to work with the complexity of implementing marine nature-based solutions.
    Examples: The exploding population of crabs in Vejle Fjord that is hindering the eelgrass restoration process by Sund Vejle Fjord.



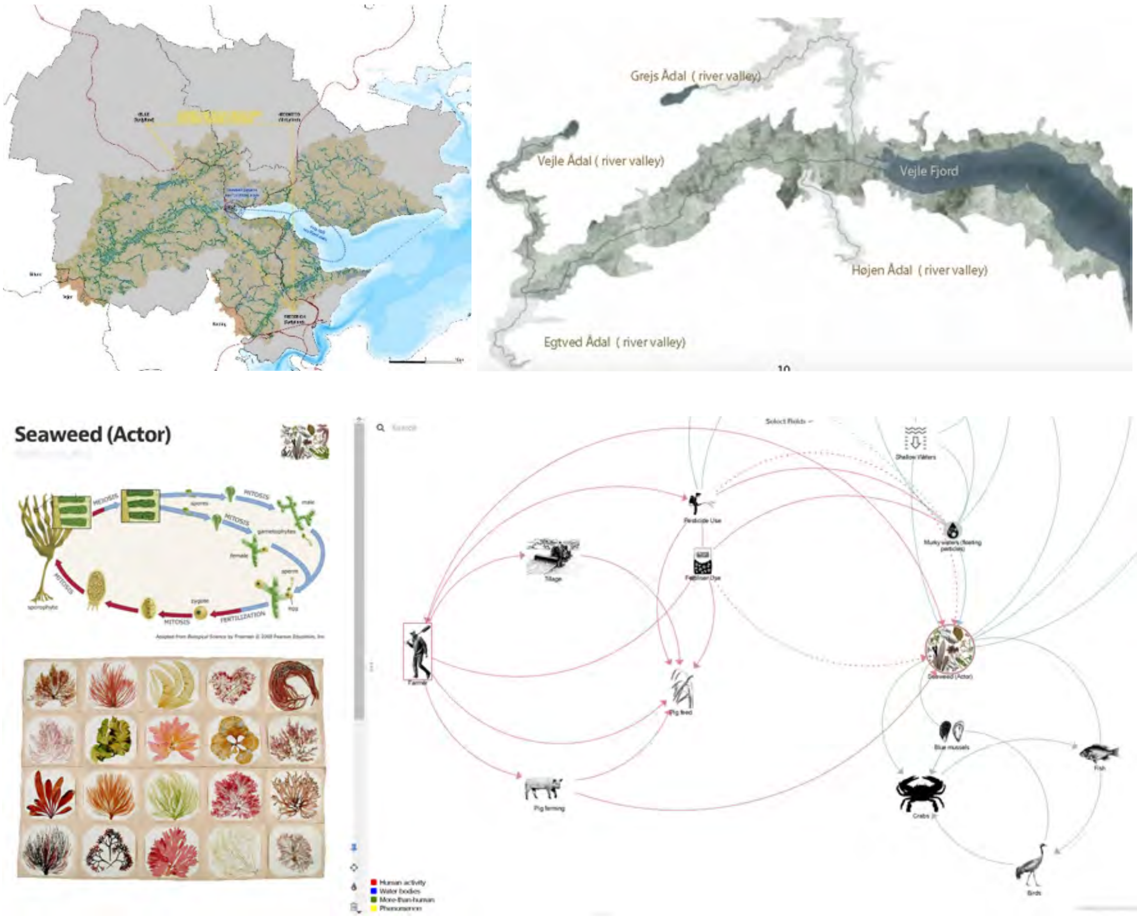


Figure 182. An amalgamation of the maps in this research that is relevant in representing the first Kumu map: Multiscalar network map. The examples highlight the importance of engaging with a macro-to-micro scale in a relational manner. For Vejle fjord, it means to see it holistically with its connection to the rivers (river valley) in its coastal catchment area and its relation to the local ecosystem. Image credit (top right image): Vejle Municipality (2019).

2. ***Temporal-projective mapping*** *to visualise past decisions that led to today's issues with water and to project future implications of today's vision*

    - Looking at the key urban development decisions in the past that have impacted the present time's path to coastal adaptation to sea level rise and increasing storm surge. Using this understanding to inform future decisions on urban development conducive to the green-blue transition of coastal cities.

    - Working with the research-through-design method to project future strategies based on the short-term to long-term IPCC deadlines (i.e. RCP scenarios – ranging from best-case scenarios to worst-case scenarios) and future predictions of SLR and SS. Moreover, acknowledging that today's decisions could have ramifications beyond these official deadlines that require longer-term perspectives past this century.

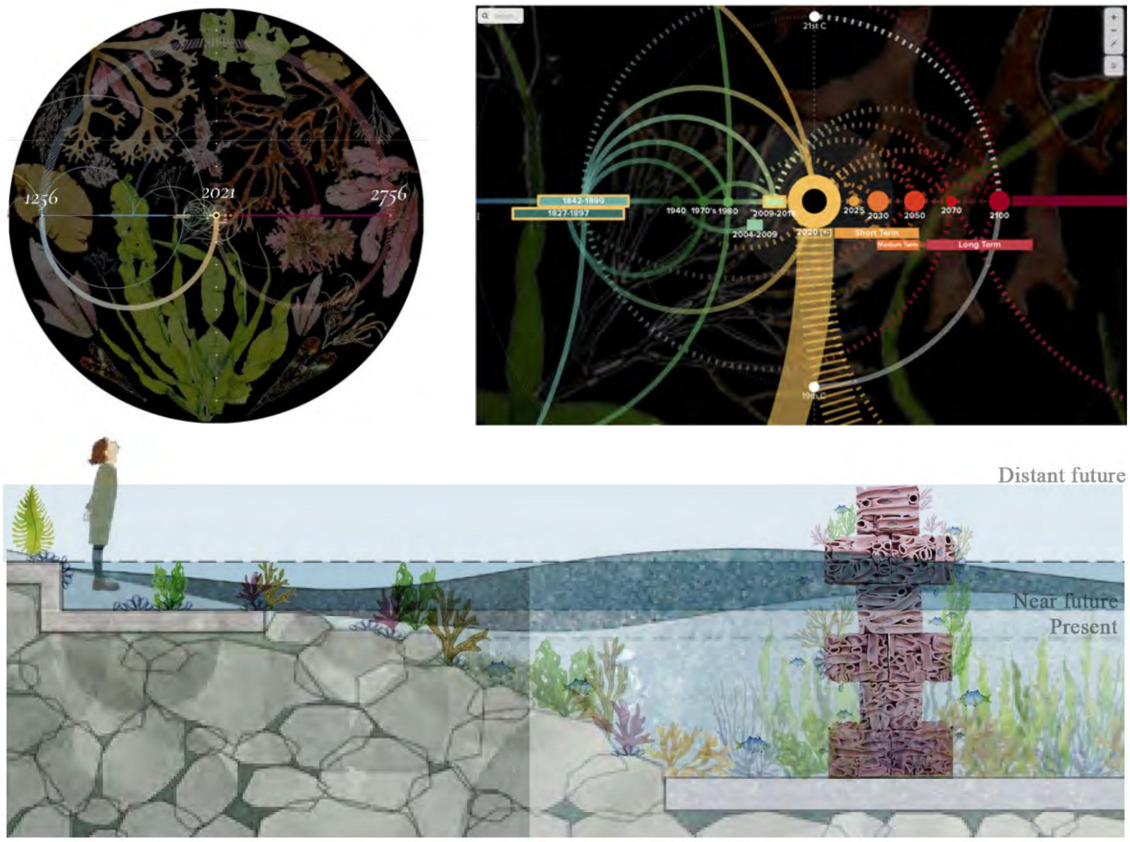


Figure 183. Temporal-projective mapping looks at the relationship between urban development decisions of the past and the consequences of those decisions in the present and future times. Based on the learnings from the multi-scalar analysis (Map 1), potential projections about the future can be made. Image credit: The Membrane team for Kanten/The Edge and SUPERFLEX (the image has been altered by the author).

3. ***Review of the state-of-the-art projects*** *– Mapping the learnings from various realised and speculative projects around the world to inspire more marine nature-based approaches to coastal development.*

   - It is important to broaden the scope of what constitutes relevant state-of-the-art projects. Therefore, it needs to contain reviews/learnings from both built and unbuilt projects, locally and internationally, technical and artistic, educational and cultural outcomes and show the interconnections between them. Moreover, it should also include non-physical outcomes such as urban planning policy, alternative narratives, and world views.

   - The state-of-the-art review needs to consider the same type of projects but understands that the same proposals might work differently in different contexts for various reasons. *Example: Nature-based solution in coastal cities with more violent storm surges (i.e. West coast of Jutland) will require a much denser and larger scale of NbS to mitigate the strength of waves as opposed to coastal cities with more sheltered coast with much weaker wave strength (i.e. East coast of Jutland).*

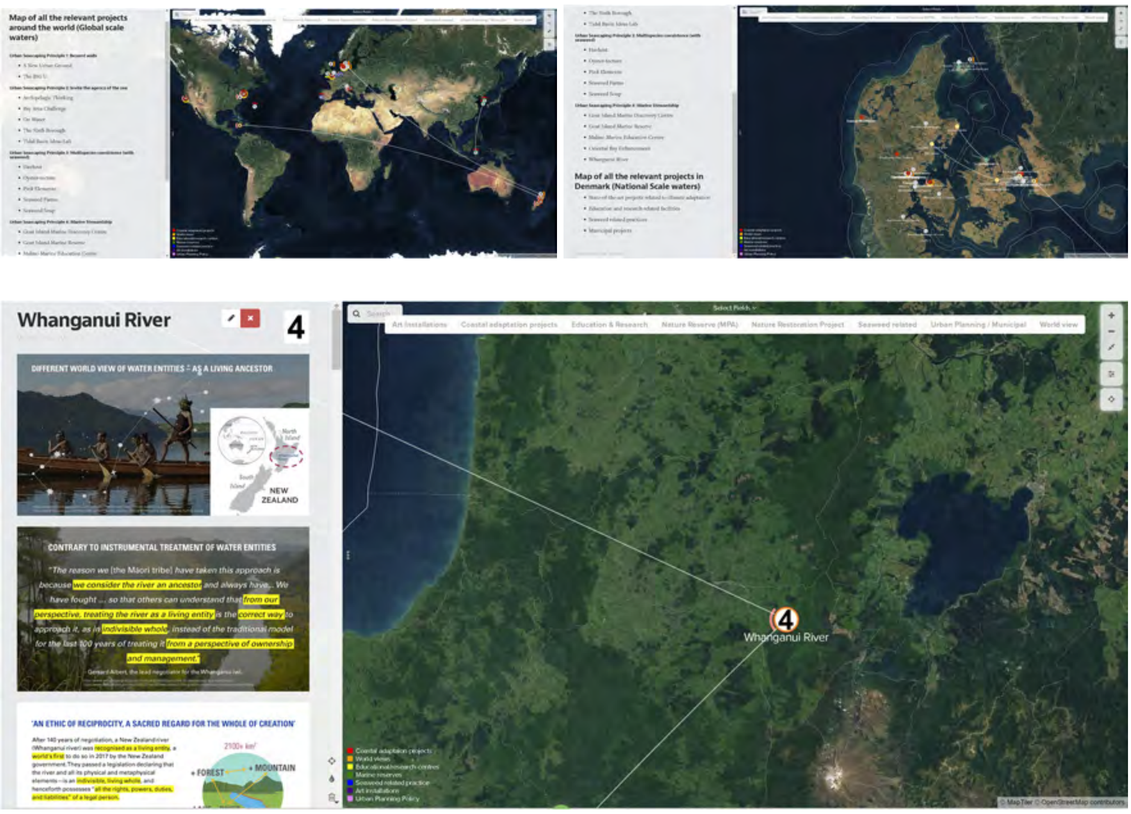


Figure 184. State-of-the-art projects in the second Kumu map show the nine categories that could be relevant in answering the main research question. They are art installations, coastal adaptation/protection projects, marine education and research centres, marine nature reserves and restoration projects, alternative policies and world views concerning SLR and SS and examples of B-A-U urban development models in coastal cities.

4. ***Multimedia, curatorial and interactive dissemination** of findings in the digital (COVID-19) age.*

- The importance of hosting research on more accessible dissemination platforms for knowledge-share, such as online websites, to ensure that wider audiences (outside academia) can be reached. The online website format of Kumu maps also allows hyperlinks to other materials (i.e. research journals, videos, webpages etc.), connecting the research to the wider network of works online and, therefore, can host more variety of visual mediums such as animated pictures, videos and audio files.

- The value of online interactive network maps such as Kumu is that it is not a "finished product" but an ongoing process. The interactive elements allow a more exploratory engagement of the user compared to static 2D maps on paper.

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APPENDIX

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Appendix 1: Reference of sources for GIS data (Danish)

These are the sources of GIS data I have used for my mappings:

Source of GIS (Danish) and live maps	Website URL
GEUS De Nationale Geologiske Undersøgelser for Danmark og Grønland	https://frisbee.geus.dk/geuswebshop/index.xhtml ▪ Geomorfologisk kort over Danmark 1:200 000, version 3 ▪ Havbundssedimentkort Højde og dybde i det danske område, PDF og shape format ▪ Jordartskort ▪ Prækvartæroverfladens højdeforhold, PDF og shape-filer
Styrelsen for Dataforsyning og Effektivisering KORTFORSYNINGEN DOWNLOAD	https://download.kortforsyningen.dk/
DATAFORSYNINGEN Styrelsen for Dataforsyning og Infrastruktur	https://dataforsyningen.dk/
Miljøministeriet Miljøstyrelsen MiljøGIS - Data on nature and the environment	https://mst.dk/service/miljoegis/ ▪ https://miljoegis.mim.dk/cbkort?profile=vandrammedirektiv2-2016 ▪ https://miljoegis.mim.dk/spatialmap?profile=vandrammedirektiv3tilstand2021 ▪ https://miljoegis.mim.dk/spatialmap?profile=fosfor_kortlaegning_dk ▪ https://miljoegis.mim.dk/cbkort?profile=miljoegis-plangroendk
Miljøministeriet Kystdirektoratet	▪ https://kyst.dk/kyster-og-klima/vaerktoejer/ ▪ https://gis.nst.dk/portal/apps/webappviewer/index.html?id=a024f7d135434250a0bb5620e43532e8
Kystdirektoratets Kystatlas	https://kystatlas.kyst.dk/
Kystplanlægger 2120	https://xn--kystplanlgger-cgb.dk/

Klimatilpasning	Datakatalog til klimatilpasning. Overblik over eksisterende data til brug for kommunernes klimatilpasning (SDFE, 2017). ▪ https://kamp.miljoeportal.dk/ ▪ https://www.klimatilpasning.dk/vaerktoejer/oversvoemmelseskort/se-oversvoemmelseskortet/ ▪ https://www.klimatilpasning.dk/vaerktoejer/ekstremnedboer/ekstremnedboer
Danmarks Arealinformation Danmarks Miljøportal	https://arealinformation.miljoeportal.dk/
Historiske kort på nettet Geodatastyrelsen Styrelsen for Dataforsyning og Effektivisering	https://hkpn.gst.dk/
vejle KOMMUNE	▪ https://gis.vejle.dk/NetGISRuntime/basis/index.jsp?custid=233&custgrpid=44&login=klimatilpasning&password=klimatilpasning ▪ https://www.vejle.dk/om-kommunen/fakta-om-os/rapporter-og-analyser/vaekstbarometer/
DMI	https://www.dmi.dk/klima-atlas/data-i-klimaatlas/
DHI	https://marine-vegetation.satlas.dk/
SCALGO	https://scalgo.com/ https://scalgo.com/da/learning/webinar-archive
DinGeo Boliga	https://www.dingeo.dk/
Krak til søs	https://tilsos.krak.dk/

Table 5. A list of all the main GIS data sources for Denmark (not an exhaustive list).

Appendix 2: The profiles of all the interviewees

The first round of expert interviews:

Interviewee (Contact)	Date/Location/ Time	Profile / Expertise
Ole Mouritsen ole.mouritsen@food.ku.dk Expert in: History of seaweed in Denmark and seaweed as food.	06/11/19, 14:30 CEST Duration: 1.5hrs In-person in a café in Aarhus C See Appendix 3 for interview notes	Ole is a Professor Emeritus at the University of Copenhagen (KU) in the Department of Food Science. He is a physicist and professor of gastrophysics and culinary food innovation. He wrote a book called "Seaweeds: Edible, Available & Sustainable" in 2014 (both in Danish and translated into English) (University of Copenhagen, 2007).
Joachim Hjerl joachim@havhoest.dk Expert in: Seaweed as food, community outreach and marine education.	03/12/19, 13:00 CEST Duration: 1.5hrs In-person at the Havhøst headquarters: Slagtehusgade 11, 1715 København V	Joachim is the founder and director of Havhøst, where he is the project manager and concept developer/entrepreneur. Havhøst (Sea Harvest) is an association of maritime utility gardens, NGOs, schools, businesses and citizens who promote regenerative cultivation in the sea and invite as many as possible to take part in the blue-green transition through educational programs and food festivals (Havhøst, n.d.). (Note: This interview was in the combination of touring the Havhøst headquarters in Copenhagen. Additionally, I was able to meet him on several other occasions due to Havhøst's various activities and workshops).
Michael Palmgren michael.palmgren@smkc.se Expert in: Community outreach, marine restoration, ocean literacy and marine education.	23/11/19, 12:00 CEST Duration: 1hr In-person at the Marine Education Centre: Ribersborgsstigen 4, 216 13 Malmö, Sweden See Appendix 4 for notes	Michael Palmgren (a marine biologist) is one of the founders of the Marine Education Centre (Marint Kunskapscenter) in Malmö, Sweden. Since the 1970's Michael has been working on numerous issues related to the sea. For the past 25 years, he has used various educational tools to help raise awareness about the sea among the general public. He is also involved in marine restoration projects and lectures internationally on Ocean Literacy (SMKC, 2022). (Note: This interview also involved a tour of the Marine Education Centre).
Lasse Hornbek Nielsen lasse@purealgae.dk	01/07/20, 10:00 CEST Duration: 1hr In-person at Pure Algae headquarters:	Lasse is the current head of development and operations at Pure Algae (a marine biologist). Pure Algae is Denmark's first supplier of technology that enables stable and sustainable production of seaweed on land. The intention of the technology is to grow high-quality and allergen-free seaweed with its

Expert in: Seaweed cultivation (on-land) and seaweed as food, automated marine cultivation systems.	Færgevej 2B 8500 Grenå Interviews notes are not publicly available due to sensitive information.	automated, closed and controlled systems (Pure Algae, 2022). (Note: This interview was in a combination of attending Havhøst's public workshop on promoting awareness of seaweed as food and as art at the Kattegat Center in Grenå, Denmark).

Table 6. Profile of the interviewees (experts) for the initial period of research (see Appendix 3 and 4 for interview notes and transcriptions).

The second round of expert interviews. The interviews were recorded but were not made publicly available to protect the opinions of the winning entrants.

Interviewee	Date	Profile / Expertise
Kanten/The Edge competition: 1st place winners. Josephine Philipsen, Andres Hernandez, Luisa Brando With Cintia Organo Quintana Experts in: Urban landscapes dealing with river-related projects	24/11/20, 15:00 CEST Duration: 1.5hrs Online Interviews notes are not publicly available due to sensitive information.	The project team consisted of three participants. Josephine Philipsen, a Swedish landscape architect from Malmo, Andres Hernandez, a Columbian architect from Bogota and Luisa Brando, a Spanish artist/architect from Madrid. This was the only team that consisted only of international members out of the winning entries. They consulted a marine biologist for their project. They worked together through the whole duration of the competition online due to the COVID-19 lockdowns. Andres Hernandez: hernandezwilliamson@gmail.com Luisa Brando: luisabrando@gmail.com Josephine Philipsen: jch.philipsen@gmail.com
Kanten/The Edge competition: 2nd place winners. (Absent: Jonathan Houser) Jonas Lambert With Cintia Organo Quintana Experts in: Urban landscapes dealing with "landscape art" projects.	24/11/20, 13:00 CEST Duration: 1.5hrs Online Interviews notes are not publicly available due to sensitive information.	The project team consisted of two participants, Jonathan Houser, a Danish artist/architect from Copenhagen and Jonas Lambert, a Danish architect/landscape architect from Copenhagen. They have been working for different practices in Denmark. Jonathan Houser: jonathan.houser@gmail.com (absent at the interview) Jonas Lambert: jonas@jonaslambert.dk

Kanten/The Edge competition: 3rd place winners. Karen Gamborg Knudsen Kasper Magnussen With Cintia Organo Quintana Experts in: Art installations, and urban landscapes dealing with "landscape art" projects.	13/11/20, 13:00 CEST Duration: 1.5hrs Online Interviews notes are not publicly available due to sensitive information.	The project team consisted of two participants from a small Danish interdisciplinary architecture/art practice called, Gamborg/Magnussen, based in Copenhagen. Their portfolio covers projects in Denmark and abroad. Karen Gamborg Knudsen: gamborgmagnussen@gmail.com Kasper Magnussen: kaspermagnussen@hotmail.com
Kanten/The Edge competition: Special mention SUPERFLEX's Rasmus Rosengren Nielsen (Absent: Baldios) With Cintia Organo Quintana Experts in: Public art, sculptures, video art, paintings, urbanism, interspecies living,	19/11/20, 10:00 CEST Duration: 2hrs In-person at SUPERFLEX studio: Nyborggade 13 DK-2100 Copenhagen Interviews notes are not publicly available due to sensitive information.	The project team consisted of at least two members, an art collective called SUPERFLEX (represented by Rasmus Rosengren Nielsen), in collaboration with a Portuguese landscape architecture firm called Baldios. This is the only winning entry to have a transdisciplinary team (including close collaborations with marine biologists). SUPERFLEX is a well-known art collective founded in 1993 based in Copenhagen. Their entry for Kanten/The Edge design competition is an extension of the work they have been doing for several years in collaboration with marine biologists (SUPERFLEX, 2022). (Note: This interview was in a combination of attending SUPERFLEX's studio in Copenhagen, where I was able to observe their other similar projects running in parallel).
Cintia Organo Quintano cintia@biology.sdu.dk Expert in: Marine biology/ecology, water pollution from agriculture, biodiversity, nature-based solution, ecosystem services, marine restoration and public outreach.	16/09/20, 30/10/20, 03/12/20, 06/04/21, 17/08/21, 11/10/21, 15/10/21, 02/02/22, 30/09/22, (this is not including the Kanten/ The Edge deliberation meetings). In-person and online meetings (also various email exchanges)	Cintia Organo Quintana is an assistant professor at the University of Southern Denmark in the Institute of Biology. She is a marine biologist/ecologist originally from Brazil. Her research covers topics such as ecosystem-level responses to various disturbances (e.g. pollution, hypoxia, eutrophication, physical stress, climate change and bioengineering solutions for the restoration of coastal habitats), studies on biodiversity and ecosystem functioning (i.e. degradation of organic matter and regeneration of nutrients such as nitrogen and phosphorous) to name a few. Cintia was appointed as the marine biology expert (advisor to the judges) for Kanten/The Edge design competition. (Note: On 16/09/20, I visited Gyldensteen Strand project with her students).

Table 7. Profile of the interviewees: The winning entrants and advisors for Kanten/The Edge design competition.

Interviewee	Date	Profile / Expertise
Elizabeth Macpherson elizabeth.macpherson@canterbury.ac.nz Expert in: Legal frameworks for environmental protection, Nature resource law, environmental law, water law, indigenous rights	15/04/21, 11:00 NZST Duration: 1.5hrs Online See Appendix 6 for notes	Elizabeth MacPherson is an associate professor at the Faculty of Law of Canterbury University in New Zealand. She has research expertise in indigenous and environmental rights to natural resources, particularly indigenous water rights in Australasia (i.e. Te Awa Tupua - Whanganui River Claims Settlement Act 2017) and Latin America.
Hamish Rennie Hamish.Rennie@lincoln.ac.nz Expert in: Urban planning, policy and regulatory frameworks (resource management act in New Zealand), the intrinsic value of ecological systems, management of commons (water)	19/05/21, 13:00 NZST Duration: 1.5hrs In-person at the Lincoln University campus	Hamish Rennie is an associate professor at Lincoln University in the Department of Environmental Management (Faculty of Environment, Society and Design). His research area is geography, environmental planning and management, with a special focus on the management of commons (e.g., oceans, freshwater, biodiversity), especially multi-layered commons. He has been working toward investigating ways to establish formal and informal institutions to achieve sustainable, resilient communities by shaping coastal policy.

Table 8. Profile of the interviewees (experts) during the research stay in New Zealand (see Appendix 6 for interview notes and transcriptions).

Interviewee	Date	Profile / Expertise
Teis Boderskov tebo@ecos.au.dk Expert in: Large-scale seaweed/kelp cultivation (blue growth), vertical farming, sustainable alternatives to industrial fishing, seaweed as food and water purification.	24/11/21, 15:00 CEST Duration: 0.5hrs Phone call See Appendix 7 for notes	Teis Boderskov is part of Aarhus University's research team in the Department of Ecoscience – Marine Ecology. He has been working on the development of macroalgae (sugar kelp, Ulva and S. Latissima) and blue mussels' cultivation with various case study sites in Denmark. He has valuable hands-on experience cultivating seaweed in Denmark's challenging coastal waters.
Steen Hedrup steenhedrup@mail.dk Expert in: Seaweed cultivation, seaweed as food and community outreach (nature guide), Vejle fjord.	03/12/21, 10:00 CEST Duration: 1hr Online	Steen has been working with Vejle Municipality as a Nature Guide for over 25 years. He is also the Vice-Chairman of the local Havhøst association/Vejle Fjordhave (sea garden, marine utility garden) for Vejle Fjord, growing blue mussels and seaweed for local consumption. He has valuable hands-on experience with cultivating seaweed in the challenging coastal waters of Vejle Fjord and his work with raising awareness of nature in Vejle among locals and visitors.

	See Appendix 8 for notes	
Mads Fjeldsø Christensen MAFCH@vejle.dk Expert in: Ecological restoration projects, eutrophication/water pollution, Vejle fjord, local engagements and dissemination (marine stewardship).	06/12/21, 10:00 CEST Duration: 1.5hrs In-person Interviews notes are not publicly available due to sensitive information	Mads is a biologist in training and the project manager for the "Sund Vejle Fjord" (Healthy Vejle Fjord) project for Vejle Municipality (Natur & Udeliv Teknik & Miljø in Vejle Kommune). He has been behind in attaining funding for the project and is working with numerous local associations and researchers to improve the ecological conditions of Vejle Fjord (see section 1.4.1 for more details on the "Sund Vejle Fjord" project). He is also involved in the dissemination of the progress of the project to the local public.
Dorte Krause-Jensen dkj@ecos.au.dk Expert in: Seaweed species in Denmark, climate change, blue carbon, eelgrass/seagrass, nature-based solution, protection, restoration, monitoring and management of marine vegetation.	02/02/22 In-person See Appendix 9 for notes	Dorte is a marine biologist and a professor in the Department of Bioscience and Arctic Research Centre at Aarhus University. She is one of the leading experts in macroalgae research in Denmark, especially regarding their potential use in mitigating climate change. (Note: This interview was in combination with attending the NordSalt workshop in SDU Odense. She was one of the organisers of the workshop).

Table 9. Profile of the interviewees (experts) for the latter part of this research (see Appendix 7-9 for interview notes and transcriptions).

Appendix 3: Interview notes with Ole Mouritsen from Copenhagen University

About eelgrass as seaweed:

- "…Eelgrass is a plant; it is not seaweed. There are some Danish names that indicate it is a seaweed, but technically it is a sea plant; it has roots."
- "The eelgrass has been diminished in this part of Europe. There is not much left. There are certain parts of Denmark where there is more eelgrass than in other places, but it has been devastated. There are many animals that live in eelgrass that are dying, and of course, eelgrass also protects the bottom of the sea. In the old days, eelgrass what used for all sorts of things, like building materials and roofs."
- "Eelgrass has sharp edges that make it difficult to be edible. There is probably potential to do something with it in the lab, but I think it is much better to use it for building materials."

Possibility of growing seaweed in the coastal waters of East Jutland:

- "Most of the places you are considering do not have the best substrate for seaweed. Seaweed requires mostly stone substrate. The other thing is that because of the change in salinity, it will be difficult to have one species that could survive the various different conditions because the different areas could have saltwater, and other times it could be freshwater or brackish water from the other side (rivers).
- "Seaweed needs to be fixed; very few seaweeds do not need fixation. That is the way they get nutrients."
- "Middlefart is very deep, and you do not have shallow waters there; it is some of the deepest parts because you have strong currents."
- "You don't see the big brown seaweeds on the Danish coastline because they are out on the deeper water where you also have rocky ground. Some people in the maritime garden try to get permission to dump stones on the bottom that could provide a substrate. The question is if you could bring something like that closer to land."
- "Before World War 2, there was a fairly large natural population of seaweed in Djursland that could thrive without being rooted. It was almost made extinct because it was over-harvested. But that was floating close to land and fairly shallow. The species is called Danish agar, Furcellaria (a genus of red macroalgae),"
- "The areas where there is freshwater will lower the salinity and prevent seaweed from growing. You do not want the rainwater anywhere near the seaweed. There is also an issue with the circulation of water. Seaweed needs nutrients. Where you have the most seaweed is where you have the most "violent" water. You would have to be able to circulate the water."
- "There is no seaweed on the west coast because there are no rocks. And on the east coast, you have less flow of water. In Denmark, seaweeds are in the deep waters where you have the rocks, like in the Kattegat. We don't see them because we only have 30 cm of tidal variation. We only see a few species like bladderwrack (blæretang) near the coast."
- "Usually, it is said that there are more larger species of seaweed in colder waters."

The role of maritime gardens in coastal cities:

- “What is the objective of growing seaweed in more urban coastal areas? Is it for recreation, coastal protection, increased biodiversity, and anti-pollution? Different objectives are not always mutually agreeable.”
- “The maritime garden is a way to bring the ocean close to land, like gardening. It makes sense from an educational setting. One of the key ways of bringing people together is food. Seaweed is edible and acts as a way to create a culture around food.”
- “Seaweed is not going to solve any issues on how much water comes into the city (sea level rise), but it could solve problems in relation to more sustainable food production.”
- “Seaweed that is grown closer to the cities would be edible. The water needs to be tested. There is a maritime garden in Copenhagen where they grow blue mussels and oysters, so it is possible. When it comes to Vejle and Randers, you have the issue with rivers and a lot of nutrient-filled water.”
- “Farming seaweed on a bigger scale (like in Kattegat), you have the benefit of capturing carbon dioxide.”
- “To create an environment closer to the coast to accommodate seaweed, you need to create a lagoon, salinity, flow of water (nutrients), and stones.”
- “There are a number of smaller seaweed species that are happy in the tidal belt. In Denmark, you wouldn’t find much more than bladderwrack, sea lettuce, and a few brown species, string algae etc.”

Seaweed as a beautiful entity:

“Many seaweed species have been used by artists in textile design, and they have different textures and shapes. They are considered beautiful.”

Appendix 4: Interview notes with Michael Palmgren from Malmo Marine Centre

Marine conditions around Malmö – the role of eelgrass and mussels:

- "There is a lot of sand in Malmo. They are sediments for eelgrass so that they can grow their roots. We actually have the best eelgrass area around the globe. We have eelgrass down to 11 meters. If you look around on the West Coast in Sweden or England, or in the United States, you can find eelgrass only down to 5, 6 or 7 meters. One of the reasons is the clean (transparent) water. We have so many blue mussels here; approx. 73 square kilometres of common mussels. They clean all the water. Therefore, we have great visibility here; we can actually go out on a boat and see the bottom down to 14 meters. One of the reasons why is that we don't allow bottom trawling fishing practice that damages the ocean beds."
- "The significance of eelgrass in Scandinavia is that it is the nursery area for the ocean. In the springtime, when the sun reaches down, photosynthesis is exploding, and all the shrimp and the fish grow up there. All the way down to 10-15 meters, that's the most biologically important area."
- "Unfortunately, this is where all the harbourfront/waterfront construction happens. People want to extend the municipality out into the water (land reclamation), and that damages all the marine nurseries."
- "Here are some of the important areas, Øresund and the bridge. Good for eelgrass, common mussels, the blue mussels. All of the 54 islands are covered with mussels. There are roughly 138,000 mussels per square meter. These mussels filter everything, but they are also food for the fish and the crabs, birds and so on."
- "There are mussel farms out here, but not for growing and eating because the mussels grow faster in more saline water. So, the more brackish water, they grow smaller and not so fast. So that's not an economic thing to grow here.
- "Every 54 of those islands are 54 new artificial reefs. Every island is roughly 25.5 meters and 8 meters high, covered with mussels and attracting schools of small fish and bigger fish, and it is really nice to dive there."

Malmö Marine centre – Education and marine literacy

- "There are roughly coming 350 school classes coming here each year. We have built a new exhibition for a new nature room in Øresund. A nature room is a "port" to marine nature and a visitor centre for nature. Our marine centre calculated 80,000 new visitors here each year, so we are quite busy. We have two boats, and we are doing research as well. Together with the school classes here, from seventh grade up until the gymnasium, we have 40 school classes out on the ocean each year. We also have guided snorkel tours; you can read about the crab or the bladderwrack."
- "We have a lot of eating programs together with the schools. When we had our inauguration, the food was done by the high schools, and they created a three-course meal. It is important to see what we have here, to protect awareness of the ocean. You can do that by smelling, tasting, and feeling".
- "We have created a lot of the snorkel paths around the south of Sweden, and we also have walking paths along the shoreline of Malmo city."

- “Nobody cared about the ocean until the 2000s. That’s about ocean literacy. 70% of our oxygen comes from the ocean, and the ocean is the biggest carbon holder. Education is really important because it starts to build up interest and awareness of our ocean.”
- “When the municipality wants some data, or they want to know something, they come to us, and I can say that here we have a really good possibility that this (particular) area is going to grow (eelgrass, seaweed, etc.), and we have a can have biodiversity there.”

History of Malmö harbour and its developments

- “Malmo started as a small fishing town. We have a big wharf here that they shut down in the late 70s. There is a new vision for the city (harbourfront area). They want to build a new city that extends to the water. Malmo has a history of land reclamation. About 4 or 5 years ago, we had a start-up plan to develop the new harbour with 8-9,000 people living here and 16,000 people working here. The idea is to shallow the water from 8-9m in depth to 3-4m by putting rocks there (and not make it dangerous for people). There is some contaminated soil here that needs to be covered with limestone, clay, rubber and rocks. This costs a lot. But if we do this, we can increase the biodiversity, you can swim and fish there, and if you are a house owner, you can see that you have marine nature outside.”
- “There are already results of eelgrass and fish coming back after putting the rocks back. We have done similar things with the Øresund bridge, we have dug out an area to get pylons in, and then you should collect the sand from Copenhagen and Køge Bay/Bugt and cover it with sand. We can now see the improvement under the bridge, the sand and the new adaptation with the eelgrass and the mussels. Nature can improve things if we let it.”
- “When they built a tunnel (under the water), they covered it with rocks to protect the tunnel, and also have some sand, and now we have eelgrass, bladderwrack (blæretang), mussels and fishes within two years’ time. By creating areas where there are areas where there are possibilities to grow, things that want to grow there come in there. The two key conditions for marine biodiversity is it can’t be too deep because they need access to sunlight, it needs to be something to attach to like rocks, and then you give it time.”
- “I will show you the drydock from the wharf. They made a tunnel to the big boats, and we had a tunnel for the big boats, and we had a problem because they were really toxic, and all the algae were going down this channel, and that was a dead area. When the Copenhagen/Malmo port wanted to move from the new harbour to the port further up, they wanted to excavate some of the bottoms. There was a proposal from the University in Lund together with Malmo city, to take that extricated material and fill up the port area. It was made over a couple of years.”
- “It used to look like this, dead areas. First, they covered it with limestone and sand; it started to improve with eelgrass and then a lot more eelgrass. If you do improve things and get the surface and bottom conditions right, you can manage to rejuvenate the water. “These were really shallow areas before the 1800s, so the possibilities to reclaim and recreate these dug-out harbour basins, you can actually improve that and make a really nice area.”

Visibility below the surface

“The shallow areas of depth of 2-4m, you have the eelgrass. If you stand there on a sunny day, you can actually see down 2-3 meters. If you have 4 meters and someone falls down, you can dive in and get them up from the floor, but if you have 7-8 meters, it's completely dark, and you can't do it; you would have to be a diver with gear. You need to know how the surrounding areas are and what type of areas you have so that you don't create a "new area." If you have a lot of eelgrass, you can also have both rocks and sand so that you attract different kinds of species."

Sea level rise in Malmo

- Malmo will be affected by sea-level rise. And so, the architects discussed building some islands outside, and what they are creating is an island that is higher. But that's not the solution because if you create boundaries where seawater can't flow. The solution should have more "soft areas" and allow for some buffer zones for the water to come. We constantly take more of the ocean; we need to see the importance of the ocean and give back."

Land reclamation in Malmo:

- Land reclamation has the consequence of taking out the shallow area with biodiversity and then creating these marine dead zones because it is too deep (lack of sunlight reaching in), so you then need to put in extra efforts to recreate that biodiversity again (by putting the rocks back and making the water depth shallow again), which is expensive. And when you talk about a deep harbour, you are going to put houses on the land, they need stable ground, and they need protection like piles. If there is shallow water, you don't need the piles as deep, so that's also an economic aspect to why land reclamation of shallow waters was popular."
- Important to talk to developers developing the harbourfront to say that recreating the "shallows" will create recreational areas, it is safer, so it is a win-win situation for everybody."
- "In the deep harbour, we put some stones and sand, and yes, that's new, but it used to be a shallow area. To "recreate" is about law and jurisdiction because you need to apply for permission for the "new things." I say that we recreated and took back the ocean as it used to be."
- "More than 50% of Malmo city area is ocean area (land reclamation?)."

Sustainable fishing:

"In the new harbour, we also discussed that we have a role with the new marine centre. We wanted to have a program with our local coastal fishermen. We were the second in Europe that create a community-supported fishery where you buy shares from the fishermen. You buy a share from the farmer instead of from the market, and the farmer gets some of the money. It is a kind of crowdsourcing. And then, they start a sustainable fishery, and members of the community support it. Now we talk about a company that's called Gårdsfisk, and they are growing fish on land. Growing fish on land is a sustainable way of growing fish. If you grow fish in the water, you end up with a lot of eutrophication, and salmon farming is really bad. If you grow it on land, you can take care of the faeces on land, and you have a controlled system. We talk about a new Scania fish which symbiosis on the new harbour with local, sustainable fish in the ocean together with sustainable fish on land."

Appendix 5: Interview questions for the winners of Kanten/The Edge competition

1. *How did you hear about the Kanten competition, what made you want to enter it, and how did you assemble the team? And, if you worked as an interdisciplinary team, what were the pros and cons?*
2. *What were your initial thoughts and impressions of the brief? What are your thoughts on the judge's comments on your project in the Dommerbetænkning/judge's report? (see: https://vejle.citizenlab.co/da-DK/projects/idekonkurrencen-kanten)*
3. *What was one of the main philosophies that drove your project and remained true throughout?*
4. *What were your biggest barriers and challenges?*
5. *What aspects of the Kanten competition brief (or/and the inspiration videos) helped you frame your project? Did you ever depart from the analysis/approach outlined by the brief by Vejle Municipality?*
6. *How does your Kanten competition entry project differ from your practice to date?*
7. *What aspects of your Kanten entry project are specific to Vejle, and what would be valuable for other cities facing sea level rise/storm surge?*
8. *How would you (re)formulate the Kanten brief if you were designing for ALL areas of the coastline and not just in the harbour zone and the nature zone as outlined in the competition brief?*
9. *What do you think the future holds for architects/designers working on sea-level rise and climate change projects for public officials, building developers and citizens?*
10. *Do you think, in general, the current architects/designers are equipped to handle the increasing complexity and challenges of climate change? (i.e. sea level rise, storm surge, biodiversity, mitigating pollution, integrating nature over and underwater etc.)*
11. *Finally, what were your key learnings from doing this competition?*

Appendix 6: Interview notes with Elizabeth MacPherson from Canterbury University

General introduction on expertise and current projects

There has been increasing interest in "more-than-human" relations in the US. Elizabeth is involved with researchers in Norway who want to test the concept in collaboration with NZ, especially due to granting legal personhood to ecosystems.

Elizabeth is working on the "Sustainable Seas" project and numerous other projects where she works in an interdisciplinary context; often, she is the only lawyer collaborating with scientists, planners etc. However, she cannot see the interdisciplinary boundaries anymore. She finds herself constantly taking the least legalistic approach to her non-legal counterparts. She states, "It's all normative, there is no hard law, and practice and customs are just as much law; whether written down in a statute or not, people still follow it. The question is, what is the reality in the world, and grounding it in theory to understand the power dynamics."

I ask about the article Elizabeth wrote with an Australian academic (Erin O'Donnell) about the problem with granting legal personhood vs legal living entity status. I ask Elizabeth to elaborate on her hopeful message in the article that there is potential for legal personhood.

Elizabeth wrote that article a few years ago, and her thinking has evolved since then as she has spent more time researching. She still thinks it is very important to reframe the way we look at nature, looking at ourselves as a component of the ecosystem, for example, looking at a particular manifestation of nature through a river or a mountain as having its agency, interest and right to survive and thrive. She thinks it is powerful in legal and non-legal ways. She is less convinced that the legal fiction of legal personhood is particularly important. For example, from all the cases she has looked at, not many have taken that into full consideration; the original scholarship around it claimed it is important for, say, the river to be able to go to court, but that's not important in New Zealand because there are general environmental public interest law standings that allow anyone to take any case to court if they think that there is a risk to the environment. So perhaps this legal personhood is more important in places like the US. However, in other cases where the river (ecosystems, marine environments, forests etc.) has been granted some kind of legal right has become more of an inspiration and captured people's imagination.

- 10:48 (Soo): "Giving legal personhood can be problematic because it triggers some sensitive responses, and people start suing the river. Is there potential in personhood instead of just giving it a living entity status?"
- 11:40 (Elizabeth): "I think there is something very important in reframing the way we look at nature, and looking at ourselves as a component of an ecosystem, looking at a particular manifestation of nature through a river or a mountain as having its own agency and right to survive. I am least convinced that the legal fiction of the legal person is particularly important because, in all of the cases that I am looking at, not a lot really turns on it."
- 12:32 (Elizabeth): In New Zealand, that's not really important because we have the general environmental public interest law, so anybody can take a case to court if they think that there's a threat to the environment."

- 13:42 (Elizabeth): "A lot of these legal person cases around the world have been driven by international environmental NGOs, which have their own agendas. Sometimes the NGOs use the indigenous communities to achieve rounds on the board for the rights of nature. Often they are not very much in touch with local communities or indigenous communities. A lot of local communities and indigenous people are now experiencing a backlash and having their back against this rights-to-nature movement."
- 14:36 (Elizabeth): Other things are happening that do not look directly like the rights of nature but are really interesting. In the NZ context, it is the new Te Mana o te Wai[279] framework. "Te Mana o te Wai is part of the new policy statement for freshwater management in New Zealand, and it comes from a Maori worldview. It recognizes that the rivers are living, holistic, integrated entities. It does *not* say anything about legal personhood, but it sees that rivers are alive and have relationships with people."
- 15:38 (Elizabeth): "This works quite nicely when you talk about coastal management because freshwater flows to harbours, and you can't divide those lines. This must be taken into account by decision-makers and planners. We are just starting to see some court decisions where the court is starting to prioritize the health of the environment instead of other uses like primary production."
- 16:29 (Elizabeth): "In my research, I think it is of constitutional relevance. I do think it has direct implications for planning. These sorts of ideas, I think, are transferable to other countries."
- 19:20 (Soo): "The indigenous way of thinking interconnectedness with nature fits so well with the current environmental movement."
- 20:09 (Elizabeth): "It is basic ecology. Science confirms that it's very hard to draw a boundary around an ecosystem. Ecosystems are interconnected, and humans are just one component. Often the indigenous community have a better appreciation of the ecology."
- 29:15 (Soo): "It is applicable for everyone, not just humans, but non-humans as well. The important thing is that this idea or belief system can be shared with a lot of people."
- 31:26 (Soo): "Crits have been asking me about the idea of giving the river personhood, and what has happened since then? So has this been more than inspiration and more than different thinking?"
- 33:40 (Elizabeth): "In terms of the Whanganui river, I can't talk about it because I am not from there. What I understand is that a lot is happening behind the scenes. A lot of work is not recognizable to people on the outside because it is about internal planning and management. It is difficult to measure the impact because of the life cycle of ecosystems. That is a problem characteristic of environmental management and river management. My understanding is that the community and the social benefits are incredible, but that is really not about the legal person. It's about the values of the river. It is about all the relational forums that have been created that allow people that care about the river to be involved in decision making."

279 For more information: https://environment.govt.nz/what-government-is-doing/areas-of-work/freshwater/work-programme/ and https://environment.govt.nz/what-government-is-doing/areas-of-work/freshwater/e/freshwater-reform/

- 39:20 (Elizabeth): “There is a big international movement around the rights of marine areas, both beyond national jurisdiction in Antarctica and local places. In New Zealand, there are guardianship arrangements for marine and coastal areas (i.e. Goat Island Reserve). There are also collaborative governance frameworks involving local communities and local governments in New Zealand. They are not legal rights, but they do recognize holistic and intrinsic values. ”
- 40:55 (Elizabeth): “Is the influence of where Maori have been saying for a long time, this is our ancestor, it is connected to our health, and you can’t separate the coast from the streams, from the biodiversity. That’s why I think river being a legal person is that making a difference is the wrong question because it is too narrow.”
- 42:27 (Elizabeth): “The idea is so good, the idea of getting a community to be guardians for a river. There has been a social impact; there has been a resurgence of culture and connection between people and the river. We just have to keep building on that. The fact that the river is a subject of rights is where it is weak, but the other stuff is important.”
- 43:43 (Soo): “If you empower the people that represent the river, it could lead to more legal protection of the river.”
- 43:55 (Elizabeth): “Where the legal implications are more important are in the day-to-day decision making. It is not really about going to court.”
- 44:25 (Elizabeth): “The real concern that I have about legal personhood advocacy is that sometimes the people who are posturing these approaches are not doing it for the right reasons, pushing transnational and NGO agendas in a way that ignores the authority of the local population and in particular the indigenous people.”
- 45:08 (Soo): “Putting the environment before people?”
- 45:13 (Elizabeth): “They are not actually putting the environment before people; they are putting their own human interests and their own egos. We have seen it in some of the court judgements. I have been fairly critical of the amazon case because those territories are indigenous territories, and indigenous communities were not consulted at all.”
- 46:00 (Elizabeth): “A lot of indigenous communities are very wary of the rights of nature as a western movement which may not align with the interest of the indigenous community. Just giving people governance rights through legal person models is not going to resolve the underlying problem. That’s why I increasingly like to focus on this, looking at them not as a complete solution, but as an approach that tends towards greater recognition of the living nature of ecosystems.”
- 56:42 (Soo): “Can it be a compromise between economic agendas and intrinsic values? Can it be more than a compromise?”
- 56:59 (Elizabeth): “There is no such thing as an entirely eco-centric approach. This is all about human interests and human rights. It is about nature's relationship with humans, and nature's relationship with different humans, and the compromise, the negotiation, and the conflict and how those are resolved for hopefully the best interest of the environment. It is not different from existing models, but I think what is really promising is where you got overarching higher level bottom lines around the native support the life-giving properties of ecosystems.”

- 58:03 (Elizabeth) "There is always this balance of use and conservation. I think we can all say it is not drawn at the right place at the moment. I think these models are most interesting in terms of their relational potential."
- 01:02:58 (Soo): "So if everything comes from a human agency, you really need to empower people so that they can protect."
- 01:03:12 (Elizabeth) "You can do all of that without an actual legal person, legal subject, which might provoke a backlash. Some of that stuff could be done a bit more under the radar by maintaining the promising parts of this model without the legal person."
- 01:04:53 (Soo): "The legal person acknowledges that the river is alive, but it does not mean it belongs to the Maori?"
- 01:05:03 (Elizabeth): "Not really, no. My view as a legal scholar is that the governance arrangements, the relational stuff, and the conceptualization of the rivers as living and connected, that is the bits that are interesting."
- 01:21:12 (Elizabeth): "We don't have the protection of marine environments where we need it. It is in these pristine off-shore areas that aren't used for anything. We don't have protection where we need it, which in our urban coastal front, areas of development, that's where we need the coexistence of people and ecosystems."
- 01:21:39 (Soo): "Why do you think we need that protection in urban areas? Is it not already very polluted?"
- 01:21:49 (Elizabeth): "The idea that we can assign pristine areas of the ocean for protection by drawing squares on maps, and then allow fishing trawlers to settle exactly right outside of them and bottom trawl everything underneath doesn't make any sense from an ecosystem perspective. We need to look at the way we use things like harbours. We need to look at protecting harbours, not just from cities but from the impact of sediment flowing into them. The interface between sea and land is so important. The traditional approach to marine spatial planning does not account for it very well."
- 01:23:46 (Elizabeth): "It is just a different approach of let's protect these pristine areas where there are no humans, and lets humans trash everything else."
- 01:25:20 (Elizabeth): "The mentality of we can somehow engineer ourselves out of this problem without changing our behaviour in any way."

Appendix 7: Interview notes with Teis Boderskov from Aarhus University

- Sukkertang (Sugar kelp) can get up to individual blades 3m in East Jutland (in the right conditions – good seasons). 2.5m in the first growing years is possible (most productive). Not as long as they do in Korea (5m). Most of the time, it is 1-1.5m long.
- It is possible to grow sukkertang in Vejle. It is a nice place to do so because of the nutrient load (nutrient-rich), ok salinity level, and a lot of water coming from the little belt. Great place to grow seaweed (sukkertang is growing in the deeper part of the outer fjord).
- In winter, they grow – during summer (autumn), they slowly stop growing and lose the outer part of their blade, so they get shorter.
- In summer and fall, they lose the tip. If say, they were max. 3m long, they would shrink to 1-1.5m long. Quite small. Depends a lot on the site and where they are.
- They grow from the bottom in winter and spring.
- In Spring, they grow the fastest – they can be around four years old.
- Upper leaf of 24 degrees. Above 20 degrees, they are stressed. 1m deep sukkertang, and if they get over 20 degrees, they might die. You can lower the line temporarily to avoid heat death. (definitely doable – you can raise them again. Therefore, it is important to design the cultivation system well). The method used in China and Korea is labour-intensive (making it too expensive in Denmark – using an automation system in Denmark – esp when there is no big market for seaweed).
- In the future, we can breed favourable conditions to make them grow longer (china and Korea have bred this over the years – big leaves – selective breeding. Island of Jeju has lots of seaweed farms). If we keep the seaweed in optimal conditions (1m depth – close to the surface to have access to light).
- Part of the explanation for seaweed cultivation in Denmark is that there is no market demand. Seaweed farmer needs to do everything themselves, grow it, sell it (no one will sell it for you in Denmark). Therefore, they find it hard to create a market for seaweed.
- Seaweed as fertiliser – that is a possibility. The problem is that people will not pay much for seaweed. Too little profit for seaweed farmers.
- Another possibility is for pig feed (which is already done). A lot is going to feed. There are experiments that seaweed in feed is better for the gut health of the animals, so they ferment the seaweed and mix it with fermented rapeseed for the meal for pigs. Health demand as pig feed.
- Economic barriers make it hard to make seaweed in demand for fertilisers.
- Global warming is driving warmer temperatures – does sukkertang have the potential to survive in a changing climate?
- They will survive in deeper waters. Harder to survive in summer
- But better growth in winter – higher temp in winter increase the capacity to grow (below 5 degrees, they are restricted in growth slows down). If they are above 5 degrees in winter, they will grow significantly faster
- More rain, more nutrients – more growth.
- A bigger yield in kelp in the future is possible.

- Fowling of other organisms/animals – you deploy them in late fall, and harvest in spring before (may) small animals attach to blades. If only harvesting for fertiliser – then you can wait till late June and get a higher yield.
- (pig feed –can disturb the fermentation process). So only really appropriate for using it as fertiliser.
- A seaweed system will definitely do something about the waves and take up the worst waves, but when you have a flood, you have massive movement of water; a seaweed farm won't mitigate that. It will only do something about the wave. Storm surge on the east coast is a "silent storm surge."
- The problem is that the water is coming from the west, water is pressed into the Kattegat because it cannot go faster into the straits, it will rise, water will also come from Baltics (east), water will rise. You can also have problems without the wind because of water coming up. Seaweed will not mitigate this. So maybe you should focus on areas where there is a problem with waves, like the west coast and some places in the Kattegat (or places with coastal erosion – North Jutland).
- Kelp hanging onto the ropes after a storm – they could sustain there, but 2m depth – the system needs to be able to take the forces. He is sceptical there is a system in the world.
- Company Ocean Rainforest – a system used in the Faroe Islands, this system should be able to withstand storms. This could be a solution. This is based on growing lines on vertical orientation.
- Growing kelp on the North Sea (close to shore) – you need to place lines close to the water surface because the water is murky. (between 1-1.5m). In hot weather, you need to take it to 5-6m in depth.
- He has seen kelp dying in Horsens at a depth of 0-4m in hot summers.
- Silent storm surge means less role in wave attenuation – but other benefits of kelp – are blue carbon, nutrient uptake, etc.
- Say 5km^2 of kelp forest – lower current speed will have a higher rate of sedimentation - will impact sediment flow
- Permit for putting lines on Vejle; you will have a hard time. "People are aggressive in taking up space on the water – you would need a good argument for helping the city."
- Coastlines with coastal erosion – better argument for this system. (North Jutland, for example). Locally in the South of Aarhus also have problems with coastal erosions. They are making stone reefs.
- Storm surge protection is probably a long shot in Vejle.
- In terms of the uptake of nutrients, you would need a LARGE area for it to be significant. Mussel farming is more effective in removing nutrients than seaweed. More research is needed to do integrative farming with mussels and seaweed.

Appendix 8: Interview notes with Steen Hedrup from Vejle Fjordhave

Growth of sukkertang by the Vejle Fjord Havhøst Association

- Every October, the Vejle sea garden harvests the string with sukkertang. It grows from Oct – April (0m to 1.2m in length), which was the recorded length last year (it won't grow much longer during this period). If hung out longer, the waves will demolish the leaves and wear out the string. But there is a possibility to redesign a better system that allows the sukkertang to grow longer.
- However, stone reefs in the fjord will make it possible to grow all year. – The best way to have a steady growth of sukkertang is from stone reefs, where they attach better than the current rope system in a storm (strong waves)
- Water clarity prevents sukkertang from growing well. We can see up to 3-7m in the outer fjord (on a good day, 7m, on a bad day, 3m). What is important to sukkertang is salinity. The measured salinity was 19 to 25 parts per thousand, which is the condition on the outer fjord. SukkerTang has to be on the outer fjord due to salinity levels. They live a certain depth below the water line– 2m-6/7m. (the string is on the outside)
- The forest called Kornsko is located 1km west of Træskohage; this is where the association have the lines for the mussels and seaweed (sea garden).
- You can eat the sukkertang – the fjord is polluted but not poisoned.
- The sea garden association eats a lot of mussels. 100,000 mussels.
- The fact that the crabs and starfish are present in the Fjord is not a problem; the issue is that there is an unbalanced food chain that results in a huge exploding population of crabs and starfish. Ducks are also eating them. They made a net to keep the mussel line off against the ducks. Stone reefs are an important nursery so that cod can grow (big cod that can eat the small crabs) – Houses for fish are a good idea.

Pollution, protection areas and regulations

- You can't fish around the mouth of the river. Locks and gates are temporary, so they won't be a huge problem for fish. Last 25 years, they have always been open. There is a law against blocking the travel of fish up and down the river.
- Inner fjord protection (Natur og Vild) – no commercial hunting in this area.
- Natura2000 protected woods along the coast of the fjord – very important in filtering the agricultural runoffs
- Scientists recommended a directive to limit fertiliser use within 300m from the coast (i.e. No agricultural fields near the fjord). However, it has not been passed as a law.
- Not so many agricultural fields near the Vejle Å. So the inner fjord is actually in better condition than the outer fjord.
- There is very minimal seaweed food culture in Denmark. So the first step is to mix it (seaweed) into normal food so people don't know it's there. The presence of more sea gardens in the fjord could encourage people to be aware of seaweed as food (so people can see that they are being harvested).

- The sea bed is very flat, sandy and muddy, with about 1-2m of mud. This is a problem with growing seaweed. More stone reefs are needed in deeper water where the salinity is stronger on the outer fjord, so more effective to put them in the outer fjord (where seaweed like sukkertang will grow)
- The seabed in the Vejle fjord has been stony before (but some were used in the construction of harbours), and the fishing boats that took out the mussels (bottom trawl fishing) and small pebbles and stones. It was then taken to be used on land. Now they need to put it back.
- Norway is selling stones for gravestones and kitchens. There are a lot of small stones in Norway, and they don't know where to use them. You can get them cheap from Norway (and Sweden).
- When we made stone reefs (in Tirsbæk) after one year, it was in a condition that was really good to look at. Lots of organisms thrived in the rock reefs. Construction waste material could work to create the reefs. Everything that is 3D that could be positive (i.e. like a shipwreck).
- What is below the surface very important- The biggest problem. Steen has been a nature guide (Naturvejleder) for 23 years. From small children to old people, no one knows anything about what's under the water. They know there is fish and some seaweed, but that is all. They don't know how these animals and organisms live or their ecology, and they have very little knowledge and awareness.
- First of all, it has been politics that have created a barrier to putting more stone reefs in the beginning. The biologists weren't allowed to do it because they had to prove that there were stone reefs before in that exact location (And they couldn't provide proof). The law is a bit better these days to enact stone reefs – esp for biodiversity.
- It is important to Danes that interventions on the water are not ugly to look at (in reference to any intervention such as the large-scale floating buoys for sukkertang lines)
- Seeing it with "another pair of eyes" is important – Steen believes architects have a role in this. To showcase the marine world in another way (esp to convince political p.o.v).
- You only get seaweed from the beach where the rocks are hence why they wash up and can rot, which can turn off Danes from developing a more positive relationship with seaweed.
- The 40 years of history in the oceanarium in Hirtshals was only about showcasing what kind of fishes are there and not about climate change, water pollution etc. But Steen thinks that the political views and narratives are changing, and the mindsets are changing due to climate change and the biodiversity crisis. It is more in the mindset of the people than before.
- It is important that there are marine centres that help people understand that it is important to do something in the water, not just on the land.
- About 8 to 10 places in the inner and outer fjord are possible to grow Ålegras/eelgrass (through tests). In some places are obvious that it is not possible to grow them (near the stream where the sand will overflow them, in some places too many crabs, and in some places too muddy and make the water murky).
- Architects are able to make the waterfront a "nicer" place to view the beauty of the sea – many other buildings in the Vejle – are made by famous architects – **people are really looking at the buildings – do the same for the marine life. Connect with the biologist to say to the public this is beautiful; this is interesting.** The combination of architects

and biologists is a very important partnership. The people revere architects more than biologists.

- Omle Torv Mådele Åen – Dæmning – Open up the måleøen åen – Havnegade – Steen was in a group to advocate opening up the Vejle river (stream) with artists, architects and engineers – to make the bridges over the måleøen ten years ago. Covering up the river means no marine life can grow there. However, fish can go through. Uncovering the river will be better, biologically speaking. By giving more space for the river so that more water can move up (when it is open) and for the river to bleed. He hopes that river will open up more (moleåen)
- He also confirms that Danish agricultural activities are the main culprit of the pollution of the fjord. 70% of the pollution in Danish waters makes the water murky and difficult to see.
  - One of the solutions could be to eat less meat – and no agricultural activity near the coast (as a starting point). There is potential to replace the fertiliser with an organic fertiliser such as seaweed.
  - Yesterday, the association fished up 58 kg of mussels for a party – people in the association were invited to eat the mussels (25 people). Denmark is only fishing a few species because that is what people know. There are many other diverse forms of seaweed that could be eaten (instead of meat).

Appendix 9: Interview notes with Dorte Krause-Jensen from Aarhus University

Possible reasons why seaweed is ignored in Denmark (DK)

- The possible reason why seaweed is not the focus in DK compared to other coastal ecosystems could be because the coastal sea bed conditions are largely sandy – which is a better environment for eelgrass compared to seaweed. Therefore, coastal areas were a hotspot for eelgrass. 100 year ago, a belt of eelgrass in coastal areas reached 1km. People are more aware of eelgrass because it is more common, and people are aware of salt marshes because they are visible (unlike seaweed which is submerged). However, a disease wiped out eelgrass meadows in the 1930s, and coastal erosion intensified. The name of eelgrass in Danish is ålegras (related to eel fish living in the eelgrass), but also called "bandtång" (common eelgrass: Zostera marina). There is confusion about Båndtang (band, chain, link) eelgrass as seaweed in DK– which shows the lack of awareness of the marine species of DK.
- Seaweed harvest for food is very new in Denmark (thus, low interest and awareness). DK had an industry for harvesting the focus (red algae), but it is gone now. Moreover, seaweed is not part of "normal botany" education in Denmark, further adding to the lack of awareness. There is some awareness of bladderwrack/blæretang, which is common in DK, with memories of popping the air bubbles out as a kid (a coastal nation with closer interaction with water). In DK, only the term "tang" is used as a general term for seaweed, but there are two in Norway - "Tang" and "tare", which already have more differentiation between the different seaweed. More rock reefs in Norway have more exposure to seaweeds; therefore, they garner more interest in Norway compared to DK.

The motivation behind going into specialising in seaweed

- Dorte's motivation for going into marine biology, specialising in seaweed, was due to the beauty of seaweed. Initially thought of seaweed as a nuisance when swimming (smelly and gross, something you want to avoid), but was surprised and convinced by its beauty – introduction to a new world of marine botany.

Useful references

- There are some exposed shores near harbours and some rock reefs. But very few Danes have seen rock reefs. However, in front of the Copenhagen Opera house is a project from Copenhagen municipality to install an artificial rock reef, and a camera is monitoring and showcasing what is under the water.
- There is a national marine monitoring system/program looking at the stone reefs:
  - https://www.naturibyen.com/steder/koebenhavns-rev/
  - https://www.havne-fronten.dk/2021/aalegraes-og-stenrev-biodiversitet-i-koebenhavns-havn/debat/
  - https://kulturhavn365.dk/category/artikler/land-vand/i-vand/
  - https://mst.dk/natur-vand/overvaagning-af-vand-og-natur/hav-og-fjord/
- The latest annual report on the state of the marine environment based on the national monitoring data – stone reefs (stenrev) is part of Ch. 7. https://dce2.au.dk/pub/SR475.pdf
- Booklet on stone reefs made by Karsten Dahl:
  - https://www2.dmu.dk/1_viden/2_Publikationer/3_miljobib/rapporter/MB02.pdf

Appendix 10: Notes and photos from workshops, meetings, events, field trips and festivals

Host/Event	Date	Key relevant learnings
Havhøst in Kattegat Centre in Grenå (aquarium/ oceanarium)	01/07/20 In-person in Grenå	This was a public event from Havhøst, promoting seaweed and mussels as food (new Nordic cuisine). Education on various properties of seaweed and its use and an exercise in dry pressing seaweed collected from the waters of Grenå (see Figure 19). The dry press seaweed exercise was used throughout the research as visuals for mapping. I spoke to Lone Thybo Mouritsen, Head of Research at the Kattegat Centre, who was running the event with Havhøst.

Figure 185. Photos of various seaweed-related activities taken from the Havhøst event at the Kattegat Centre on 01/07/20.

Table 10. A public event with Havhøst in the Kattegat Centre in Grenå Oceanarium.

Host/Event	Date	Key relevant learnings
Seaweed Festival (Tang Festival) and Tang safari in Nykøbing Susan Løvstad Holdt Ruth Nielsen DanskTang	02-04 July 2021 In-person in Nykøbing	This was a public event for seaweed, drawing all the specialists on seaweed from across the country. While there were no official interviews, there were informal conversations with researchers and experts on the various benefits of seaweed (see the list below). Members of the www.tang.nu network (seaweed network in Denmark) were present, including; - Susan Løvstad Holdt, Associate Professor at DTU in the National Food Institute Research Group for Bioactives – specialising in seaweed cultivation for food and for other sustainable use. - Ruth Nielsen, Associate professor emeritus, Faculty of Science at KU – is the co-author of the two-part book series on macroalgae in Denmark (Danmarks Havalger),

		which goes into extensive depth about each macroalgae species and their distribution in Denmark. - DanskTang is the only distributor and retailer of harvested seaweed in Denmark. The festival includes going out into the waters of Nykøbing to harvest seaweed (Tang Safari). I was able to derive more hands-on experience with seaweed in shallow waters (under 1m) to witness the good visibility of seaweed at these depths.

Figure 186. The photo was taken by the author of various seaweed on display in glass casing for the public during the Tang Festival on 02/07/21.

Table 11. A public seaweed festival with various organisations and companies in Denmark in Nykøbing.

Host/Event	Date	Key relevant learnings
Goat Island Marine Reserve (Te Hāwere-a-Maki in Maori) and Goat Island Marine Discovery Centre in New Zealand Tim Haggitt	14/05/21 In-person at Leigh, NZ	The site visit to the Goat Island Marine Reserve included an informal interview, a tour of the Marine Discovery Centre and a brief presentation with the project leader and marine biologist, Tim Haggitt, from the University of Auckland. His findings showed the value of the Goat Island Marine Reserve (no commercial and recreational fishing allowed) in supporting marine life and the importance of creating a decent-sized protection area. He stressed the importance of the role of local Maori representatives and their worldview on guardianship to help build a case for protecting these areas. He also addressed the reason MPAs are a linear boundary line so fishermen could easily recognise them to prevent them from fishing inside the MPA. What this highlighted was the prevailing anthropocentrism in the way of dealing with water's border. Unfortunately, the marine reserve was closed due to a stranded whale, but I was able to go on the coastal walk that enveloped the reserve.

Table 12. A tour with the marine biologist from Auckland University around the Goat Island Marine discovery centre and the marine reserve.

Host/Event	Date	Key relevant learnings
The Algae Platform (Luma Arles from the Luma Foundation) with Space Caviar in V-A-C Foundation/ Zattere, Venice. Invited by: Johanna Weggelaar and a team of architects and designers from Luma Arles Guest expert: A local marine biologist who is working in the Venetial lagoon with seaweed was invited to give us guidance.	16-19 December 2021 In-person at V-A-C in Venice	The four-day workshop consisted of industrial designers (material), architects, interior designers, engineers and artists focussing on working with algae in various manners from all over Europe (I was focussing on kelp and its wave attenuating properties). The workshop involved a field trip on a boat around the lagoon to see the various habitats of seaweed and a knowledge exchange session with the local marine biologist working with seaweed. Unfortunately, due to bad weather, it was not possible to see the controversial MOSES project (coastal protection system for Venice). However, from speaking with local experts, it is likely that the MOSES will be used more frequently than intended due to SLR and SS events in the future, thus enclosing the hydrological systems of the lagoon into a pond (affecting water and nutrient circulation). Already, land reclamation projects in Venice have significantly altered the hydrological systems of the lagoon, with negative impacts on soil deposition and marine life. The findings from the workshop and from the marine biologist indicated that there is still sewage being deposited into the lagoon (from some of the residential buildings – not commercial buildings) in which the local and invasive species of seaweed have been working to purify the water. However, many negative perceptions of the invasive kelp species exist for Venetians as it disturbs the motor engines of boats and its invasive and foreign nature (however, it is no longer an invasive species but has settled into the local ecosystem). Seaweed is categorised as waste, therefore, preventing its use as a sustainable form of paper production in Venice. Furthermore, there lacks a local common name for the invasive species of kelp, which is referred to as either the scientific name or the Japanese common name (Algae Platform and Atelier Luma, 2021).

Figure 187. Photos from the workshop in Venice with the members of Algae Platform and Space Caviar.

Table 13. A workshop with The Algae Platform (Luma Arles) with Space Caviar in V-A-C Foundation, Venice.

Host/Event	Date	Key relevant learnings
NordSalt Workshop led by researchers from SDU (marine biology) and other experts/ actors from various backgrounds Invited by: Cintia Organo Quitana from SDU	02/02/22 In-person at SDU campus, Odense, Fyn	Discussions on NbS of salt marshes from various perspectives and interests. i.e. value propositions (there were many different actors present in the meeting. Including architects (me), engineers, ecologists, economists, and sociologists? with various traditions and backgrounds). There were discussions on the barriers to salt marsh implementations, perceptions of the salt marsh by the public (i.e. aesthetics, landscape identity etc.), economic funding issues, pollution from agricultural activities, etc. Furthermore, there were discussions on what constitutes "original" vs "alien" nature that could be implemented in the future due to climate change, to name a few. Refer to the project's website: https://www.sdu.dk/en/forskning/nordsalt

Table 14. NordSalt workshop organised by marine biologists from SDU in Odense.

Host/Event	Date	Key relevant learnings
Visit to Gyldensteen Strand project Invtied by: Cintia Organo Quitana from SDU	16/09/20 In-person with students and staff from SDU to Glydensteen Strand, Bogense, Fyn	I was invited to join a field trip to Gyldensteen Strand in Fyn with Cintia Organo Quitana's students. The walking tour included visiting the local forest, bird watch towers, a walking trail around the lagoon (salt and freshwater), refurbished former mills (remnants from former agricultural activities) and the visitor centre with educational panels communicating the work that the biologists and local volunteers have done). Cintia disseminated the progress of restoring the lagoon to the students while the students asked questions. For instance, Gyldensteen Strand is implementing sand capping to limit floating particles from agricultural activities. However, this is difficult to implement in places where there is a lot of water movement (i.e. Vejle fjord due to the presence of the river bringing in a lot of water movement and materials that will bury everything in mud again).

Figure 188. Photos from the field trip to Gyldensteen Strand with Cintia Organo Quintana's biology students at SDU on 16/09/20.

Table 15. Site visit and a field trip to Gyldensteen Strand, Denmark, with students from SDU.

Appendix 11: Kanten/The Edge related: Inspiration videos, meeting notes, and judges' report

Virtual start-up inspiration seminar for design competition Kanten/The Edge

Five inspirational videos were created for Kanten/The Edge design competition (15 April 2020) for the entrants to introduce them to the history of Vejle, its contextual background, the main focus of the competition brief and the different perspectives from experts ranging from art, landscape architecture and marine biology. The videos are to provide inspiration and information to kick off Kanten/The Edge competition. Refer to: https://vejle.citizenlab.co/da-DK/projects/idekonkurrencen-kanten for the videos (in Danish and English). The Danish inspiration videos are translated into English, and the transcripts are shown below:

VIDEO 1
Introduction to the idea of competition Kanten
Background to the competition, storm surge protection is growing with the city
Introduction to the competition assignment (especially the nature-based solutions)
By Christina Korsbek Olesen / Lotta Tiselius from Vejle Municipality

VIDEO 2
Presentation on water, nature and art in Vejle / Another perspective on water (Oplæg om vandet, naturen og kunsten i Vejle / Et andet perspektiv på vand)
By Lisbet Wolters - city architect for Vejle Municipality

VIDEO 3
Review of the competition area (site) and the two zones
By Lotta Tiselius from Vejle Municipality

VIDEO 4
Inspirational presentation 1: Urban seascaping
By Soo J. Ryu - PhD fellow, Aarhus School of Architecture

VIDEO 5
Inspiration presentation 2: Between land and water in Vejle Fjord / Sund Vejle Fjord (Mellem land og vand i Vejle Fjord / Sund Vejle Fjord)
By Mads Fjeldsø - biologist, Nature & Outdoor Life (Natur & Friluftsliv)

VIDEO 6
Inspiration presentation 3: A different perspective on water / Asking a new question (Et andet perspektiv på vand / At stille ny spørgsmål)
By Marie Markman - landscape architect, artist and art consultant

Appendix 11A: Video 1: The City, Water, and Art – A common ground by Lisbeth Wolters (the city architect of Vejle)

The creation of the city, topography, and water

Hi, my name is Lisbeth Wolters, a city architect from Vejle Municipality. I will talk about my perspectives on urban development and water in Vejle. The word Vejle means 'ford' (the only place where one can cross the river). Vejle City has emerged as a little settlement on a little elevation in a river valley. The elevation allowed you to cross the river valley without getting wet feet when going from north to south or vice versa. There was a little elevation, and that is where Vejle is placed today. Here the deep fjord meets the river valley while the hills surround the city from north to south, and the rivers twists and turn through Vejle Kommune and gather in the city to flow out into the fjord. Vejle thus was created on the conditions of the water, and the existence of water is integral to the self-perception of Vejle. The rivers and streams defined the city's border with the landscape, and the streams supplied (mentions a specific place with specific streams) worked as an early harbour. Back then, there was a special connection between the city and the water. In the drawing of Vejle from 1627, you can clearly see the connection between the city and the water. The presence of water is a condition for the city's existence, and the city's structure is a consequence of the landscape and the topography around it.

Later they had to transform the city's areas; they had to build residences and industry, harbour activities etc. Industrious activities have filled out the fjord water and built the city further and further east into the ocean, and in that sense, the presence of the water in the city has diminished.

The beech forest and the topographical landscape are a part of the nature around Vejle. It is a big potential, and on a beautiful spring day like today, the water – as it is materialized in the trickles down the stream - is one of the most calming and beautiful sounds that you can enjoy if you move through the landscape. On a day like this, the water is not a threat but an aesthetic dimension when you go for a walk, almost like a symphony; this sensibility toward the water's trickling is something we enjoy when we walk out here.

The City, The Fjord, and the Space of the Edge

The border between the city and the water is changeable. Those of us who live in the city think that the edge that the city creates toward the water is a fixed thing, the edge between the city and the water is a definite line. In reality, however, this border is very fluid and changeable. Historically, Vejle has developed from within the elevation of the town from the Middle Ages, and now it has been developed far into the fjord water. In that sense, the border has always been in different places. At the harbour, where I am now, is one of Vejle's newest architectonic works, Fjordenhus, which is behind me here, drawn by Olafur Eliasson. Furthermore, he actually works, with this work, with this border between the city and water. In his building, the border becomes space and form. He has composed his work excellently. You start out by coming into this place covered in cobblestone. From the dense city, which you leave behind, you enter this kind of pause. It is a place where you take a deep breath before you go in and experience his work. Then you walk across this pier, which is quite long and which extends into the fjord, and which is slightly conical, which highlights the perspective and the experience even further and guides one's gaze out into infinity, into the fjord water, and here he introduces what it is all about. You let your gaze rest on this sight, and then you walk across a bridge and into the building.

You step onto a bridge and into another world, perhaps a ship? Into something that is undefinable. It is still a wharf, but it is a sheltered space, yet you are also outside and inside at once. In general, Eliason's work questions what a city is and what water is as well as how water can affect our experience of the city, which we leave behind when we step unto the bridge.

Inside the building, there are also actual pieces of art that also work with the element of water. There is a work called 'underwater expectations', which you have to look far into the water to notice. There is also another work that is called Fjordreflector, where the playful reflection of the light on the water enters the building. It is a sensorial experience of the water, which, in reality, down here at the harbour is a threat because it is also a building that is at risk of storm surge. Because it is this part of the city that is under threat of storm surge. Yet despite this, Eliason has accomplished getting this aesthetic sensorial quality into his work. Seen from my perspective as 'stadsarchitect' (city architect), this building itself is ensured against sea-level rise. It is placed into the water, which grows along the side of the building. But the bottom level of the building is made so that in case of sea-level rise, those with the upper floors can sit and work without being flooded. So this is a resilient way of building, and it is also a way of a building where this whole attention to the water is something changeable and aesthetic and sensorial element while also being something threatening and violent. Here, the edge is not a sharp line but a space where the water's poetry is set loose.

Art in the city

In Vejle, we have a big tradition of using art and architecture when we are developing our city space. You can see this when you walk around the city, and it shows in everything from manhole covers to the fences on the bridges, "spånsvægge" along the city's streams. Lightning and spaces and plazas and playgrounds and even the waste water facilities have been worked by artists, who have interpreted the city and the nature around it and in each, their way contributes to providing an experience when you walk through the space of the city. Here, in the "monumel"-area, in Jelling, there is an artistic work which has worked with an old Viking site. And perhaps, instead of making a true imitation of the palisade of the building as it looked like in the time of Harald Bluetooth, then you have here, in Vejle Kommune, chosen to interpret this palisade (which was done by Inger Kronhammer og Kristine Jensen). Here, you see how the palisade's extension and geometric forms have been interpreted with white concrete elements, which of course, do not imitate how it looked back then but might, in fact in a much better way to convey the sense of grandness to the many visitors who come here every day.

We also have a gravel pit which has been worked in by Robert Jacobsen and Jean Clareboudt. Their artwork uses iron constructions that make us notice the movement of the sun, using shadows and materials that pick up the presence of light and the sun and give us another sensorial experience of the natural surroundings that we live amidst.

Architecture, Art, and Architectural Politics

In Vejle, we consider art, not as a special or separate measure from the other things we do. In "teknisk forvalting"; which is where I work, we make roads and city spaces, and technical facilitates, and climate-change safety measures. And in doing so, we often look at these things from an artistic perspective. That is also what we want to do with this competition. With art, we explore how to get something alternative out of *things. If we are building and investing anyway, then how can we get the artistic dimension with us into what we do.*

For example, we made an art boardwalk, which started as a completely common project of making a road and boardwalk and climate safety measures, but then we worked artistically by inviting Anders Bonnesen to make a work in it. He created a poem which unfolds across 400 meters, which reads as you read from A to B. We thus made something as boring and dull as a boardwalk into something interesting, which is part of the city space.

Vejle commune was the first municipality to adopt 'architectural politics'. We did that in 1997, and it is actually the essence of the politics that we are working with today. Here, the politicians have formulated how both architectural and artistic quality needs to be a central element when we develop our city and when we create good public spaces for its citizens. So, in reality, one might say that we have a political mission and political mandate to try to work with storm surge safety-making and the edge between water and city as something that can more than simply be a technical barrier and a technical solution.

Art and Resilience

And then I think that art can do something special when we talk about some of these violent and unfathomable challenges that we see ahead of us in the future. Rising sea levels, increased rainfall, and storm surges are all things that are very abstract and can be hard to understand because they are 100-year events, and 'KOTER' and CO2 Emission reductions that we talk about in percentages. The language of these challenges is very technical, and it is very far away from the potential that there is in the way that we have an opportunity to connect with the water. I think art can help us understand these challenges in a new way, and it can help connect us to the future in ways that, perhaps, could make us more resilient people and more resilient citizens in Vejle.

Appendix 11B: Video 2: Ecosystem services in Vejle Fjord by Mads Fjeldsø Madsen (marine biologist)

Hello everybody. My name is Mads, and I am a biologist in Vejle Municipality, where I am part of the Nature and Wildlife Group under "Teknik og Miljø". I am at home here in my cosy living room. I am in corona quarantine, so if anybody is wondering about the odd location for talking about coastline protection and storm surge protection, then that is why. I also want to stress that I am not an expert in coastline protection or storm surge protection, but I want to still try to give a short introduction to some of the mechanisms that work in the natural protection of our coasts in Denmark in normal circumstances, and by normal I mean healthy coastal areas and healthy ocean environments. There aren't that many left of those, so there are definitely some imbalances that we feel very much today, and I will try to talk about those as well.

I'm going to start by talking about a big project in Vejle right now. We call it "healthy Vejle Fjord", which started on 1/1/2020 and is going to run for the next five years. The project is financed by Velux Fonden. It is a project that, as a municipal project, is very ambitious in which we want to try to restore the nature in Vejle fjord and change some of the imbalances that we see there today. And this includes coastal protection.

In the last decades, we as a human species have affected our ocean environments in very negative ways. We have, since the 1950ies and 1960ies, emitted a lot of nutrients into the ocean environments, especially in the inner Danish waters, and this is a big problem. I will get back to that. But we also experience big challenges in relation to climate; we experience warmer temperatures and higher rainfall, which means that we get bigger storms. And storms and currents are both important factors in relation to coastal protection.

If we are to provide a brief overview of the problems that Vejle Fjord is facing, then we can primarily highlight that we have, throughout a number of years, emitted nutritional salts (næringssalte - fertilizer). Nutritional salts (næringssalte - fertiliser) are, amongst other things, from agriculture but also from the cities. We've become better over the last 20 years; since the 'water mixers' started in the mid 80ies, then we have seen a dramatic reduction in the emission of nutritional salts (fertilizer), which are so tough on our ocean environment. In fact, we have today halved the emissions that we had at the beginning of the 80ies. The main problem for Vejle fjord is that the many nutritional salts result in algae blooms. The most negative consequence of this is that the transparency of the water is reduced drastically, and this means that many of the natural plants that have been in the fjord (which are still there, but in very limited numbers) are now heavily affected. Especially ålegræs (eelgrass) is suffering from the fact that the transparency of the water is bad. It is in addition not only transparency but also that other algae species grow on the ålegræs, which limits the light intake that the ålegræs needs to grow. Ålegræsset has for many years been very dense, and the fact that the ålegræs-beds have disappeared has negative consequences for the protection of our coasts.

Apart from the negative effects that the nutritional salts (fertilizer) have on the ålegræs and the algae that grow on it (and thus suffocate the ålegræs), the big blooms of plankton-algae means that when the algae die, they fall to the bottom as a layer of mud, in some cases up to several meters thick. And these layers – and the radical changes it has to the sediment of the sea floor have had big consequences for Vejle fjord. The Ålegræs, apart from being suffocated, have a hard time connecting to the sea bed. And this is another factor why the Ålegræs is in sharp decline.

We see similar things in the "rørsumpe" (reed bed), which we see along Ibek Strandvej. We have images from the 1940s where we had enormous "rørsumpe" throughout Vejle fjord. Typically, it is tagrør. We can also *see that this plant has declined heavily in the transitions from the water phase to the land. It has also diminished significantly. Probably because of the changed sedimentary conditions in the fjord.*

Finally, the increased amount of mud has consequences for the mussels in Vejle Fjord. There have been large amounts of blue mussels and blue mussel beds. Large structural reefs of blue mussels, and they too, have disappeared significantly. We are not entirely sure why but it is most likely because the small mussel larvae have a hard time growing on top of mud surfaces. They prefer more fixed and firm substrates such as stone or sand, and they struggle to stick to these when there is so much mud.

This is all very technical, I guess, but the overall point is that we have lost a lot of the fixed structures of the inner fjord. We have lost some of the structures that are important for coastal protection. We have lost the mussel beds, which have dissipated the waves. The beds have taken the energy out of the waves before they reach the land, and that was the first barrier. The second barrier, in a way, has been the Ålegræs, which also take some of the energy from the waves. And then, finally, when we reach closer to land, we used to have "rørsumpe", which also affected the water flood. And when you remove these natural barriers, then we experience increased stress on the ocean coast.

This project, "Healthy Vejle Fjord", tries to undo these imbalances in the fjord. It is not a project that is exclusively dedicated to coastal protection, but it is a project that is about restarting the natural mechanisms. Because it is clear that, when you remove the Ålegræs, which you can compare a bit with the forests of the land, we lose the mussel beds, and to some extent also stone reefs – as many of these have been removed – when you lose these firm structures, then you also rob the structures that fish use. You lose places where the fish can hide. The natural balance between big fish and small fish and fish breeding has been lost. This has meant for Vejle Fjord that the big fish, the predators, such as cod and whiting (Merlangius merlangus), and flounder (they all eat crabs) have almost all but disappeared. Again, this has meant that the beach crab (crab) has exploded. There are millions and millions of beach grabs (crab) in Vejle Fjord today. Again, this is a bad circle because the crabs can also destroy the ålegræs beds. The crabs, like the crustacean, help keep the levels of bad algae down (i.e. mussels). The crabs predate on these crustaceans and so on. These mechanisms have been broken. So, with Healthy Vejle fjord, we are trying to re-plant the Ålegræs. To give it a bit of first-aid. To plant it manually. That is one of the big nature restoration projects of the project. The other is to try to reproduce the mussel beds. Recreate them in facilities when they are large enough to survive on the muddy ocean bed and when they have reached the size where the crabs can't eat them. So we are giving the mussels a bit of starting-help. Finally, we are also trying to put out new stone reefs. There probably weren't that many stone reefs left in the past, but there have been some, and we are trying to put out new ones by simply putting out stone into the fjord. Finally, we are trying to reduce the number of crabs, at least in the area where we are planting ålegræs/eelgrass, because this will lead to less stress on the new ålegræs beds. Of course, we cannot fish all the crabs, but we are trying to keep the levels of crabs low in the areas where we have been working. Storm surge is typically a consequence of a number of events that happen simultaneously. Typically, it happens that we, following a number of days with a rough wind from the West, experience a higher level of water in the fjord caused by the "vindstuvning" [wind something] - Water from the Østersøen accumulates and eventually, it needs to go back, and that affects the water level in Vejle fjord significantly. The high water level, in combination with increased rainfall, results in the fact that Vejle Å and the Græs Å cannot get rid of their water, and that leads to flooding. In relation to "Healthy Vejle Fjord", then there is no doubt about the fact that if we are successful in doing what I described earlier, then this will have an effect. But I need to stress that these phenomena are the result of a wide range of factors and that these need to be addressed in order to engage in storm surge protection. The biological mechanisms cannot resolve all the problems, but the project *of a healthy Vejle fjord would be able to contribute to reducing the water levels (height of storm surge) in the fjord in these cases where there is a high level. At least, it will take a lot of energy out of the waves. So, if we are able to get the Ålegræs back, then that will be a very good step in the right direction. It is possible to do much more in the inner fjord specifically, especially from a biological perspective. It isn't an easy science because just establishing ålegræs in the fjord can be difficult, given some of the issues that I have outlined above. But if you consider the inner fjord and look at the biology and ecology in that literal zone that exists between the deep waters and into the shallow waters and into the coast and into this – by looking at this zone, we can create better coastal protection. You might imagine that the first part of the biological barrier is the ålegræs, which is at 1.5-2 meters depth, which could be the first thing we can get back, which would be the first element in this littoral zone in this barrier. Behind this, we could imagine the mussel beds being established, which would reduce the energy of the waves, and then finally, you could imagine in the third phase/succession along the coast that we could work with "rørsumpen" and, in reality, also the beach itself. If you look at Tirsbæk strandvej in the stretch from the harbour out to the Skyttehus-have, then there are a lot of options that one might do. You could, for instance, make it significantly wider, if that was possible, and to establish a rørsump and make the zone wider than it is today. A wider coast stretch would also create better recreational possibilities in relation to the stretch between the harbour and the Skyttehus-have. And it would create much better conditions for life, especially birds, if you had a wider rørsump on that stretch. This, however, wouldn't be that easy because things do not simply grow in and of themselves. We work with "salinity". There is salt water in the fjord, but the closer we get to the outpour from Vejle Å, the more fresh water it becomes. So you'd have to work with some organisms and plants that can live with that level of salinity that exists. There will be species that I would be able to point out that could work in relation to this kind of biological storm surge protection. In addition to the Ålegræs and the tagrør, one might also consider a plant-like "Rødel – (Alnus glutinosa)", which endures some level of salinity. It is already there on the stretch of the Tirsbæk Strandvej. It has kind of the same function as the mangrove has in tropical countries, as its wide roots help secure and fix the substrate along the coast. There are also other plants that might be relevant to look at. Apart from "ålegræs" and "tagrør" and "rødel" (Alnus glutinosa), you might also consider "børstebladet vandaks", which is robust and salinity-enduring. In general, you should look at a mosaic of plants and biological structures; if you want to look at the storm surge protection in Vejle Fjord – a mosaic of measurements would be my suggestion for a good approach.*

Plants (and fish) that grow in Vejle Fjord that makeup salt marsh and wetlands:

- Ålegræs (Eelgrass) – In drastic decline
- Rørsumpe (reed bed)
- Tagrør (Phragmites australis) – Common Reed - In drastic decline
- Rødel (Alnus glutinosa) – Black Alder (Denmark's equivalent of mangroves)
- Børstebladet vandaks (Potamogeton pectinatus) - Fennel pondweed
- Blue Mussels (blue mussel beds) – in decline
- Small baby fish have nowhere to hide (due to a lack of eelgrass and reed beds) and thus never grow to be big fish. Hence big fish like cod (which eats small fish and crabs) is in decline
- Cod
- Whiting - Merlangius merlangus
- Flounder
- Millions of crabs (no predators) destroy by eating eelgrass (unbalanced system) and mussels.

Appendix 11C: Video 5: A different perspective on the water – on asking new questions by Marie Markman (Artist, consultant, researcher)

What kind of solutions do we need to begin making by the end of 2020 if we need to be able to live at the fjord and the ocean and the forces that reside there.

Vejle Kommune has initiated the new competition 'Kanten', where they seek new possibilities and solutions on how we can co-exist with the rising seawater. They seek solutions across art and natural science, and they seek ways to do things in a new way. These are global problems. We are under pressure everywhere in the world by the rising sea levels, but it is local solutions that we search for in relation to 'Kanten'. Place-specific solution for Vejle. We are looking for places where water meets the asphalt and the city as well as the place where water meets the more open landscapes, such as the place where I am standing now. We hope that many people will apply.

My work areas are mainly art, urban planning, and research, and to combine these things. My big interest is in creating transdisciplinary alliances that can help face the problems that we have. Vejle Kommune asked me, in connection with a sum of money from Realdania for the rising sea level, to be part of the project, and this has led to many very interesting conversations about perspectives of time and what kinds of things we have to consider in new ways in the future city planning. One thing we talked about as being important was having the courage to start projects that are innovative, despite the uncertainty of knowing where these projects end. It is the future generations that will be taking up the projects where we leave them, working with them in their own ways, and we have to have confidence in these future generations. But it is, professionally, an immense pleasure to see artists, landscape architects, and urban planners be invited as peers to be part of the project and to forge alliances with other professions to discuss the edge that we are standing at here as well as the edge in the city where the ocean meets the concrete.

The other perspective on water that we are looking for will turn things around from business as usual. We want an everyday life where the art contributes to the pressing questions – questions that we didn't know that we had. We think that the content and aesthetics will contribute to us becoming able to do things in new ways. But what do we mean when we say that we want to turn things around? We mean to change our course, to do something different from what we normally do. The oceans are dying around us while the ocean is rising. We need to turn things around in urban planning. What happens if we look – unlike how we have done in the past – equally on the part of the city that is under and over the water? How do we forge new alliances and raise new questions?

We do not know what the art looks like here in this zone between water and land. We are genuinely curious, and we hope that you will be ambitious. We hope that we will be able to see the future perspective in the projects, perspectives on the unknown. We hope to get new perspectives on aesthetic, social, economic and ecological problems. We have looked at art projects in other domains and art projects all the way back to the 80s, which have inspired us. One of the projects that we have been inspired by and that we thought were future-oriented and exciting is a work by the Scottish Katie Patterson. The Work started in 2014 and will end in 2114. The work is a forest with a thousand trees that have been planted outside Oslo. Every year in that hundred-year period, an author or another literary scholar is invited to create a work that cannot be seen or read for another hundred years, but at a special event every year, you can join an excursion to the forest, where they hold a giving-over of the work, and then a few people say a few words, both the artist who contributes with the work but also the individuals around the project. The work is then taken to the library *in Oslo, which, by many, is called 'The Future Library', where it will be stored in a special place and in 2114, they will chop down the forest to make paper for all the books that will be published and become available for the public at that point.*

What we think is interesting about this work is this idea that we are beginning something, something that is about processes in the natural environment and that we have confidence in the fact that, even though we cannot finish it, others will take over once we are gone, hopefully leaving expressions that can be cherished at that later point.

Another work that we were inspired by was a work by the American-Hungarian artist Agnes Denis. The work was done in 1982. The work was a wheat field that the artist had sown in Manhattan below World Trade Center. The artist was commissioned to make a public sculpture, but she used the opportunity instead to sew a wheat field. The work was an expression of indignation toward how food is distributed in the world, so she sowed the wheat field, and she lived at the site during that time. When the grain was harvested, the grain was distributed to exhibitions around the world to address how we consider the ecology and how we handle the inequalities that exist in the world, along with the different conditions that we are bound to live within different places.

The next work was done in 2012 by Lars Ågaard og Grethe Henningsen. The work is called "The Plants that Disappeared" and is made in Equador in Kito. The work was done because the artists worked with a wide range of social projects in radio and female rights. They also experienced a big landslide, and they discovered that on the slopes where people lived, there had previously been plants that had disappeared as a result of developing the slopes of residential areas. That the plants weren't there, any longer meant that the landslide happened following heavy rainfall. So what the artists did was identify the specific plants that used to grow on the slopes. And then, they began to give the plants to people for free so that people could plant these around the area. They also provided stories with the plants so people could read about the plants' history and understand the tradition that people had neglected – and, ultimately, to highlight how the plants might contribute to mitigating the issues that the locals had been experiencing.

The last project that I want to mention is the project 'Dive-In' which was made by SuperFlex in 2019. Outside L.A., Superflex created a very large pink installation that was used on occasions for film screenings. The intention was to make it into a drive-in cinema where you could arrive in your car and watch movies, but what was shown was instead the same objects but on a smaller scale, submerged into the Pacific Ocean as building blocks for fish. Formerly, the area had been an ocean, and if you survey the landscape today, you see the remnants from this past beneath the water's surface. The perspectives were thus turned upside-down and how we might imagine the world be like in the future.

These were a few examples of artists and artworks that we feel have set a new agenda in relation to how to think of art. We don't know, as mentioned, what this looks like in Vejle, but we hope that you will go to Vejle, that you will walk along the fjord, that you will experience the fjord, and that you will experience it while the sun is shining and when the rain is pouring. Is it new time horizons that we are working with? Is it new meetings? New species? Old species? Who are we planning for when we are planning how everything needs to look like? And who is to do the development? Entrepreneurs? Citizens? We are curious and excited, and we hope that you will be ambitious along with Vejle Kommune and contribute.

Appendix 11D: Meeting Minutes from the deliberation meetings

There was a total of three meetings to deliberate the winning proposals from The Edge/Kanten design competition held by the Municipality of Vejle in 2020. Texts in italics have been translated into English from Danish. The meeting was all conducted in Danish. The judging meetings were held in: Spinderihallerne Fotoatelier 1. sal, Spinderigade 11, in Vejle.

Here are the records of all the meeting agendas and notes taken from the meetings. Some of the more controversial and private comments made by the judges are anonymised.

1. First assessment of the competition entries – The Edge on the 13th of August 2020
    a. Summary
    b. Review of proposals, summing up the main themes
    c. Questions and explanations

2. Second assessment of the competition entries – The Edge on the 20th of August 2020
    a. Advice from the judicial advisors
    b. Evaluation of the entries
    c. Narrowing of proposals to 5-10 entries

3. Third assessment of the competition entries – The Edge on the 8th of September 2020
    a. The decision on the finalists

4. Reserved assessment meeting of the competition entries – The Edge on the 14th of September 2020
    a. Reserved meeting if the deliberation of winners is not finished

5. Declaration of the winning competition entries – The Edge on the 30th of September 2020
    a. Judge's report written
    b. Winners will be contacted

6. Architecture Day in Vejle – Prizegiving on the 5th of October 2020
    a. Winners will be announced for the closing event on The Architecture Day in Vejle
    b. Prizes are given

Appendix 11E: Excerpts from the Judge's Report (translated into English)

Competition facts

The competition was announced as an open idea competition by Vejle Municipality, with the Architects' Association as the competition advisor. Realdania has partially funded the competition. The language of the competition is Danish.

Competition period
April 2020 - July 15, 2020

Assessment period
August 10, 2020 - September 16, 2020

Number of proposals submitted and admitted for assessment
25

Judges Committee
Jens Ejner Christensen, Mayor, Vejle Municipality
Niels Ågesen, Municipal director, Vejle Municipality
Michael Sloth, Director of Technology & Environment, Vejle Municipality
Lisbet Wolters, City architect, Vejle Municipality
Klaus Enevoldsen, Head of the Nature & Outdoor Life Department, Vejle Municipality
Gerda Haastrup Jørgensen, Chairman of the Technical Committee, Vejle Municipality
Karl Erik Lund, Chairman of the Nature & Environment Committee, Vejle Municipality
Flemming Hedegaard, Museum director, Vejle Art Museum
Tom Nielsen, Professor, PhD, Aarhus School of Architecture

Advisers to the Judging Committee
Pernille Rom Bruun, Director, Vejle Art Museum
Soo Jung, Ryu, PhD student, Aarhus School of Architecture
Cintia Quintana, Assistant Professor, Department of Biology, University of Southern Denmark
Marie Markman, Artist, researcher and art consultant

Competition Secretary
Lotta Tiselius, Architect MAA, Vejle Municipality

Judging criteria

The proposals have mainly been judged on the strength of the main idea and the conceptual solutions for a nature-based, value-based and recreational storm surge protection above and below water in Vejle, with a special focus on architectural, landscape and artistic innovation and quality, i.e. the competition programme's requirements and wishes.

The assessment

The judging committee has held a total of four judging meetings in addition to an initial meeting with competition secretary Lotta Tiselius, Lisbet Wolters and Tom Nielsen, who act as professional judges in the competition. At the meeting, all 25 proposals were reviewed.

- The first assessment meeting, Lisbet Wolters and Tom Nielsen presented all proposals to the judging committee.
- The second assessment meeting, the following proposals were selected to proceed with the assessment: 2, 4, 6, 13, 17, 19, 20, 24
- The third assessment meeting, the proposals were re-evaluated, and the judging committee revisited the decisions and discussions from the second assessment meeting.
- The fourth assessment meeting (reserve meeting) decided which proposals were to be awarded and for which prize money.
- At the last meeting, the judge's report was signed, and the ballot papers were revealed.

Preface

In April 2020, Vejle Municipality announced an open idea competition called Kanten (The Edge). The idea competition invited architects, landscape architects and artists to come up with innovative, nature-based and recreational offers for the storm surge protection of the future in Vejle.

With great excitement and anticipation, we have been waiting for the proposals which were submitted on 15 July 2020. We are proud and happy that 25 proposers from both home and abroad have shown interest and submitted proposals for the competition. Not least, considering that the competition was announced just when the Corona crisis hit Denmark, and everyday life looked very different for all of us. Therefore, we would like to thank all the participants in the competition.

The assessment process started in August 2020, when the judging committee reviewed the 25 proposals received. It has been impressive and inspiring to see the wealth of ideas and the height of innovation that the proposals contain. We have benefited greatly from the competition, and the open competition format has definitely contributed to the variety and breadth of the 25 proposals together.

Exciting judging meetings and long discussions have now led to a unanimous judging committee nominating the winning proposal and two more award-winning proposals. In addition, a fourth proposal has been procured. Therefore, with great pleasure, we can reveal the award-winning proposals through this judge's report.

Vejle Municipality is now looking forward, in collaboration with the award-winning proposals, to further process the proposals so that they can contribute to us in Vejle being able to develop innovative, nature-based and recreational storm surge protection in Vejle.

Signed by Mayor Jens Ejner Christensen

Summary of the Judging Committee

Introductory remarks

The storm surge protection of Vejle will, in the future, require large investments. The edge between the city and the water must be designed so that it can keep the water away from the city when we are hit by storm surge. It may happen once every 100 years or more often - we do not know for sure!

With the idea competition "Kanten", Vejle municipality has wanted to get new ideas for what added value a storm surge protection could create for Vejle city and its inhabitants, so the investments that must be made create something more than just a protection against storm surge events. It has not been the purpose of the competition to receive ready-made proposals that could be immediately realized and built, but instead to raise the level of the common understanding in the city of what storm surge protection can contribute. In other words, to create innovation and move beyond the "business-as-usual" solutions that are often pulled forward but also often have negative consequences for city life and resilience.

The 25 proposals together constitute an inspiring catalogue of ideas for how storm surge protection can "grow with the city" and develop as the risk of flooding increases.

The proposals have a very different character, and there is a great variety in quality and the different ways it could be produced.

Some suggestions are easy to understand, others harder to figure out. Some focus mostly on the landscape, some more on the architectural, while others have a predominantly artistic approach. In the competition, the proponents have had to work with an urban zone (Havnepladsen) and a nature zone (Tirsbæk Strandvej). However, the two concrete places are not an expression of the fact that this is exactly where the ideas are to be realized. This is partly chosen to give the assessment committee a better opportunity to compare the proposals across. Partly to get solutions for storm surge protection suitable for both urban and more natural environments.

None of the proposals can be realized in the form in which they are, but all will be able to be developed and processed into concrete solution proposals. Overall, the proposals provide a good picture of what possible paths the municipality can take to develop storm surge protection with added value.

The six themes of the competition have been unfolded with curiosity and creativity, while the desire to recreate nature and let its changeability and aesthetics contribute to the solutions of the future is reflected in virtually all proposals.

The four award-winning proposals present all innovative ideas for the storm-flood-proof urban development of the future. However, they also express four different approaches to working with storm-flood protection in Vejle.

The winning proposal 20 is an exciting and innovative proposal that contains both a strategic design for the development of the flooded Fjordbyen of the future and a storm surge protection that, like a cell membrane, opens and closes depending on the impact.

Themes

Protection and Adaptivity

It is a dike solution that constitutes the storm flood protection itself in the vast majority of proposals in the competition. The basic grip is a terrain elevation and safety on the rear edge both on Havnepladsen and on Tirsbæk Strandvej.

The protection takes the form of ramparts or dikes built up of sand, earth or stone. Some proposals work with more urban grips, where the solution is based on a constructed element that can be repeated, turned and rotated. This can be in the form of module-based solutions such as can be seen in proposal 4 where blue urban spaces are built up of "pixel elements" in concrete that create experiences both above and below water, or in proposal 6 where on a floating rescue ring blocks of, e.g. lime and crushed seashells, which are used to build a dike on land. There are also more artistic grips, such as. proposal 8 where a modular system of hexagons lies like crocheted armour over the landscape and extends into the fjord.

However, several of the projects also point to solutions that have the potential to expand the principle of the dike, and by expanding the 'edge' to a 'zone' with several different nature-based grips, the dike typology expands so much that in reality, there are new landscape forms and a completely new or reinterpreted relationship between city and water.

Some have blown up the framework of the program by submitting proposals that present a great concept. Proposal 5 connects the north side and the south side in a large dam designed as a mirror of the beech forest, while proposal 1 establishes a number of artificial islands that form a dam-like landscape across the fjord with bathing lagoons and recreational beach areas.

The program's requirement for storm surge protection that can be gradually adapted to the increasing risk is solved in most proposals by adding more material and thereby increasing the height of the dike. A few suggestions instead use movable elements in the form of city furniture or benches that need to be manually moved into place in the event of a storm surge warning and thus increase storm surge protection from elevation 2.5 to elevation 3.0. (However, it is doubtful whether this solution will actually be able to create flood protection.)

The adaptive is most beautifully expressed in the proposals that also work with the time aspect. Several of the proposals illustrate how storm surge protection will grow over time and adapt to future challenges. Proposal 19 is the competition's most innovative bid on how storm surge protection can grow and adapt as the risk increases. Here, a landscape of surplus materials is built, reinforced and sprayed with concrete and develops into overgrown ramparts over time. In this way, an interesting, adaptive aesthetic is achieved that lifts storm surge protection to a new level by creating the future landscape of today's materials.

Nature-based solutions

Exploring the potential of nature-based solutions is one of the corner flags of competition. With a fjord in poor environmental health condition, it has been desired to find out whether the investment in storm surge protection could, at the same time, be an investment in a healthier fjord. i.e., Covid-19, the start-up workshop of the competition, was replaced by a series of small videos from the presenters that were sent to the contestants. The proposals are characterised by having been inspired by the videos, and the project about "Healthy Vejle Fjord" has probably led several of the proponents to incorporate ideas about mussel production, oyster bars, proposal 14 and dissemination of project 6 in their proposals.

Many proposals revolve around restoring the original nature and the landscape where the river valley turns into a fjord by establishing salt marshes and vegetation that will filter and purify the water. Extending the protection edge to a protection zone creates an opportunity to let nature's own processes play an important role in storm surge protection and create a "buffer" that can absorb the water level rises before they hit the city. It is especially the idea of creating a wetland along Tirsbæk Strandvej that goes again. Proposal 9 extends this approach to the challenges of coastal cities in general. Here, the meeting with the water is defined by a circular nutrition system where biomass from the fjord, wetlands and land is fed to green areas in the city that form the basis for cultivation. In this way, nature is helped to be able to take care of the challenges itself.

Proposal 13 is the most far-reaching of the nature-based solutions. Here, nature builds, so to speak, its own storm surge protection. Using a degradable geocell membrane creates a resistant and adaptable marsh landscape, forming the future storm surge protection zone. The wide edge gradually makes the landscape wetter and wetter, while on the dry edge, plants and plants grow that the landscape grows wild with, e.g. beach cabbage and reeds over time.

Nature above and below the water

The program wants answers on how the storm surge protection can be designed so that nature along the water's edge and the quay's edge is brought into play. In line with the program, many of the proposals are, therefore, working to replace the safeguard edge of a changing natural area with native flora and fauna, where nature is revitalized both above and below water. Permanent and temporary water holes create changes in the landscape and are crucial for the spread of rich plant and animal life. Many of the proposals made Tirsbæk Strandvej an extended zone with stones, planting and shallow areas where nature or a natural expression gets free play. In proposal 2, the area is separated by a safety line at elevation 3.0, which simultaneously divides the nature park into a freshwater zone and a saltwater zone. The existing cycle path is moved to the nature zone, and small point houses are built, which are used by associations and visitors. Here, knowledge about the landscape and the nature development process is disseminated.

The idea of wooden footbridges floating across the nature area is also repeated in many of the proposals. The bridges make it possible to move barefoot in the nature areas without coming into direct contact with the water but also help to separate nature above and below water.

In the 2nd prize proposal 19, a design WITH water, instead of MOD water, is the main grip that relates to the entire district and creates a direction for urban development. In the 3rd prize proposal 13, the main idea is to create an underwater botanical garden in Vejle fjord and turn nature above and below the water into an experience and learning space. This proposal gives access to the underwater botanical garden via snorkelling routes, periscopes and inverted diving bells, just as it is open to the life that is already on and by the water.

Among the proposals are also examples of nature above and below water being developed to be a single grip for the development of the entire district that is in the risk zone. It can, for instance, be seen in proposal 9, where the city should collect the water rather than make an edge. But also in the winning proposal 20 and the 2nd prize proposal 19.

Another perspective on water

Although the competition is open to architects, landscape architects and artists, the artistic dimension is unfortunately not prominent. Several of the proposals, however, reflect on how urban development can be worked on through an artistic approach, e.g. in proposal 2 where a master plan is to re-establish the city's connection to the fjord through a series of impacts that unite storm surge protection, new development and art installations.

The most independent artistic expressions are seen in proposal 10 where the potential of art is unfolded through two works that turn things upside down and help us to discuss climate change and understand the storm surge threat in a new way. With its distinctive colour and eye-catching expression, this puts the focus on the challenge.

Proposal 2 uses a more quiet and sensual expression by creating a space where the sea's movements can be read directly on the surface. Trees are planted as an extension of the existing planting, and a light installation spreads in the treetops and continues further out into the fjord-like rings in the water.

In the 3rd prize proposal 13, a very strong artistic grip is seen, where water and land are literally woven together in a poetic braid with textiles, ropes and seaweed as weaving threads that weave a distinctive and unique landscape. In this project, the citizens are involved in an elongated artistic project that contributes to understanding the edge's potential and challenges.

The 2nd prize proposal 19 takes the form of a large land-art project, where the artificial landscape that forms the storm surge protection must also add an artistic dimension to the city. The beautiful model photographs show an aesthetically interesting approach to the landscape design where a dynamic between something almost formless and precisely shaped edges and seat plinths creates a great variety. The creation of storm surge protection is thought of as an artistic design process in which nature's processes over time will also play a role. With reference to the Anthropocene, as an understanding of the geological age we live in now, the proponents do not sharply distinguish between the natural and the man-made, but work consciously with mixed forms.

Criteria of the storm surge strategy

Vejle's unique topography is both the city's biggest asset, but at the same time, also the biggest challenge in relation to floods. The steep, wooded slopes and the low-lying Ådal landscape are of great quality when it comes to creating a good city to live in. On the other hand, it makes the city vulnerable to floods and creates problems if the water can not be controlled. By combining urban development and climate protection, new opportunities for financing and value security arise. Therefore, Vejle's storm surge strategy states that storm surge protection must create added value and thus help to give the citizens and the city something more than security. Therefore, it is important that the solutions chosen support the criteria of the storm surge strategy, which is about strengthening Vejle's current identity and making water an asset for social and urban capital.

Just as the residential development "Bølgen" and the commercial domicile "Fjordenhus" today draw the waterfront in Vejle, it is important that future storm surge protection is enshrined in the understanding of Vejle as a city where art and architecture are important parameters.

The four award-winning proposals all build on this understanding and will, in their own way, be able to add another section in the story of Vejle as a place where the interplay between water, art and architecture creates our common identity. They can all be developed to have a high quality and become projects that will attract positive attention and create an even higher city quality for both citizens and tourists.

For many Vejlensers, the fjord's water level and looking towards the horizon out through Vejle fjord is an essential part of the city's identity and their own self-understanding. It must be strengthened through future storm surge protection, and two of the proposals, in particular, have worked on this. The winning proposal 20 chooses to secure up to elevation 2.5 by means of a raised terrain while securing up to elevation 3.0m is done through movable city furniture so that the view of the fjord can be maintained when there is no storm surge. The second prize proposal 19 emphasises this view, both in the design of Havnepladsen but also through the planting of columnar poplars on each side of the harbour course that strengthens the perspective focus towards the fjord.

The resilience strategy

Vejle municipality's resilience strategy describes how threats must be turned into opportunities and make citizens ready for the future we do not yet know. Ownership, commitment and social resilience are the keywords. In Fjordbyen's urban space, water must be thought of as a resource that must provide value regardless of the weather. Storm surge protection must create added value and contribute to the development of the city of Vejle, including ensuring the desire to invest and the property values.

Here, Proposal 9 stands out through its very inclusive perspective, where the idea is that the citizens themselves create storm surge protection over time and where the proposal appears to a greater extent as a collaborative project. In this proposal, the port island is flooded, and natural coasts are created, where people are motivated through cultivation and communities to get involved in and take care of the edge and the construction of the coastal zone.

In the urban zone, boat rentals, community pavilions, creative pavilions, a co-working culture house, a maritime culture house, and a lookout tower will be established. In the nature zone, cabins and public floating docks are established.

With the idea of self-grown storm surge protection, proposal 6 also focuses on the citizens' direct participation and commitment to establishing storm surge protection. Specifically, the work of casting 'tabby' blocks takes place on a floating 'rescue ring' that is also thought to form the framework for various dissemination activities.

Extra notes (behind-the-scenes) from the judging/deliberation meetings

Lisbet and Tom reviewed the 25 proposals received in a professional and objective manner and then presented an overall thematization of received proposals:

- Den grundlæggende beskyttelsesløsning: *The basic protection solution*
- Strandzone + boardwalk: *Beach zone + Board walk*
- Moduler: *Modules*
- De særlige ideer: *The special ideas*
- Det store greb: *The big grip (the big concept)*
- Kunst: *Art*

- Ejerskab, engagement, social resiliens: *Ownership, commitment, social resilience*

The meeting started with a review of nine particularly interesting proposals selected by Lisbet Wolters and Tom Nielsen. The nine selected proposals were (#2, 3, 4, 6, 9, 10, 13, 19, 20)

Subsequently, the judge advisers each presented their views on the proposals received, as well as highlighted themes and issues that may be good to take into account in the assessment. The judges' advisers highlighted the following points and suggestions:

Cintia Quintana (a marine biologist from the University of Southern Denmark): The balance in nature below and above the water surface is the most important. At best, plants above and below water can be used as a natural filter. The use of eelgrass is effective, but it requires a lot of light (that they are not planted deep). Mussels inland are difficult but can be used as a "showcase" example. It takes 5-10 years for marine plants to establish themselves. We should try to "boost" biodiversity ". Highlights entries: 13, 19, 20.

Soo Jung Ryu (PhD student at the Aarhus School of Architecture, specializing in "Urban seascaping"): Pointed out our urban tendency to expand our ports and coastal towns into the water, as we have also done in Vejle. It challenges marine life. There is greater CO_2 uptake in marine plants (seaweed) than inland plants, so there is good reason to support marine life. Important to remember; to use water as a "design driver" and make the facility visible and accessible to citizens. We must reverse the trend for the environment in Vejle Fjord now and remember to do things in new ways. Highlights entries: 13, 19, 20.

Marie Markman (architect, artist and art consultant): We must consider time, trust, mystery, a common cause, inspiration, and joy. Questions to ask: Does the work/project contribute ecologically, socially and aesthetically to issues surrounding rising seawater? Is this a nature-based solution? Is the idea original? Does the idea have icon value (future icons show new content)? Does it require a special sensitivity to achieve social and ecological resilience (the artist's gaze and method as something permanent and not as a temporary feature). Highlights entries: 6, 10

Pernille Rom Bruun (museum inspector Vejle Art Museum): Highlighted the following entries: 1, 13 and 24.

Lisbet Wolters then proposed a number of the selected proposals for winning prizes or honorarium (2nd-3rd place or special mention/purchase). The judging panel then discussed these proposals.

- Proposal 2, 13, 20 - (Excellent)
- Proposal 4, 6, 17, 19, 24 - (Very good)

It is important to keep in mind that the competition proposals must be assessed solely on their answer to the task set by the competition program, as well as questions/answers /information sent out during the competition period.

Appendix 12: Realdania network-related activities

Interviewee	Date	Profile / Expertise and key relevant learnings
Two-day workshop with Vejle Municipality and Realdania research network Research network team: ▪ Katrina Wiberg (AAA) ▪ Ole Fryd (KU) ▪ Karsten Arnbjerg-Nielsen (DTU) ▪ Anna Lea Eggert (DTU) ▪ Roland Löwe (DTU) ▪ Getrud Jørgensen (KU) Vejle Municipality representatives: ▪ Lisbet Wolters ▪ Ulla Pia Geertsen ▪ Lotta Tiselius ▪ Guides x2 from Vejle Municipality	14-15 December 2021 In-person in Økolariet in Vejle	I attended a two-day workshop organised by the Realdania research network and Vejle Municipality. The workshop consisted of an exercise to find the best strategy for retreating Vejle's risk area – Fjordbyen. Researchers from DTU organised the exercise. Learnings from this exercise indicated "behind-the-scenes" aspirations of the city architect and municipal members. Vejle is seen as a holistic entity, including satellite towns and the river valley. ▪ The workshop also included a guided tour of the Vejle Å, Vejle Workshops Tour of the river storm surge. The tour entailed a look into all the protection systems in place for the streams in Vejle. Indicating its heavy reliance on gates, locks and pumps to control the water at bay. While they currently play a big role in preventing catastrophic flooding of Vejle (backwater flooding, cloudbursts), they are also at a certain limit which is to exceed in the future. However, there are issues with fish being trapped in these pumps. Regardless, there are a few areas next to the stream that are quite vulnerable. ▪ Through this research network, other vulnerable cities at risk were visited (i.e. Juelsminde, Randers, etc.). ▪ Vejle Kommune represents their scientific backgrounds and recommendations with their own agenda ▪ Economic constraints and financing play a big role, and politicians have the final say and make decisions. ▪ Population increase is managed in high-lying areas (outside the city centre), and major investments are already taking place outside the city (e.g. Vejle Nord). ▪ "Membranby" – The Membrane City is to perforate the city's core (based on Kanten/The Edge winning entry) ▪ There is an awareness that the buildings built will not last forever, which is already incorporated into the development of the city centre. ▪ Future technological development must be considered when developing long-term strategies (e.g. different types of buildings, self-driving cars, different industries, etc.) ▪ There are already wetland restoration projects next to the rivers/streams to limit the sources of water pollution from agriculture. Vejle Municipality is also engaging with farmers to deal with water issues.

Table 16. Notes from a workshop conducted via the Realdania research network and Vejle Municipality

Appendix 13: List and map of seaweed found in Vejle fjord

Number	Location	Specific location	Latin name	Danish common name	English common name	Size (average)	Depth required	General info (pg)
1	Vejle	Near the harbour	Chondrus crispus	carrageentang, blomkålstang	Irish moss	15-17cm tall	0-18m	p280-282
	 							
2	Vejle	Near the harbour	Dumonita contorta	Dumontalgae	Dumont's Tubular Weed	10-20cm tall	0.5-3m	p273-275
	 							
3	Vejle	Near the harbour	Polysiphonia fibrillosa	Violet ledtang	Purple Siphon Weed	up to 20cm tall	0.5-20m	p218, 230-233
	 							
4	Vejle	Near the harbour	Porphyra purpurea	Rød purpurhinde	Nori?	up to 31cm tall, 20cm wide	0.5-1m	p53, 58, 60
	 							
5	Vejle	Near the harbour	Gracilaria vermiculophylla	Brunlig gracilariatang		30-40cm	0.5m	p310-311
								

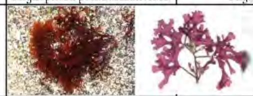
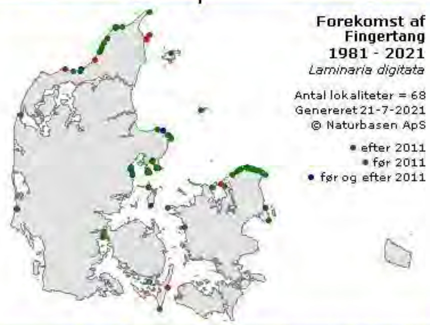
6	Vejle	In the wider fjord area	Cystoclonium purpureum	Grisehaletang kunderang		20-50cm high	low to deep waters		In the wider fjord area
									
7	Vejle	In the wider fjord area	Furcellaria lumbricalis	Gaffeltang		up to 28cm high	0.5-18m		In the wider fjord area
									
8	Vejle	In the wider fjord area	Phyllophora pseudoceranoides	Fliget rødblad		up to 28cm high	0.5-28m deep	p301	In the wider fjord area gets dirty easily
									
9	Vejle	In the wider fjord area	Polysiphonia elongata	Langstrakt ledtang		30-40cm high	1-23m deep		In the wider fjord area
									
10	Vejle	In the wider fjord area	Porphyra umbilicalis	Navele-purpurhinde		up to 18cm long, 15cm wide		p61	In the wider fjord area
									
11	Vejle	In the wider fjord area	Pyropia novae-angliae	Stribet purpurhinde		4-18cm long, 1-9cm wide	4-10cm?	p64	In the wider fjord area
									
12	Vejle	In the wider fjord area	Rhodomela confervoides	Rødris		8cm?	0.5-23m		In the wider fjord area
									
13	Vejle	In the wider fjord area	Vertebrata fucoides	Almindelig ledtang		3-26cm high	0.5-21m deep	p240	In the wider fjord area
									
14	Vejle	In the wider fjord area	Coccotylus brodiei	Smal kilerødblad		around 15 to 33cm	1-21m	p292-294	In the wider fjord area
									
15	Vejle	In the wider fjord area	Phycodrys rubens	Bugtet ribbeblad		18cm high	1.5-21m deep	p197-204	It can get dirty easily. In the wider fjord area
									

Table 17. Excel table of all the possible red macroalgae (that is visible size) in Vejle fjord (inner to outer fjord). Data on the depth they are likely to grow, typical size, common names, etc. are all contained in the excel sheet (the information in the excel sheet has been simplified and reduced in this table). Based on sources from: Lundsteen and Nielsen (2019a, 2019b), Naturbasen (n.d.) and MarLIN (n.d.).

Number	Location	Specific location	Latin name	Danish common name	English common name	Size (average)	Depth required	General info (pg)
1	Vejle	At the harbour	Chaetomorpha linum	Krølhårstang, almindelig børstetråd	spaghetti algae	up to 3m long	0.5-1m	p291
								
2	Vejle	At the harbour	Gayralia oxysperma	Sommersalat	Green Seaweed	2-4cm high		p344
								
3	Vejle	At the harbour	Ulva fenestrata (lactuca)	Almindelig søsalat	Sea lettuce	11-95cm/23-35cm	0-8m	p376
								
4	Vejle	At the harbour	Ulva intestinalis	Tarm-rørhinde	sea lettuce, gutweed and grass kelp	8-50cm high	0.1-4m	p380
								
5	Vejle	At the harbour	Ulva linza	Bred rørhinde	Slender sea lettuce	8cm wide, 20-30cm high	0-3m deep	p382
								
6	Vejle	At the harbour	Capsosiphon fulvescens	Gyldenrør		5mm wide, 18cm long		p342
								
7	Vejle	In the wider fjord area	Cladophora flexuosa og C.sericea					p299, 300

Table 18. Excel table of all the possible green macroalgae (that is visible size) in the inner Vejle fjord. Based on sources from: Lundsteen and Nielsen (2019a, 2019b), Naturbasen (n.d.) and MarLIN (n.d.).

Number	Location	Specific location	Latin name	Danish common name	English common name	Size (average)	Depth required	General info (pg)
1	Vejle	mid to outer fjord	Chorda filum	strengetang				p225
2	Vejle	outer fjord	Chordaria flagelliformis	Pisketang				p105
3	Vejle	outer fjord	Ectocarpus penicillatus (E. siliculosus)	Dunalge/vatalge				p189, 191, 193
4	Vejle	mid and outer fjord	Laminaria digitata	Fingertang	Oarweed	often 1m long (upto 1.5m), 20-40cm wide	1m - 20m	p227
						The leaf blade is divided into finger-like sections, up to 1.5 m		
5	Vejle	inner fjord	Petalonia fascia	Almindelig båndtang				p198
6	Vejle	mid and outer fjord	Fucus serratus	Savtang				p213
7	Vejle	the whole of fjord	Fucus vesiculosus	Blæretang				p216
8	Vejle	middle of fjord	Ascophyllum nodosum	Buletang				p207
9	Vejle	outer fjord	Asperococcus fistulosus					p102
10	Vejle	edge of outer fjord	Battersia arctica					p53
11	Vejle	outer fjord	Chaetopteris plumosa					p57
12	Vejle	inner fjord	Dictyosiphon chordaria					p114
13	Vejle	edge of outer fjord	Dictyosiphon foeniculaceus					p116
14	Vejle	Inner fjord	Elachista fucicola					p118
15	Vejle		Eudesme virescens					p121
16	Vejle	outer fjord	Giraudya sphacelarioides					p122

Number	Location	Specific location	Latin name	Danish common name	English common name	Size (average)	Depth required	General info (pg)
17	Vejle	middle of fjord	Halidrys siliquosa					p218
18	Vejle	inner fjord	Halosiphon tomentosus					p245
19	Vejle		Halothrix lumbricalis					p129
20	Vejle	mid and outer fjord	Leathesia marina					p136
21	Vejle	outer fjord	Litosiphon laminariae					p138
22	Vejle	outer fjord	Pilinia rimosa					
23	Vejle	inner and outer fjord	Pylaiella littoralis					
24	Vejle	inner and outer fjord	Punctaria tenuissima					
25	Vejle	Inner fjord	Ralfsia verrucosa					
26	Vejle	inner fjord	Scytosiphon lomentaria					
27	Vejle	edge of outer fjord	spermatochnus paradoxus					
28	Vejle	edge of outer fjord	Spacelaria cirrosa					
29	Vejle	the whole of fjord	Sphaerotrichia divaricata					
30	Vejle	outer fjord	Stictyosiphon tortilis					
31	Vejle	Mid to outer fjord	Laminaria saccharina	Sukkertang	Suger kelp	Length: 1 - 4 (max. 5) meters, width: 10 - 30 cm		
					It grows at a depth of 1-30 m, attached to rocks and requires at least 15 per mille salinity.			

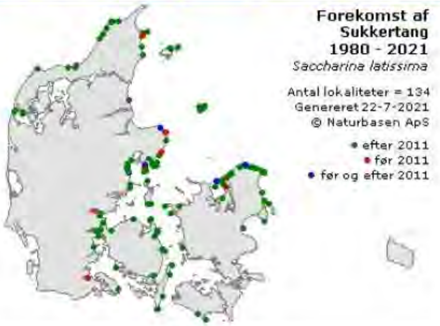


Table 19. Excel table of all the possible brown macroalgae (i.e. kelp – Laminaria family) in Vejle fjord (i.e. inner fjord). Based on sources from: Lundsteen and Nielsen (2019a, 2019b), Naturbasen (n.d.) and MarLIN (n.d.).

Appendix 14: Co-author declaration in regards to PhD dissertation

ARKITEKTSKOLEN AARHUS

Co-author declaration in regards to PhD dissertation

If a dissertation contains articles written in collaboration with others, the PhD Order, 2013, § 12, Section 4 and 5, requires that each co-author give a declaration regarding the part of the work done by the PhD student[i]. In cases with more than four co-authors it is sufficient that a selection of 4-5 of them fill out and sign the declaration, including the co-author with the primary responsibility. This is on the condition that the PhD student has collected consent to the article being incorporated into the dissertation from the rest of the co-authors.

Co-author declarations must be handed in alongside the dissertation, but should be collected as soon as possible after the publication of an article. However, it is recommend to use this form already in the preliminary stages of the collaboration on the article and to adjust it along the way to avoid disagreements about the PhD student's contribution to the article.

Name of PhD student	Soo Jung, Ryu
Title of dissertation	Urban Seascaping - How to live not just by the sea but with the sea

This co-author statement covers the following article.

Title of article	Seaweed as the denizens of the new commons in the Anthropocene
Authors	Soo Jung, Ryu and Cintia Organo Quintana
Journal/conference	Brill, Critical Plant Studies - Algae
Year/vol./no.	To be confirmed but most likely beginning of 2023

The extent of the PhD student's contribution to the article is assessed on the following scale:

A. has contributed to the work (1-33%)
B. has made a substantial contribution to the work (34-66%)
C. did the majority of the work independently (67-100%).

Declaration on the individual elements	Extent (A, B, C)
1. Formulation of the idea behind the research and the related research questions.	C
2. Design and planning of the research, including choice of methods.	C
3. Execution of the research, as well as collection and documentation of the achieved results.	C
4. Presentation, analysis, interpretation and discussion of the achieved results.	C

[i] Bekendtgørelse om ph.d.-uddannelsen ved universiteterne og visse kunstneriske uddannelsesinstitutioner. (2013, BEK nr. 1039 af 27/08/2013). https://www.retsinformation.dk/eli/lta/2013/1039

By signing below, the co-authors declare themselves in agreement with the above. At the same time, they consent to the PhD student reproducing the co-authored article in whole or part in the PhD dissertation.

Signatures of co-authors			
Date	*Title and name*	*Role (e.g. primary author)*	*Signature*
30/11/22	Associate Professor, Cintia Organo Quintana	co-author	Cintia Organo Quintana

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Date	*Signature*
30/11/22	

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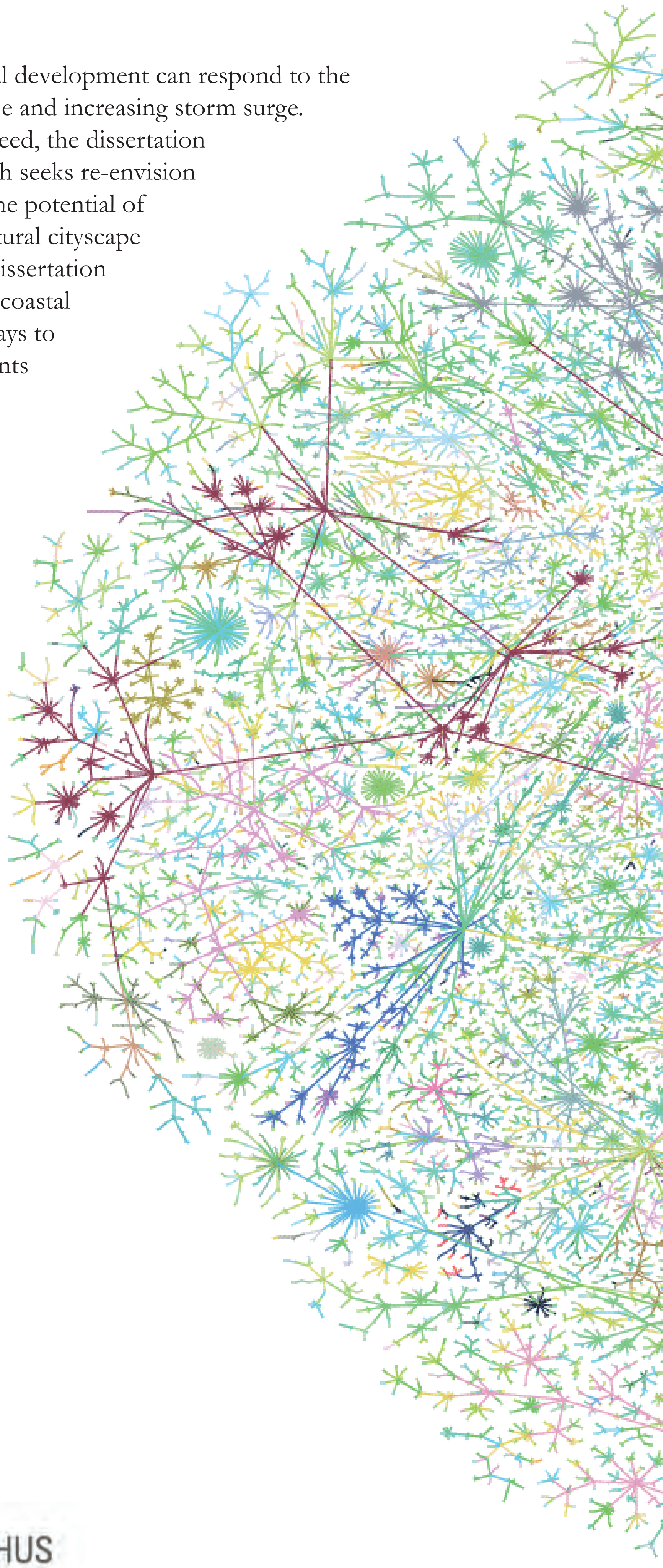
This dissertation investigates how urban coastal development can respond to the wicked problem of climate change, sea level rise and increasing storm surge. Focusing in particular on the potential of seaweed, the dissertation develops the concept 'Urban Seascaping', which seeks re-envision the border between city and sea by exploring the potential of marine nature as an active part of the sociocultural cityscape and its future resilience. Thus, the aim of the dissertation is to contribute to the fields of blue urbanism, coastal urbanism, and urban ecology in finding new ways to move beyond the business-as-usual developments at the contemporary waterfront.

SOO J. RYU is a PhD candidate at the Aarhus School of Architecture, Denmark.



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