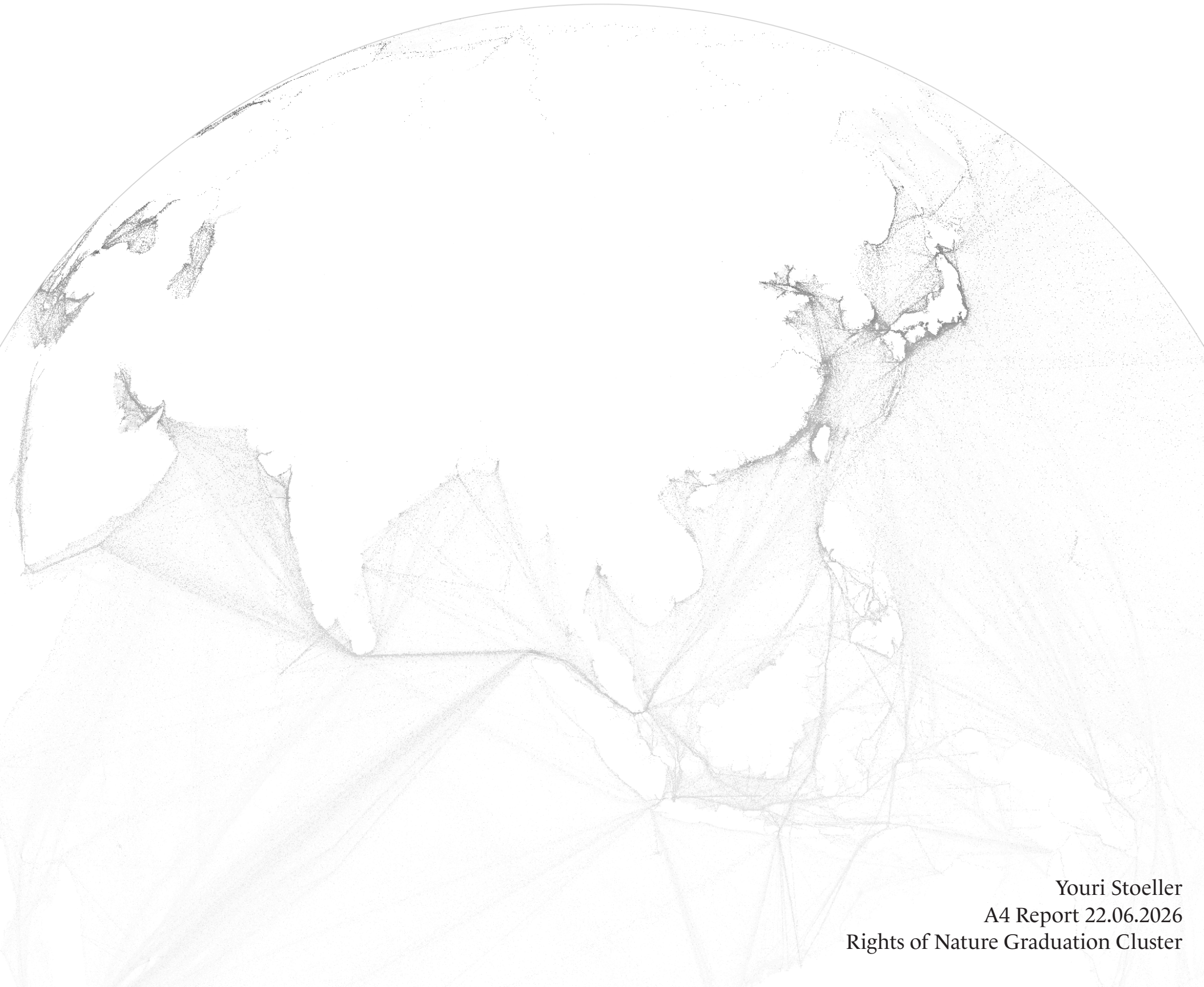
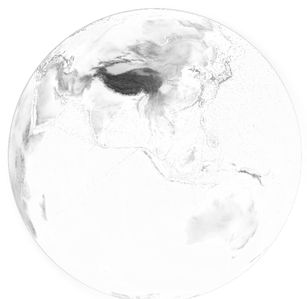
The Malacca Strait, a system to be tended to.

Landing in Contested Waters



Youri Stoeller
A4 Report 22.06.2026
Rights of Nature Graduation Cluster

Introduction



You want me to land on Earth? Why?

— Because you're hanging in midair, headed for a crash.

— How is it down there?

— Pretty tense.

— A war zone?

— Close: a Critical Zone, a few kilometres thick, where everything happens.

— Is it habitable?

— Depends on your chosen science.

— Will I survive down there?

— Depends on your politics.

- Latour (2020)

The Strait of Malacca

The Strait of Malacca is one of the world's most important maritime corridors. Stretching approximately 900 kilometres between the Malaysian Peninsula and the Indonesian island of Sumatra, it forms the shortest shipping route between the Indian Ocean and the South China Sea. A significant portion of global trade passes through this narrow waterway, with over 100.000 vessels per year, transporting oil and gas, manufactured goods, and raw materials between Asia and Europe. For the global economy, the Strait functions as a critical lifeline, making its navigability a matter of international importance.

For centuries it has functioned as a strategic route for shipping, facilitating exchange, enabling the connection of regional economies to a global market. Ports along the shores of the Strait became important centres within the global trading network, with the Malacca Sultanate in the fifteenth century as one of the most important trading hubs in Asia. Resulting in a quote by Tomé Pires, a Portuguese diplomat: "Whoever is Lord of Malacca, has his hand on the throat of Venice." (Suma Oriental, 1515). The importance of the Asian centre of power is even followed up with the following quote: "... it decides on the destiny of war and peace in the world.".

This important position within the global trade has led to it historically being a space of encounter and connection between regional economies. But this relation changed with the arrival of colonial powers, from the Portuguese in 1511, to the Dutch and finally British. Making the Strait become a part of a global system of extraction, which is currently still in place and very much reinforced through various policies.

This current use of a global shipping highway, has led it to require extensive regulation within the area, to maintain the navigability, efficiency and above all economic continuity. This is reinforced by the use of international shipping lanes, navigational safety systems, port developments, dredging operations, and maritime governance frameworks. This results in the Strait becoming increasingly understood through abstract metrics related to its global use rather than through the ecological processes and social relations that it sustains and defines.

Long before it became a global shipping route, the Strait was defined as a dynamic intertwined system, shaped by biotic and a-biotic processes. Formed by the Sunda Shelf, the shallow waterway enabled a highly intertwined dynamic marine and terrestrial system to flourish. These systems sustain large regional migration routes and local habitats alike, as well as human settlements along coastal and wetland areas. Dependency of humans on these natural systems is critical, providing them with cultural identity and livelihoods, but its current use is driving the opposite.

The current and future projected intensification of global shipping and related development along the coasts of the Strait place the area at increased risk. With resource extraction, reclamation projects, industrial agriculture and port related industries disrupting and altering the terrestrial water systems that feed into the Strait.

These disruptions, which are caused by a system that serves the global interests, are affecting the local realities. And current governance structures are reinforcing this imbalance, with multiple mechanisms that should counteract disruptions in place but inadvertently do the opposite, prioritising projects that safeguard navigability.

The very stability of the Strait depends on its natural systems to function. And so, the question rises; how can we balance these perspectives?

Colophon

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22nd June 2026

All drawings and photographs in the report are created by the author unless stated otherwise.

Urbanism

EFL STICHTING

Critical Environments

TU Delft Delft University of Technology



Vigia (nautical) – Warning on a nautical chart indicating an unsurveyed potential hazard

Tourist posing with a sign of the Malacca Strait placed on an empty piece of reclaimed land, waiting to be developed (Malacca, Malaysia)

Abstract

The Strait of Malacca is a maritime strait of global importance, yet its role as a living natural system is not recognised within current planning frameworks. Further amplified by growing uncertainty, driven by climate change, this calls into question how conventional practices of spatial planning deal with socio-environmental justice.

The Strait of Malacca is one of the world's busiest shipping corridors, resulting in conflicting perspectives, with on the one hand a critical global infrastructure, and on the other a complex natural system that sustains life for both human and more-than-human inhabitants of the Strait.

This conflict of values, of global socio-technical and economic perspectives versus ecological and social significance are seen throughout the scales. With the dominant approach imposing more and more on the socio-environmental realities that recognise and depend on the Strait as a dynamic intertwined system, shaped by interdependent ecological, cultural and social relations.

Projected increasing shipping traffic heightens the further risks of marine pollution, erosion, and marine ecosystem decay, while land-based sources of pollution driven by urban and infrastructural development constitute a major cause of environmental deterioration (Rusli, 2011). This intensification will not only increase spatial affectations but also further drive the dichotomy of perspectives and values on a global stage (Meer, 1999). Resulting in coastal and wetland areas within the Strait to be at increased risk.

This disruption and degradation of the natural systems expose the limitations of current short-term adaptive planning practices, remaining reactive and unable to address the complexity of conditions, further driving degradation and inequality.

Rather than proposing adaptive planning practices, this thesis proposes to transform the way of managing these issues, going towards a new balance which is robust, to respond to future conditions and recognise the complexity of natural systems and human dependency within the Strait of Malacca. Drawing on the concepts of critical proximity, critical zones, river basin governance and Rights of Nature, this research investigates how local reality can become operational within governance structures, that is able to respond through time and scales. This is enabled through the implementation of a new governance scale of the river basin, relating better to ecological processes shaped by water, enabling situated practices of care to inform the management of the place.

Driving recognition of the networks that have and currently shape it, to go towards a long-term transformative future which is socially equitable and robust. It is not about "fixing" an issue but about finding a new balance that tends to the Strait as a natural system where both users and inhabitants are recognised.

Key words

rights of nature, adaptive planning, river basin management, critical proximity, critical zones



Road side stall (George Town, Malaysia)

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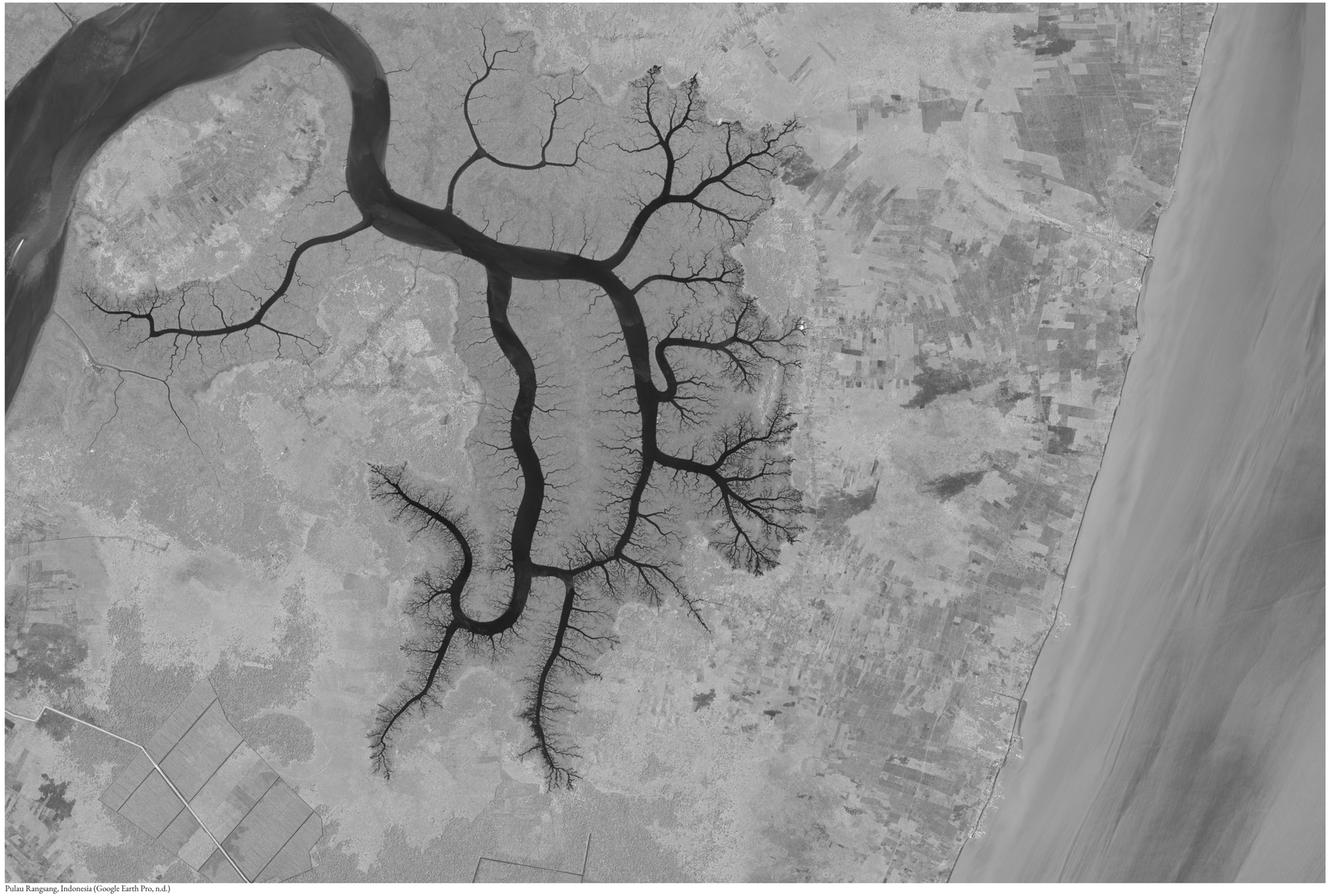
Batam Harbour-front as seen from the ferry (Batam, Indonesia)

Foreword

I would like to thank;
Diego, for always being open for a talk, supporting and encouraging me
Luisa, for ever encouraging words and enthusiasm
Susanne, for always being there for me and supporting me on the fieldwork
Pietro and Allard, for countless hours of coffee, discussion and fun
my family
my friends
and finally the EFL foundation for making my fieldwork possible



Boats in the Strait of Singapore at night (Singapore, Singapore)



Pulau Rangsang, Indonesia (Google Earth Pro, n.d.)

Motivation

Location

The Malacca Strait has been the centre of attention for centuries, connecting Asia and Europe. This has resulted in the Strait being contested for control of global maritime trade.

Besides the Strait being crucial for global maritime trade, this natural body of water is also a critical distributor of life between the Pacific and Indian Ocean and the surrounding land, playing a crucial role in connecting natural systems such as maritime ecosystems.

The Malacca Strait has been a critical global infrastructure corridor for centuries, but due to intensifying globalist demands the exploitative processes are heavily accelerated. Both ecological system and coastal societies in the process are affected, due to management of the Strait being detached from the local interests.

The inhabitants of its coastal and wetland areas are exposed to increased cascade effects of risk, due to the decay of the water system by both human and altered natural processes.

The growing dichotomy of risk and agency is growing and requires a major shift in order to sustain life in the Malacca Strait. The complexity in conflicting interests and networks makes for a system contested by many and dominated by few.

Personal Motivation

After realising the far stretching influence of geopolitics have on our local societies in recent years, I became very interested with power relations between globalist entities and local actors.

With the current decay of natural systems, with possible destruction of feedback loops, there is great urgency in recognising the natural systems that define the world we live in.

Introduction

Critical Zone

Humans have been a part of nature for a long time but, ever since the inception of the Anthropocene, there has been a shift in the relationship between humans and the natural systems. With the acceleration of a globalist perspective fed by global imperialism, industrialisation and the Great Acceleration, human activity has become the major force of transformation.

According to Latour, this distance is ever growing, not only on a physical level but more importantly also perceptually. In Critical Zones (2020) he describes modern society as viewing life from space, which creates cognitive dissonance between the reality of the Critical Zone and the image of the planetary view.

This distance becomes evident when looking at the Malacca Strait, a body of water dominated by its role as a critical maritime corridor essential to global trade. Being the primary shipping route between the Indian and Pacific Oceans, it facilitates the shipping of energy, raw materials and manufactured goods. The choke-point of the Malacca Strait is not merely a geographic connector but also a body of infrastructure functioning on the planetary scale, embedded within a global socio-technical network.

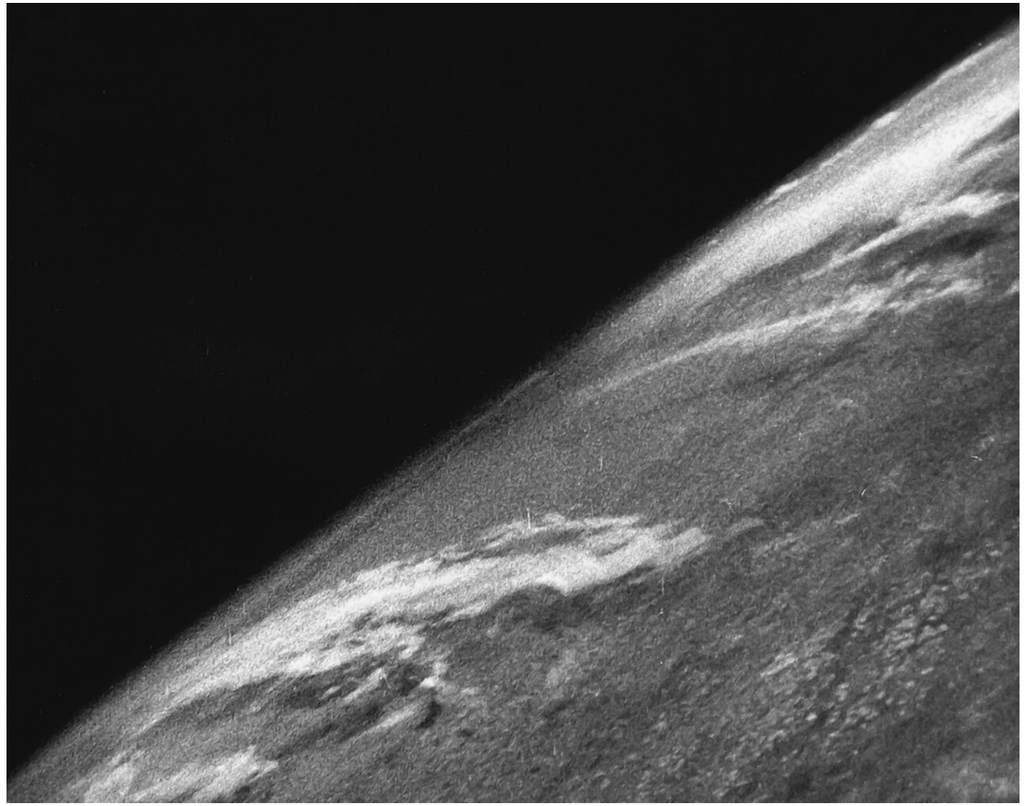
The governance of the Strait is dominated by short-term splintered management, prioritising efficiency of trade, navigational safety and geopolitics. Addressing environmental challenges by minimal modification rather than fundamentally rethinking the way governance recognises the more-than-human systems.

This short-term socio-technical approach has led to the gradual decay of the natural systems that defines the Strait. With increasingly fragmentation and disruption by port expansions, industry, shipping and human coastal defences. This decay is a spatial manifestation of the conflicting perspectives and values on the global scale as proposed by Meer (1999).

The inability of current governance to bridge diverging values and perspectives results in conflicts, degradation of ecology and increased risk for inhabitants on the local scale.

This thesis is situated in the Critical Zone, where global processes and local dependency converge. Exploring how the current role of a global infrastructure can be transformed to an alternative reality that can drive a robust and just future.

"In such a planetary view, where earth is viewed as if from out in space, all life forms as well as humans are squashed to the point of becoming invisible. This creates a cognitive dissonance since there is no commensurability between the lived experience of being situated in the CZ and the image provided by the planetary view."
- Latour



First image of Earth from space (White Sands Missile Range/Applied Physics Laboratory, 1946)

Introduction

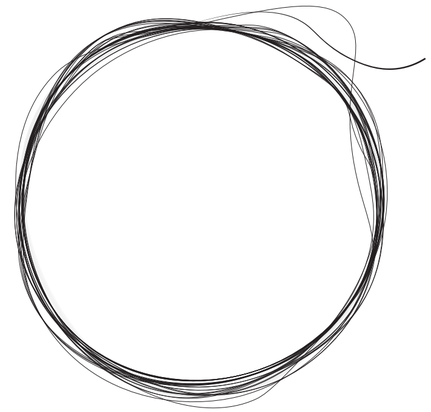
Critical Proximity

The dominant discourse through which planning and urbanism engage with the spatial have been built upon a long-standing foundational assumption that to understand a system, one must take distance from it. By making territories into abstract zones, reducing ecological processes to mere human indicators and treating the natural systems as a collection of managed fragmented entities, has formed a stance of critical distance. A conviction that separation results in objectivity. This is not only a methodological choice but also an epistemological one, changing the way research is evaluated and institutionalised.

The consequences are not neutral, a practice that reduces complex systems tends to misread them. To treat entangled as separate entities and dynamic systems as static. Local conditions, specific histories, cultures and ecologies are the exact things critical distance overlooks. Simplification is not only a limitation of knowledge but also a result of how knowledge is produced.

Latour's critique of this stance opens up a new perspective, rather than defending distance as objectivity, he proposes critical proximity. A way of research that embeds within a complex network, seeking to understand and follow connections between actors and actors. Proximity reveals interdependency, how the local relates to the global and in-between, it opens up a perspective that recognises the essential things that go unseen by the human perception, which need embeddedness to convey its value.

Neither critical approach is sufficient, one without the other results in abstractions that does not recognise interrelated systems based around specificities. The question then becomes, "how do we balance?". Maintaining the overview of systems as a whole, relating to bigger, sometimes even global relations, while remaining close enough to recognise the particular. To balance these lenses is not a compromise that limits the research, but rather a way of effectively responding to a complex world.



Introduction

Rights of Nature

Rights of nature is a movement that proposes to combat the current planning perspectives, governance and development, which have treated nature as a resource to be managed, extracted or conserved according to the interests of humans. Within this perspective, all natural systems and resources are assumed to be a resource to be exploited for human benefit (Alves et al., 2023).

To make nature into a commodity is to perceive it as a static fragmented element, diminishing the perception of the interconnected systems that have shaped and enabled it. Commodification puts natural systems at increased risk, by allowing the disruption of elements not recognised as important.

Recognition of nature requires a shift in perspective and values, from being able to contribute to human activity and existence to that of intrinsic value, what fundamental value natural systems have to exist. This shift alters relationships between humans and the more-than-human, recognising them as entities entitled to exist, regenerate and even grow (Gilbert et al., 2023).

Despite ambitions to transform current forms of planning, rights of nature exists within a socio-technical perspective of planning, leading to its success being limited. Within the Malacca Strait, rights of nature could be proposed as a strategy that recognises the value of natural systems and with it inform the spatial management of it.

The modern world-system operates far beyond individual elements, unfolding across boundaries with the flows of energy, money, ideologies and knowledge, revealing its inner complexity.

- Haoge Gan



Road to Batu Katak, palm oil plantations as far as the eye can see (Bohorok, Indonesia)



Batu Katak, Indonesia



Bohorok, Indonesia



Palm oil plantation in front of the karst forest (Bohorok, Indonesia)

Problem Statement

The Strait of Malacca is one of the most important maritime corridors in the global economy. By connecting the Indian and Pacific Oceans, it facilitates a major share of international trade that sustains a planetary economy.

Projected increasing shipping traffic heightens the risk of marine pollution, erosion, and marine ecosystem decay, while land-based sources of pollution driven by urban and infrastructural development constitute a major cause of environmental deterioration (Rusli, 2011). This intensification will not only increase spatial affectations but also further drive the dichotomy of perspectives and values on a global stage (Meer, 1999).

In current planning frameworks, the Strait is framed as a global infrastructure where efficiency and techno-social values are prioritised. This reflects the theory of Planetary Urbanisation (Brenner et al., 2013), where urbanisation extends beyond the borders of cities, abstracting and simplifying the territories and processes it touches. Viewed from this critical distance, the Strait becomes a corridor to be maintained and optimised, reducing its ecological complexity and treating living systems as fragmented rather as dynamic and interdependent. In stark contrast is the local perspective of Critical Proximity, where the Strait is not seen as an abstract entity but rather an intertwined system, providing life (Sheaves, 2009).

To bridge this gap, a shift in values is required, proposed by Latour, Critical Proximity demands embedding within complex networks. Revealing interconnectedness and dependencies, and how disruptions result in cascading risks across the coastal and wetland areas.

This cascading effect of risk is understood through the compounding water-related risks of subsidence, erosion and inundation. Related to the way water is managed, disrupted and altered by human activity such as intensive agriculture, coastal urbanisation, land reclamation, ports and related industries, and also further threatened by rising sea levels and intensified weather events. Each risk amplifies the next and is intensified with every further disruption of the natural systems.

The tension between opposing perspectives of management, between the socio-technical and socio-environmental, results in the decay of the Strait's natural systems. Latour's Critical Zones (2020) relates to how these natural systems create a thin layer of habitable Earth, where natural processes interact and enable life.

Rights of Nature as a global movement is able to contribute to the transformation of planning practices by recognising the importance of long-term natural systems over dominant short-term adaptation that prioritises economic gains. Although recent initiatives have been proposed to recognised the more-than-human perspectives and cross-border cooperation in the form of measures by the Littoral States to address pollution and protection (Ashley Roach, 2013), they still operate within existing socio-technical planning frameworks that treat risks as discrete and manageable rather than as systemic and cascading.

From a position of critical distance, these interventions address symptoms while unable to structurally recognise the local interdependencies that cause them. This friction reveals a pathway for transformative change to happen, by adopting critical proximity as a way to trace the systems and the relation to the risks, it becomes possible to tend to the Strait of Malacca as a system. Integrating Rights of Nature and Critical Zones proposes a reconfiguration of the networks that shape the Strait, expanding its framing from a global infrastructure to be protected into an integrated part of the Critical Zone to be tended to.



Malacca Gateway (Google Earth Pro, n.d.)



Kukup Aquaculture (Google Earth Pro, n.d.)

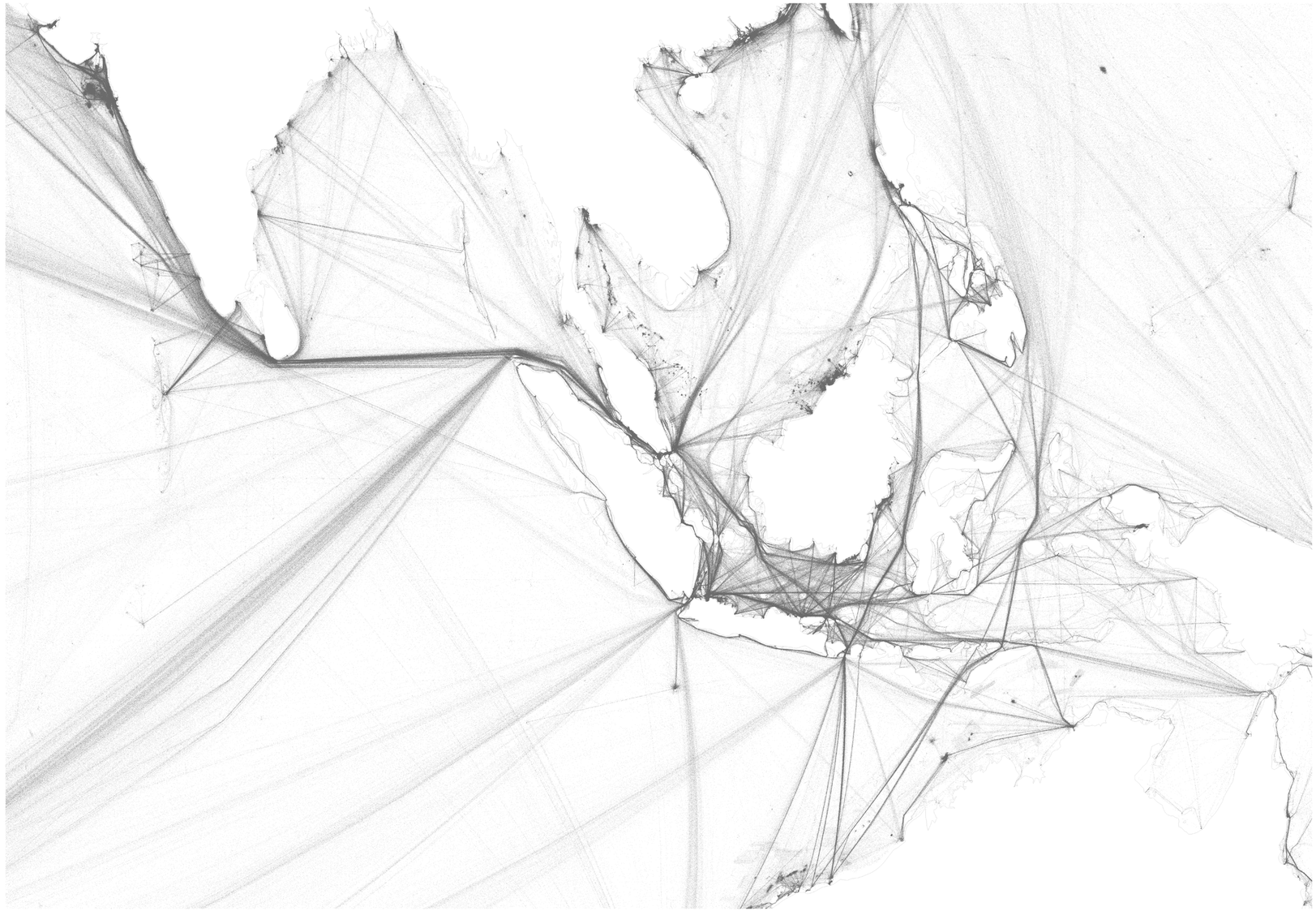


Supportive Infrastructure, Port Dickson (Google Earth Pro, n.d.)

Aim

The aim of this research is to recognise the complexity of the natural systems of the Malacca Strait, that it is more than just a maritime highway that imposes itself onto the local realities. To then translate this into a spatial framework that is informed not only by recognised human actors and systems but also more-than-human actors.

It should validate the importance of the more-than-human systems which are not currently recognised, distribute agency across all actors and find a new equilibrium for the area through a reconfiguration of the network of the Strait. Driving a transformative future, which enables synergies across multiple dimensions of space and time.



Shipping density around the Strait of Malacca

Relevance

Societal Relevance

This research contributes to society by highlighting the critical role and dependency of humans on natural systems, and how human activities are affecting them in ways like never before.

By revealing this interconnectedness, society could shift its perception on natural systems and the way humans as a collective relate to nature.

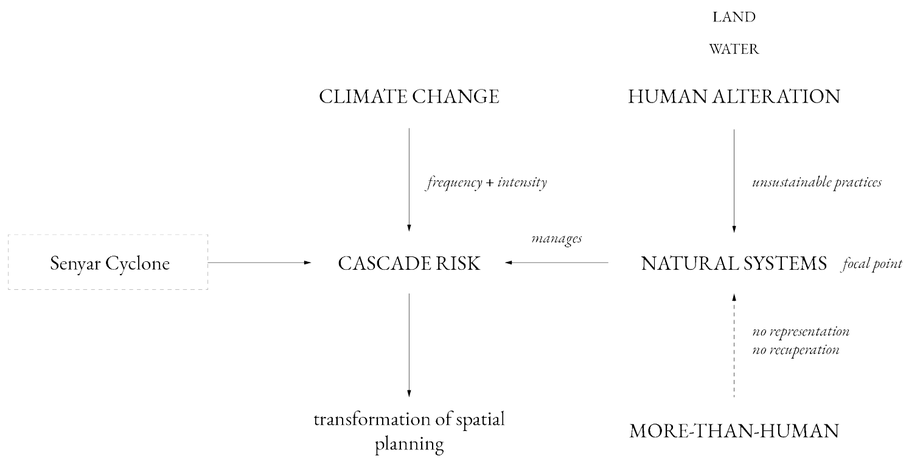
The case of the Malacca Strait drives transformation in complex natural systems which are heavily affected by human alterations, by learning from the outcomes, new futures can be revealed for areas under the same strain of contrasting values.

Scientific Relevance

This research contributes to provide academics with a better understanding of natural systems. By recognising cycles as dynamic and interconnected networks that facilitate life for both humans and more-than-humans.

The expansion of this perspective on nature could attribute to transforming spatial planning methods and inform policy related to recognising natures intrinsic value.

Urbanists have an important ethical role in shifting our collective perspective, from human centred to one that recognises humans as a part of nature.



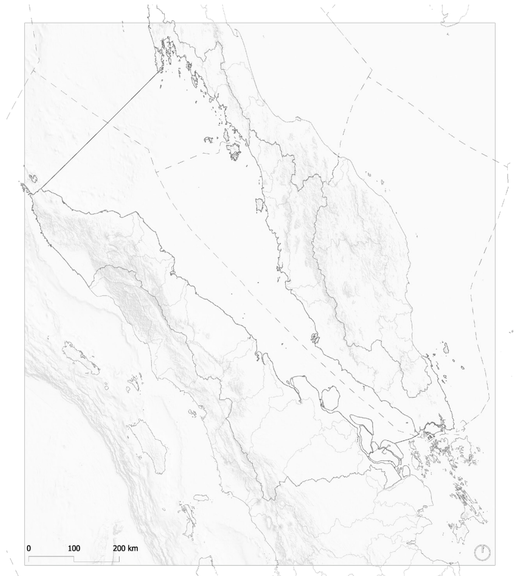
Scope

Location

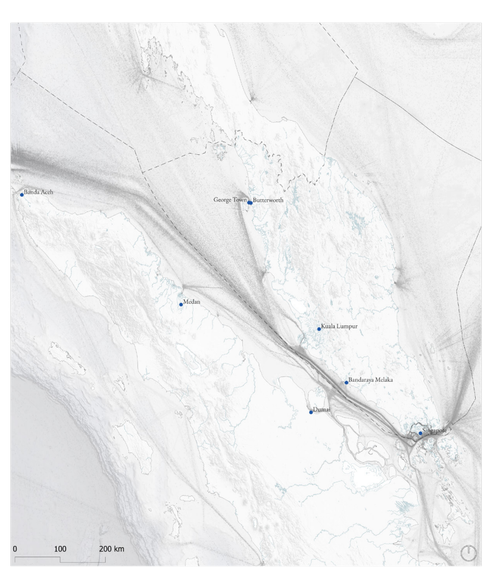
The Malacca Strait is a funnel shaped body of water, posing as crucial bottleneck in global maritime trade, connecting the Andaman Sea to the South China Sea. Located in South-East Asia, the Strait is bordered by the three Littoral States of Indonesia, Malaysia and Singapore.

Located on the shallow continental Sunda Shelf, the Strait is located between the Indonesian island of Sumatra and Peninsular Malaysia. The depth of the water rarely exceeds 50 meters, and poses a challenge for the navigability of large vessels.

This connector, often seen as a piece of maritime infrastructure, also plays a bigger role in distributing nutrient cycles between nearby oceans and offering diverse habitats that result in it being a hotspot for both marine and land-based biodiversity (Goulding & Dayrat, 2023).



IHO Boundaries of the Malacca Strait

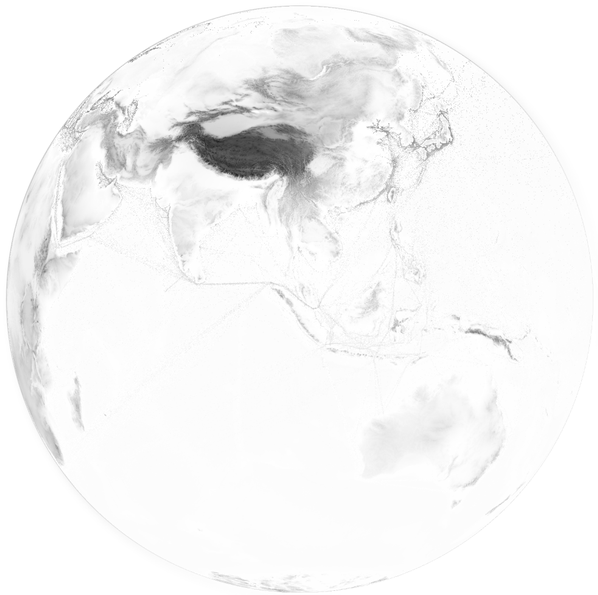


Major cities along the Strait



Sentinel-2 image of Seruyar flooding in Sumatra (Aceh, Indonesia)

Methodology



Research Question

How can a reconfiguration of the Malacca Strait drive a new future, shifting from a contested infrastructure to a critical zone, which is ecologically robust and socially equitable, by recognising critical proximity?

Sub research questions

These sub research questions aim to first take position within the context of the current use of the Malacca Strait, then embed within the system to trace the connections of the current network and asses the current risks. This will lead to a review on how the current governing bodies are managing the area and which actors are recognised in current policy. Finally a reconfiguration of the network is done and translated into a new spatial framework that recognises the more-than-human and proposes a new future.

Sub research questions

1. System Alterations
   How have anthropogenic activities altered the Malacca Strait's natural systems?
2. Balancing risk
   How are disrupted natural systems affecting the Malacca Strait coastal and wetland areas?
3. Current governance systems and (mis-)alignment
   "How are current policies managing the coastal and wetland areas and more-than-human systems?"
4. Reconfiguration of the Strait
   How can reconfiguration of the Strait of Malacca's management lead to socio-environmental justice?

Methods

To conduct this research, different methods are used, to position, embed, review, recognise and reconfigure the coastal mosaic of the Strait of Malacca.

Firstly, academic literature on post-humanist planning and values will be used to position within the academic field of planning and identify the extent of the critical habitats will be mapped together with disruptive anthropogenic activities.

Then embedding in the network is required to trace the current network of actors, this will be done by fieldwork, critical mapping of risk and literature reviews on actors.

When starting the review of current policy, critical literature reviews will be conducted on Rights of Nature and possible established spatial implementations. Together with the shortcomings of current ambitions, this will result in a statement on the misalignment of policy with the local level.

To recognise natural systems, a review will be done on human guardianship and how risk is distributed unevenly.

Finally a reconfiguration of the network of actors will be done by translating previous outcomes into a new spatial framework that recognises systems not partially but as a whole, dynamic system. This reconfiguration will build a system of care throughout scales and time, expanding the amount of guardians that will enable this transformation. It will also connect scales, both global and local by introducing the systemic scale of the watersheds to connect values and interests, fostering future social collaboration and co-management of the Malacca Strait under a diminution of risk for all.

subject	natural systems of the Malacca Strait			
problem statement	The Strait of Malacca, currently seen as a global infrastructure, is projected to intensify, reinforcing a socio-technical view of the Strait as a corridor of flow. This short-term, optimization-driven approach generates growing friction between local and global perspectives, contributing to the degradation of the local perspective, fragmenting habitats and disrupting natural cycles. Reconfiguring the network offers a pathway to re-equilibriate global flows with long-term natural systems, through the recognition more-than-human actors.			
research question	*How can a reconfiguration of the Malacca Strait drive a new future, shifting from a contested infrastructure to a critical zone, which is ecologically robust and socially equitable, by recognising critical proximity?*			
theories	critical zones latour	matters of care puig de la bellacasa	pluriverse escobar	critical proximity latour
	position	**embed**	**review recognise**	**reconfigure**
sub-research questions	Anthropogenic cause of risk	Risk for who and what?	Current policy and misalingments	Spatial reconfiguration of the system
input	Mapping anthropogenic disruptors Literature on contested history and future Malacca Strait	Mapping water-related risks and power relations	Mapping current policies and power relations Literature on governance misalignment and synergies	Reconfiguration of the Straits managements
expected outcomes	Understanding of current use and values	Exposing functioning and risks distribution	Power balances and (mis)alignments of policy	Establish drivers of recuperation on all scales

Conceptual Framework

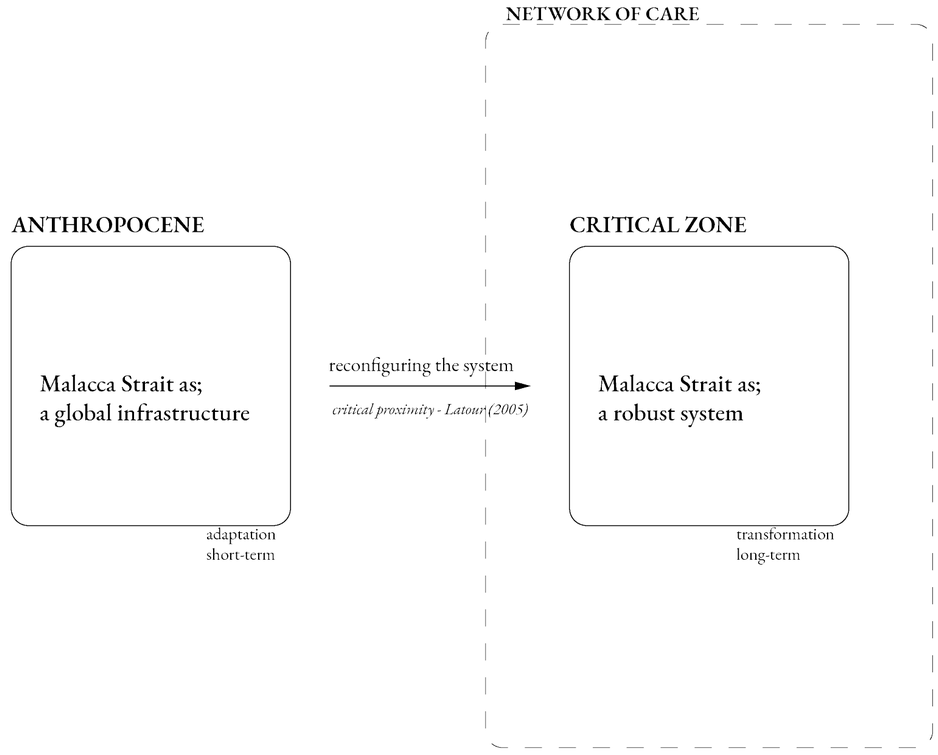
This conceptual framework shows the shift in collective perspective, towards one that recognises intrinsic values of natural systems which also include the more than human.

This reconfiguration of the network will be done by identifying first, the body and its relevant actors. This is done by means of Critical Proximity, going to the local scale and identifying how recognition, or a lack thereof, lands in reality. This includes not only the different landscapes but also its inhabitants, both human and more-than-human. This proximity will then be used to dialogue with policy makers, to enforce recognition of the local affectation of the global scale disruptive activities.

After recognising the body and actors, there is a need to identify the risk to the subject. This is done by mapping and reading on disrupting anthropogenic forces and how they affect the natural systems. This reveals the different alterations to the downstream river basin but also the natural systems that it supports and contributes to.

This risk will then have to be counteracted by recuperation of natural systems. Reinforced spatially and procedural by a spatial framework that goes beyond perceived borders of Littoral States of the Strait and recognises the local.

Resulting in the conception of the Malacca Strait as a part of the Critical Zone of which all natural systems take part in. This Critical Zone will be a part of the new post-Anthropocene perspective that will lead to a transformation of our collective planning of time and space, on the long term.



Theoretical Framework

In our current time of intensifying global crises, the impacts of anthropocentric actions become visible, survival, of both humans and more-than-humans, depends on cycles that are currently being disrupted without fully understanding them. According to Latour (2020) there is no “outside” or “above”, we are all part of this bigger interdependent system. By becoming aware of the human role in the bigger system, people are forced to re-think our future at local and global scales simultaneously.

The theoretical framework represents the various theories upon which the thesis is based and their interrelations. The main body of literature consists of post-anthropocentric literature, which is about shifting the world-view of people, re-contextualising the position of humans as a part of nature.

Critical Zones - Latour, 2020

The Critical Zone is, according to Latour (2020), the thin area on the surface of the Earth. Where life is sustained by intertwined, complex networks, not recognised and perceived by humans. These natural systems include nutrient cycles, sediment flows and hydrological systems, together sustaining a habitable planet for all.

The current view of the world is distant, represented by fragmented and short-term planning, wonderfully captured in the following quote: “Humboldt did not hide the discontinuities in a landscape he had to appropriate through great hardship, by actually going there on foot or carriage. Strangely, but for exactly opposite reasons, this is just the situation, two hundred years later, that’s revealed today by Critical Zone Observatories: heterogeneous, discontinuous, a leopard skin of data separated by large spans of ignorance, in the middle of fierce battles that thwart any simple dream of domination.” (Latour, 2020).

Critical Zones exposes the disconnect between humans and their surroundings, “The land we live in, and the land we live from.”, which is shedding a light on our perception that needs to change.

Critical Proximity - Latour, 2005

This theory embeds research within a network, instead of taking distance, as posed by traditional research methods. Leading to the recognition of not only human actors, but also more-than-human, revealing their entanglement and complex effects in a integrated network. Research and design become a practice of reformulating relations. It relates to the disconnect Latour later mentions in Critical Zones and to the recognition of the more-than-human systems in Actor-Network Theory, offering a new perspective by researching a network from within.

Focusses on tracing relations, dependencies and vulnerabilities that connect humans and more-than-human cycles.

It further challenges socio-technical perspectives which rely on abstraction of complex systems but rather encourages situated knowledge, synergies and recognition of more-than-human agencies.

Actor-Network Theory - Latour, 1979

Actor-Network Theory (ANT) (Latour, 1979), explains how societies are made up of networks consisting of human and non-human things that make a difference, or so called actors. In this network, agency is distributed across all kinds of actors, not centred solely around humans.

Agency and power are not possessed but result from synergies and constant maintenance of relations.

This concept is expanded by Boelens (2010) by emphasising the state of modernist planning and how alternatives have not been properly established: “... state-controlled planning has been fundamentally debunked as a highly regulatory and prescriptive operation, resulting in syrupy planning processes, which are very costly, inflexible and inefficient, and suppressing all new and creative initiatives that do not fit within the set framework. Postmodern and post-structural alternatives developed since then have been very effective in counter-attacking the alleged virtues of that planning strategy, but less fruitful at promoting effective and/or sustainable practices.” (Boelens, 2010).

Planetary Urbanization - Brenner et al., 2011

The urban is not bound to cities but extends beyond, making it a planetary condition. Previously perceived natural areas have become a part of a worldwide urban fabric.

Planetary Urbanization (Brenner et al., 2011) makes clear, the expansion of the needs of a city beyond its borders. The dissolving of the city-nature divide requires non urban spaces to be planned for. This relates to the creation of Critical Zones (Latour, 2020) as a planetary system that is interlinked and complex, revealing the importance of systems beyond our dominant socio-technical values. Envisioning a new possible future where socio-environmental justice can be granted, based on different needs and specificities of the location as informed by Critical Proximity (Latour, 2005).

Planetary Boundaries - Rockström et al., 2009

To maintain a stable environment, Rockström et al. (2009) proposed a framework that bases planetary boundaries. Defined by a threshold in which humanity can operate while respecting the systems of the Earth and their functioning. Important to note are the limits and what happens when they are exceeded, up until now there have been natural counter-reactions to adapt to these changes. But there is no guarantee that these systems will stay working, once boundaries are crossed, risking disastrous consequences for not only humans but also other systems deeply intertwined.

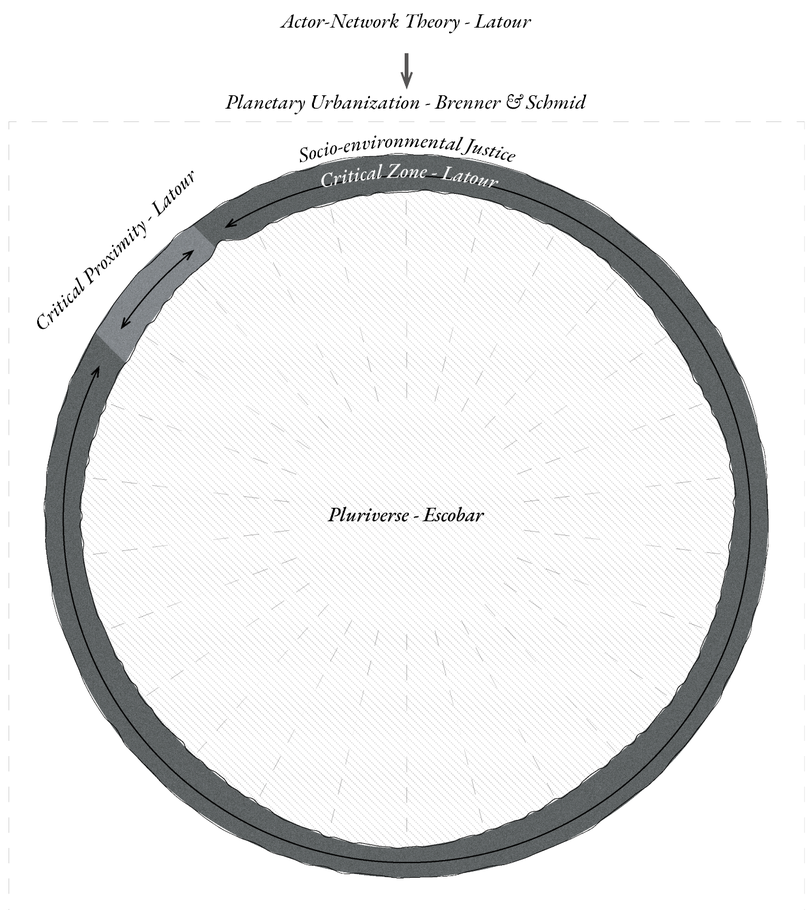
Pluriverse - Escobar, 2018

By recognising not a single dominant world-view, of abstracting reality as captured by Varela (1996), alternatives emerge from situated and relational practices. This results in the rejection of posing a singular and static solution or view on the future of the coastal mosaic. It should recognise differences, complexity and dynamic properties of natural systems and adapt to each locations specificities, leading to different realities that support the same values.

Socio-environmental justice - Schlosberg, 2007

Socio-environmental justice addresses the unequal distribution of benefits and risk. It is comprised of different types of equity; the distributional, procedural and recognitial (Schlosberg, 2007). It also evolves to extend beyond the human perspective, by including the more-than-human.

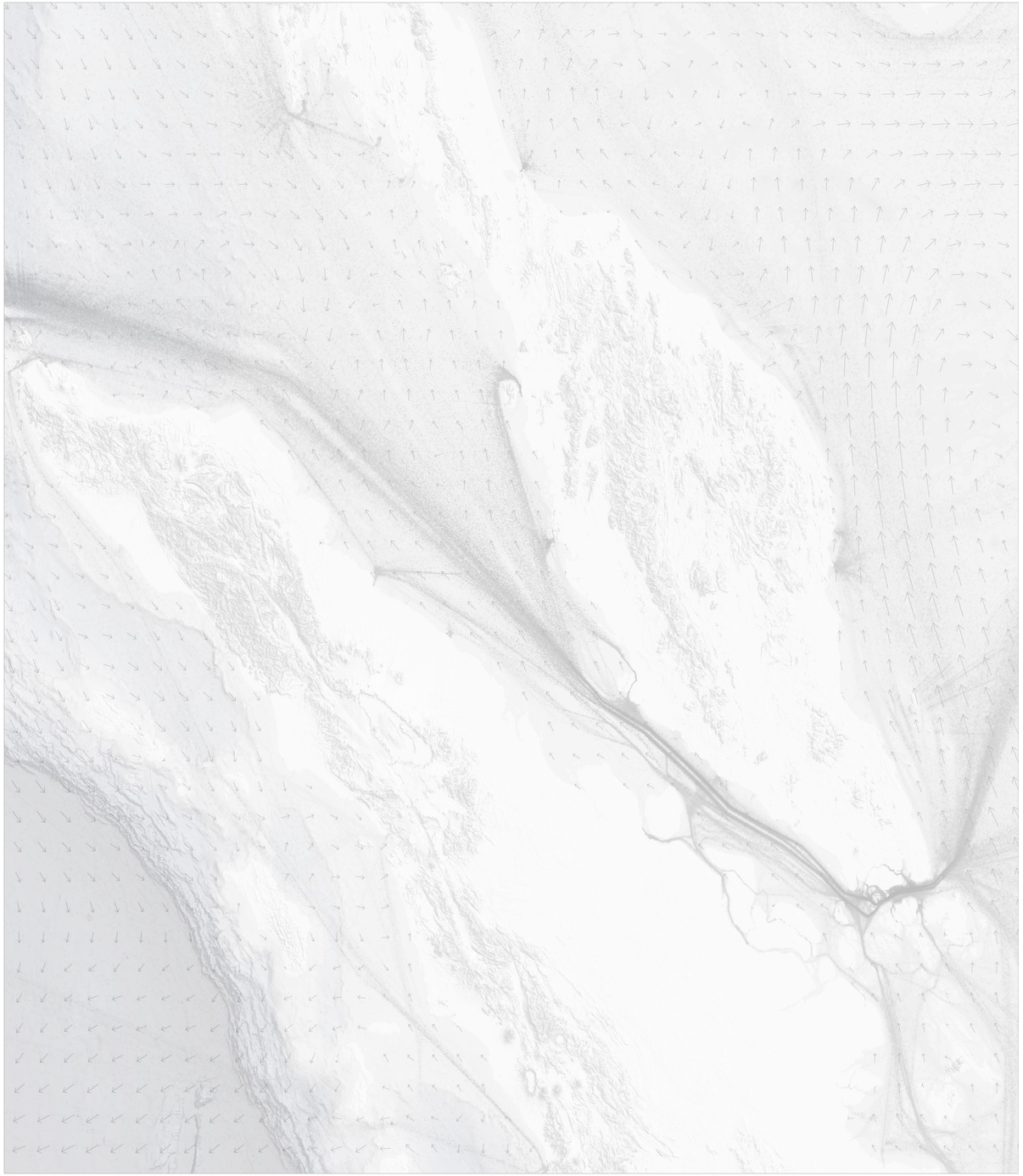
Rather than being a single theory, it functions as a framework to guide actions.



Design challenge

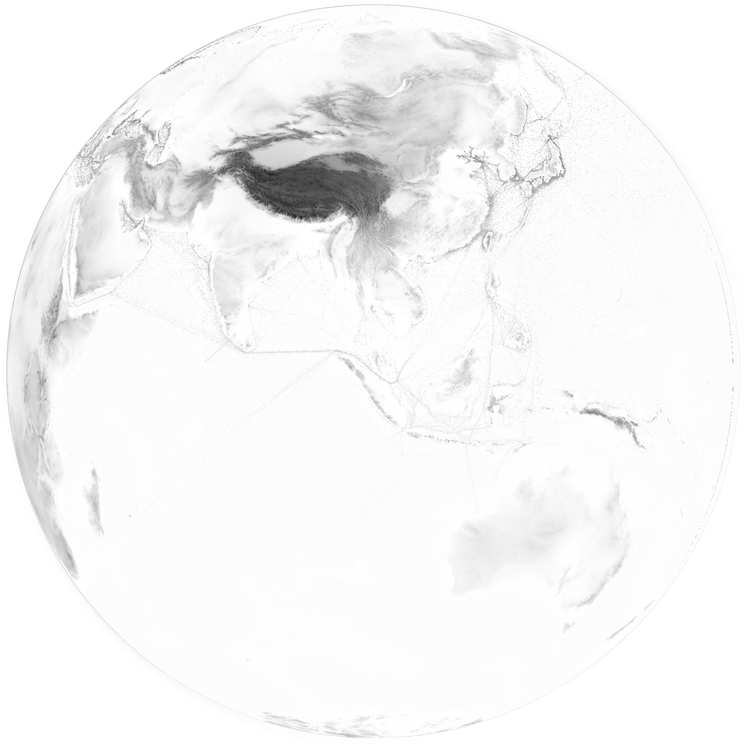
The research of this thesis will propose a redesign of the various scales of the Malacca Strait coastal and wetland areas, to reconfigure the current and future requirements for actors to be recognised and integrated into a synergetic network that drives a socially equitable and ecologically robust future.

This new spatial framework for the Malacca Strait, is meant to provide inhabitants of the coastal areas with socio-environmental justice. Spatialisation of current Rights of Nature has been plagued by limited recognition and perception of natural systems, and so the challenge also is to translate socio-environmental values into spatial recognition of dynamic and complex systems.





Contested Waters



System Alterations

"How have anthropogenic activities altered the Malacca Strait's systems?"

Anthropogenic activities have played a major role in the disruption of natural systems. One of the biggest contributors to this has been the global maritime trade, intensifying its disruption in the geomorphological bottleneck that is the Strait of Malacca. With this global shipping established in the Strait, ensuring the shortest route between Asia and Europe, the coastal areas surrounding the Strait are also used to reinforce the position of the shipping industry. Resulting in the construction and expansion of ports, logistical infrastructure to support this system and other industries such as oil and gas.

In order to reveal the anthropogenic activities that disrupt the natural systems of the Malacca Strait, there is a need to identify spatially how the area has been altered throughout time and by which activities.

Changes in land use and affected habitats show the alterations and disruptors, making clear the current values that governance operates on.



Construction of Silicon Island (Penang, Malaysia)

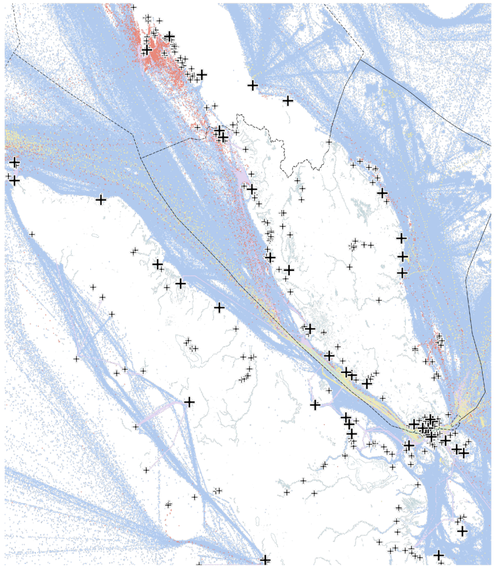
Conflicting values

The tension between global and local perspectives on the Malacca Strait are not only abstract, they become visible in the landscape.

In the historic city of Malacca, a UNESCO World Heritage site with a buffer zone that represents its historical cultural values being pressured by values of the socio-technical represented by land reclamations and industrial areas. The city was once the most significant port city in the area, but is now left without a port, in a desert of sand reclamation slowly eroding away.

The Malacca Strait is a contested infrastructure, where the ambition of the global perspective does not remain an ambition but becomes a local reality, it is not a difference in perspective but a driver of spatial transformation with consequences on the local scale.

In the following analysis, the current challenges of the Malacca Strait will be revealed. Showing how it is a contested infrastructure and disconnected from local perspectives.





Malacca UNESCO Zone (UNESCO World Heritage Convention, n.d.)





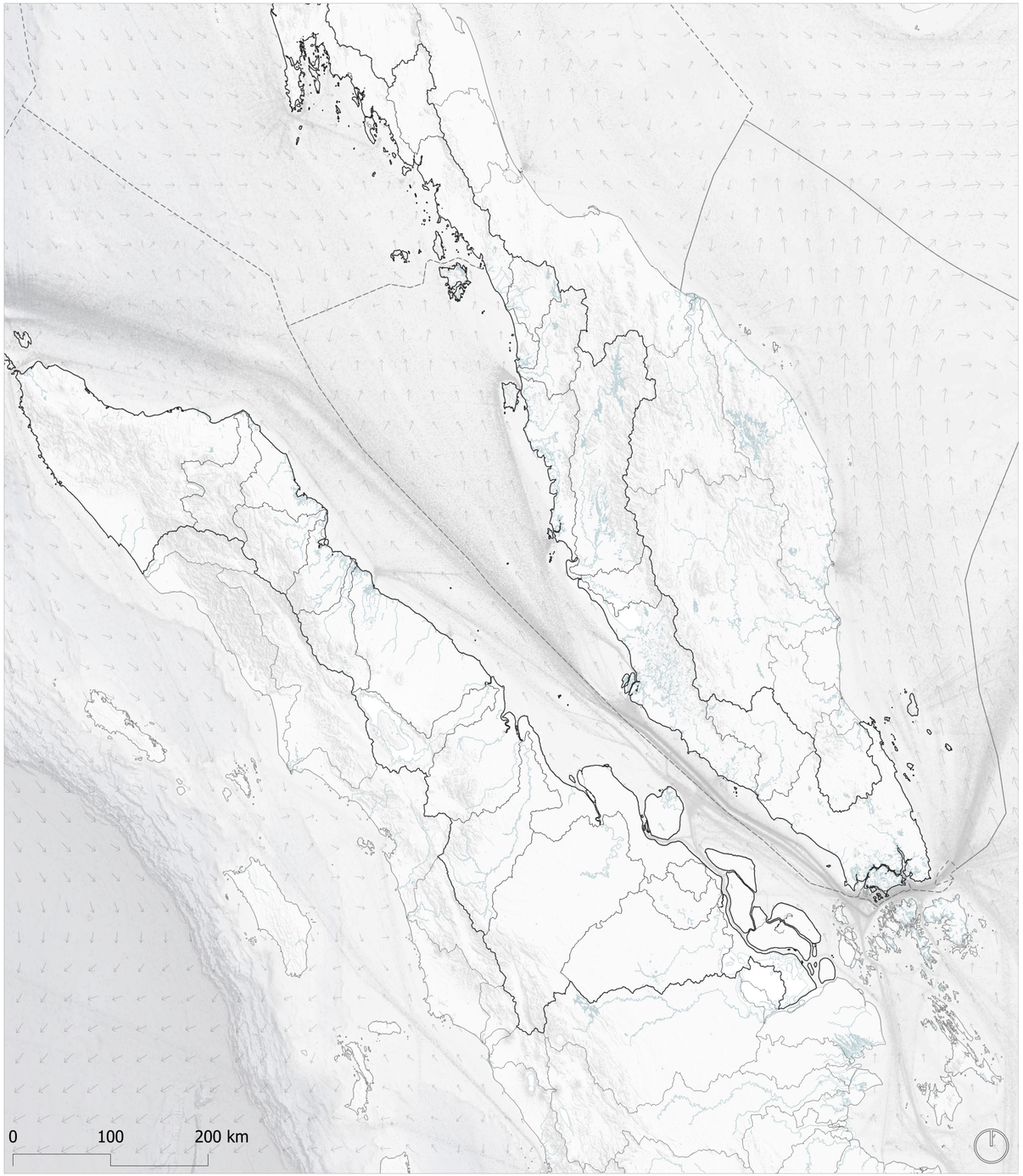
Coastal reclamation projects next to the original coastline (Malacca, Malaysia)

Dredged sand for land reclamation projects (Malacca, Malaysia)

Going beyond the banks of the Strait

Shown are the river basins in the area, defined by geomorphology, they are one of the determining factors of the different habitats and natural systems that are present in the area.

To analyse the natural systems of the Strait of Malacca, it is required to look beyond the physical body, from coast to coast, and enter into the connecting systems that enable the Strait to be so contested. This results in looking at the river basins feeding into the Strait as the physical extent to assess the functioning of the Strait. By analysing from the water system, the analysis takes a first step to the recognition of the natural systems.



Setting the physical boundaries

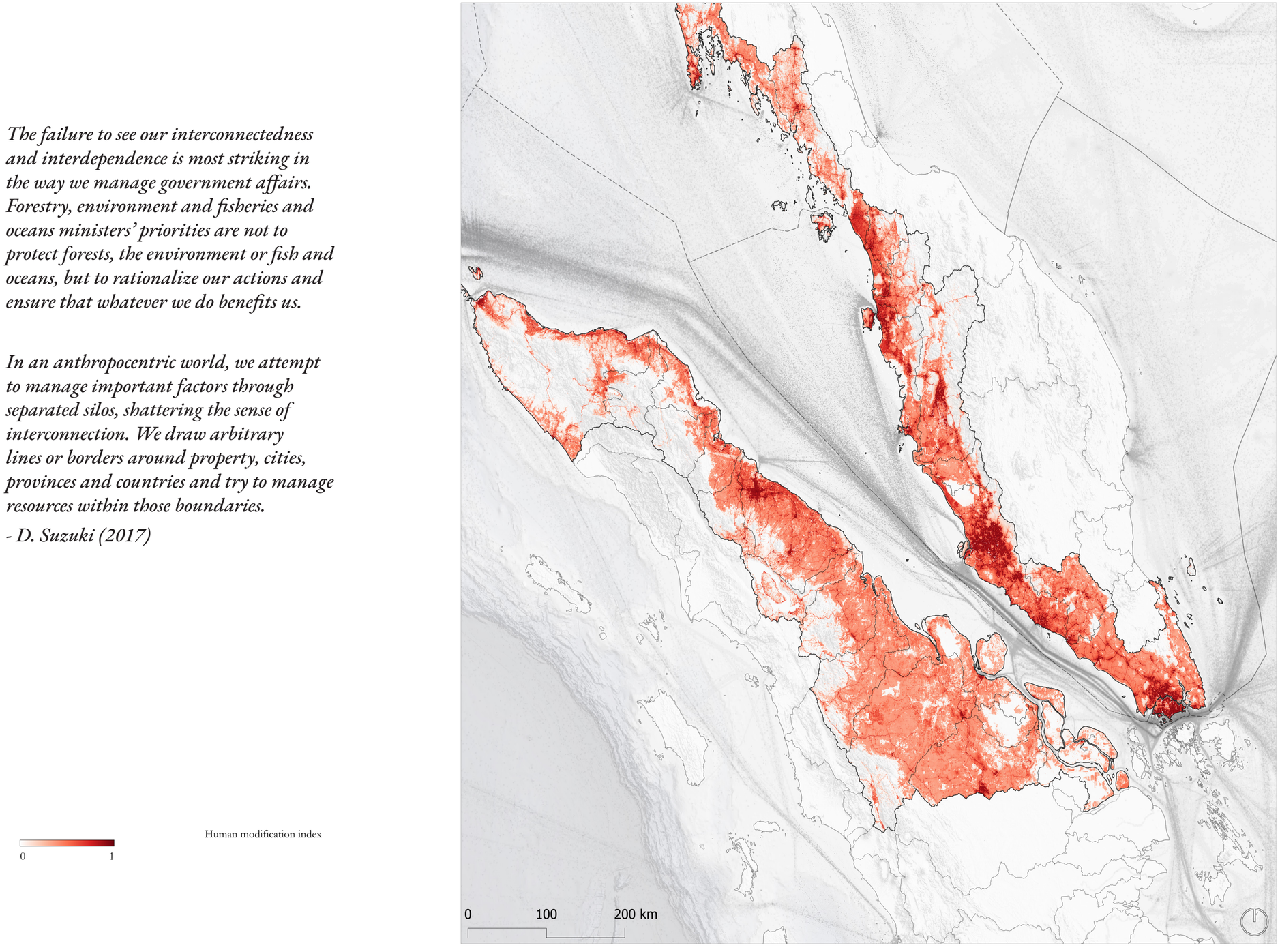
The human disruption index shows a clear pattern in the extent of disruption, focussed primarily around the coastal and wetland areas within the lower area of the river basins, with the highest amount of disruption located in the major cities along the Strait such as Medan, Butterworth, Kuala Lumpur and Singapore.

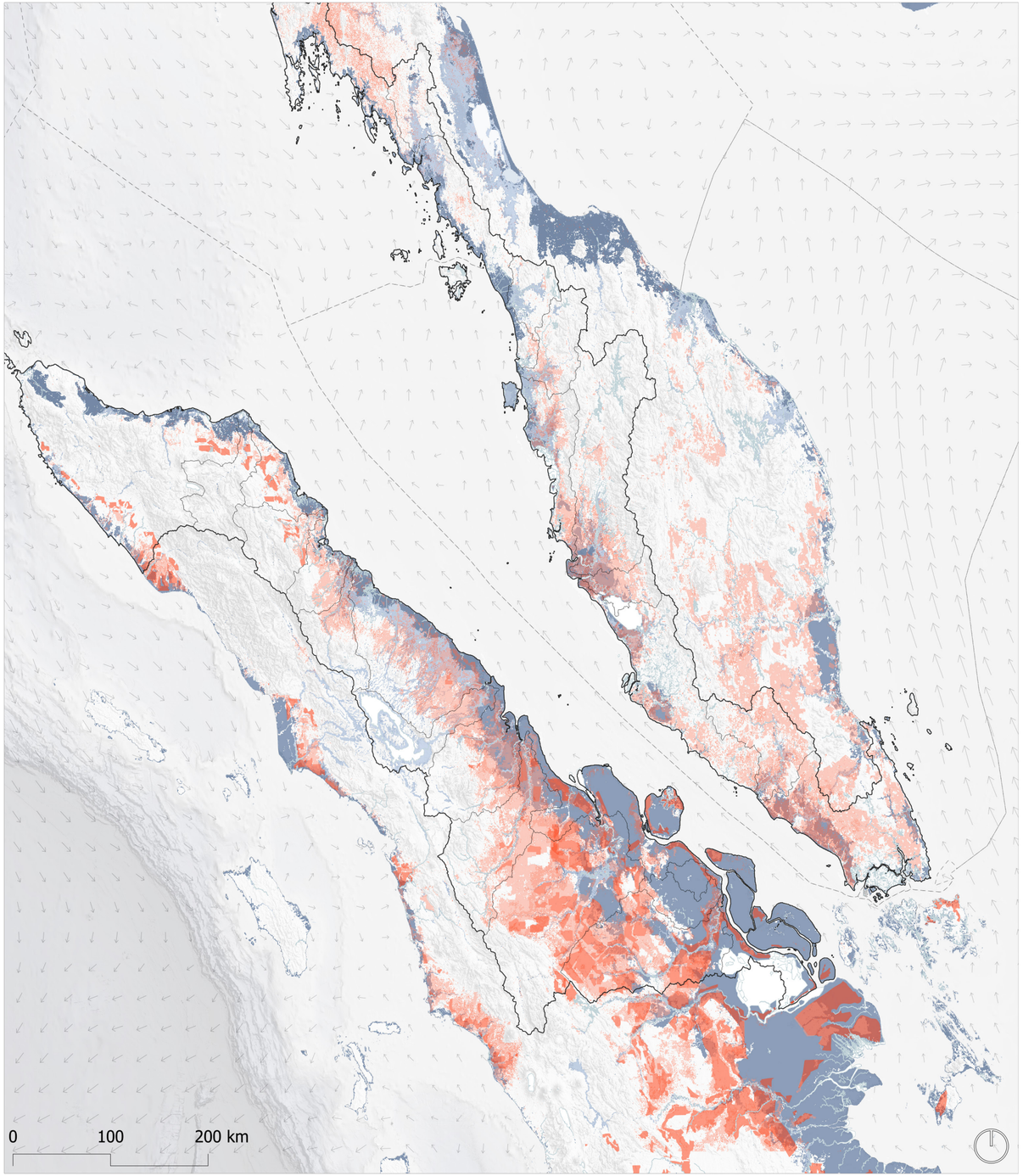
This disruption sets a clear extent for the research, taking the feeding river basins towards the Malacca Strait as a base for the analysis, with a focus on the lower lying areas.

The failure to see our interconnectedness and interdependence is most striking in the way we manage government affairs. Forestry, environment and fisheries and oceans ministers' priorities are not to protect forests, the environment or fish and oceans, but to rationalize our actions and ensure that whatever we do benefits us.

In an anthropocentric world, we attempt to manage important factors through separated silos, shattering the sense of interconnection. We draw arbitrary lines or borders around property, cities, provinces and countries and try to manage resources within those boundaries.

- D. Suzuki (2017)

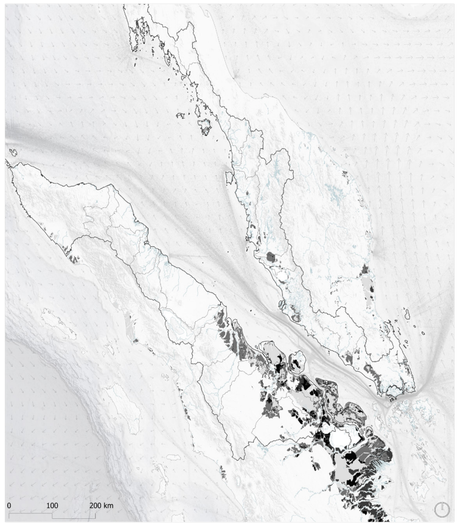




Disrupting practices

One of the biggest disruptions of the area of the Malacca Strait is that of the intensification of industrial agriculture, primarily the current palm oil plantations. The countries of Malaysia and Indonesia are the biggest producers of palm oil globally, and the amount of plantations has grown over the years. This growth has been enabled by the draining of coastal and wetland areas, the drainage of these habitats, mostly peat-lands, results in increased risks of inundation and subsidence.

Map on the left shows the wetlands and coastal areas being dominated by palm oil plantations, showing the wetland areas underneath that enable the fertility of the area. The map on the right shows peat land drainage and its emissions, making ground available for further intensification of agriculture in the area.



Emissions from peat drainage
0 - 15
15 - 29
29 - 44
44 - 58
58 - 73

Industrial oil palm plantation
Small scale oil palm plantation
Wetlands



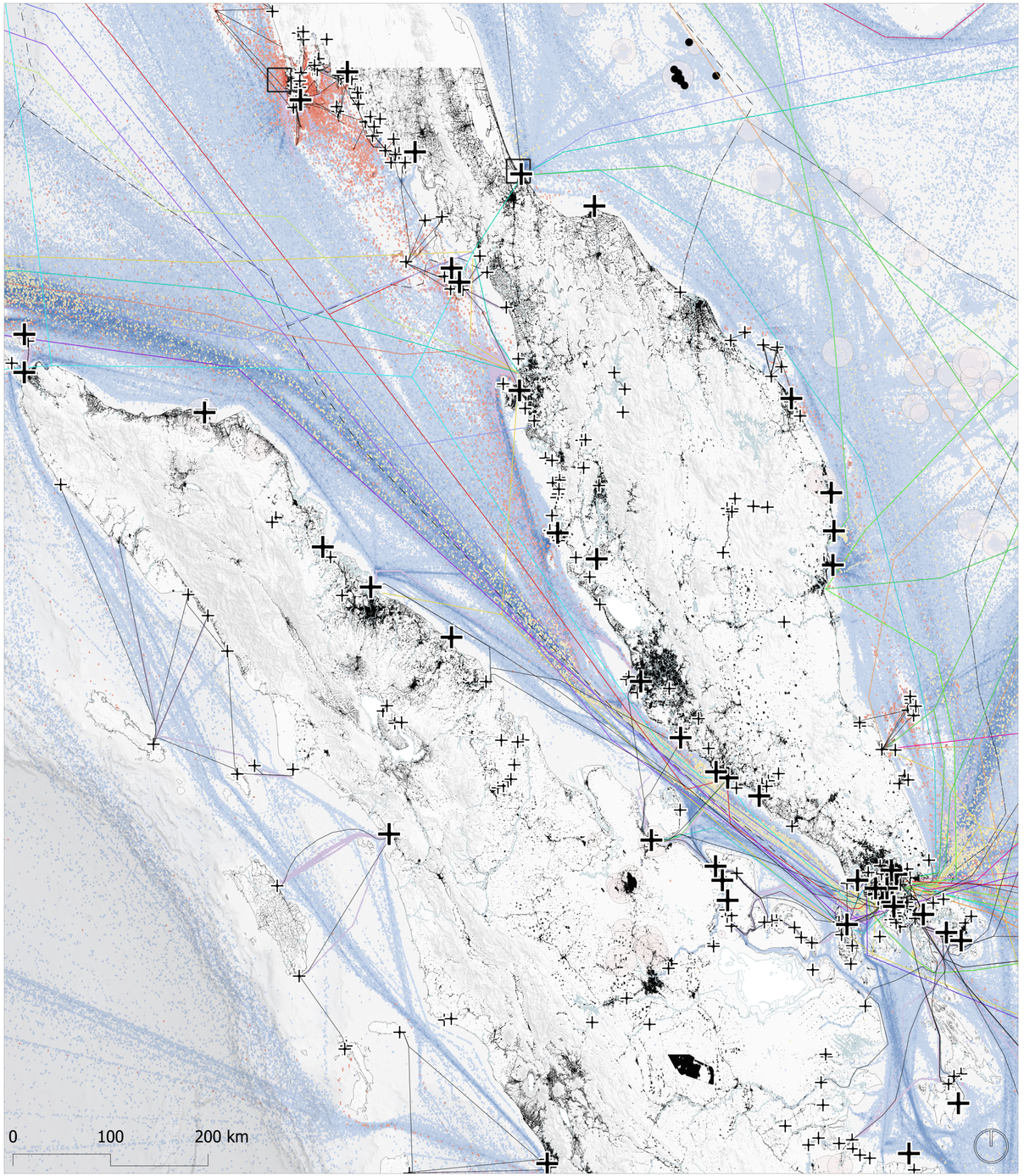
Entrance to a palm oil plantation near Bohorok (Bohorok, Indonesia)



Enhanced irrigation terraces (Bohorok, Indonesia)



Cut down patch of a palm oil plantation, showing clearly the irrigation channels, near Ipoh (Ipoh, Malaysia)

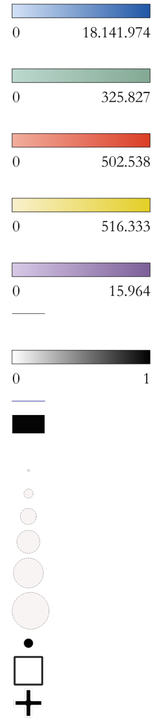


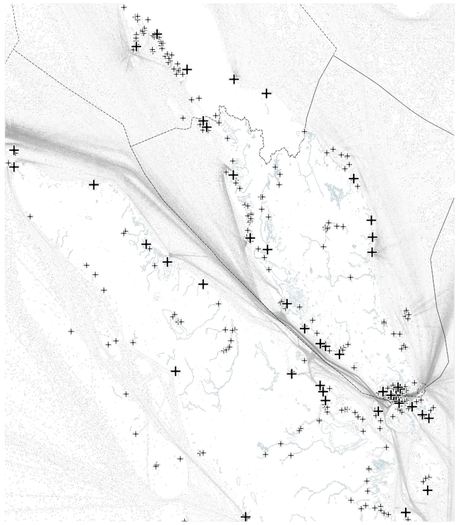
Contested infrastructure

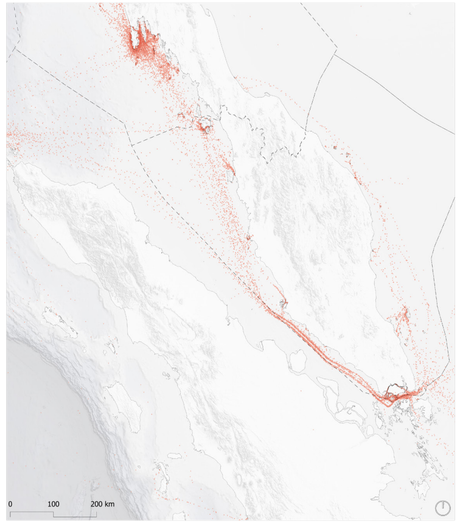
The different types of shipping provides an insight into the different types of ports and shipping within the area, revealing how certain power relations are. With commercial ships passing through the Strait, only making stops in the major ports, it shows the function of the Strait as a global highway for shipping. In contrast, local industries and practices such as fishing are overshadowed by the commercial shipping, making it barely visible.

In the Northern part of Peninsular Malaysia as well as Thailand, shipping related to leisure can be seen, this can be assigned to tourism related to pristine natural islands, relatively unaffected by the shipping.

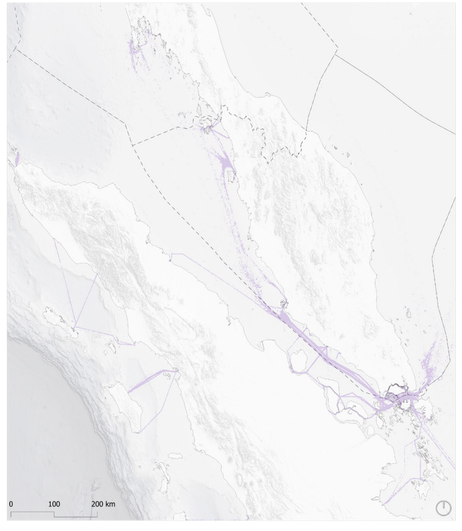
Clear pattern between high volumes of shipping and urban expansion can be seen, with Medan, Kuala Lumpur and Singapore being the clear primary cities along the Strait.



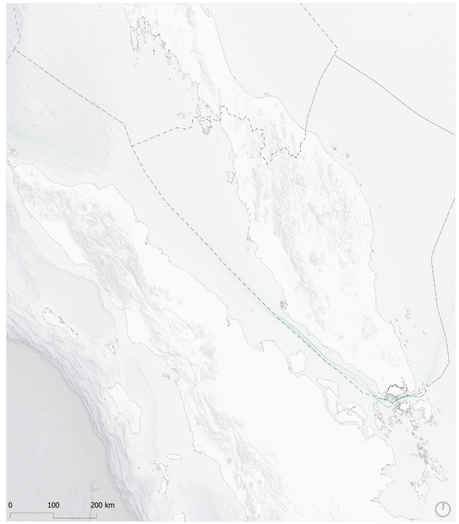




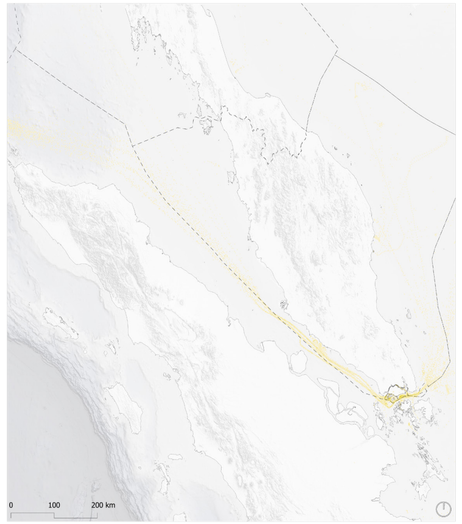
Leisure



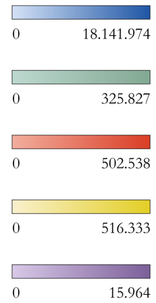
Passenger



Fishing



Oil and gas



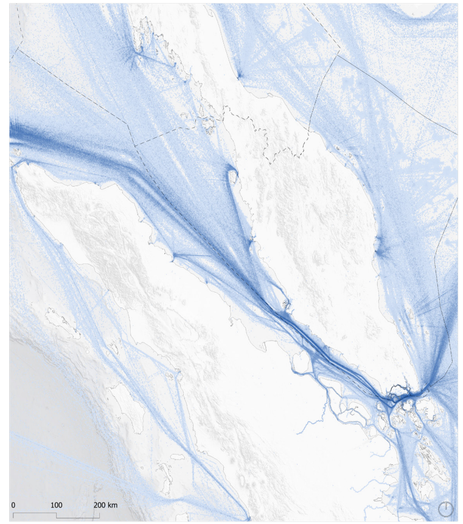
Density commercial

Density fishing

Density leisure

Density oil and gas

Density passenger



Commercial


TRANSCO 3
JAKARTA





Malacca Strait

Danish Straits

English Channel

Strait of Hormuz

Panama Canal

Singapore Strait

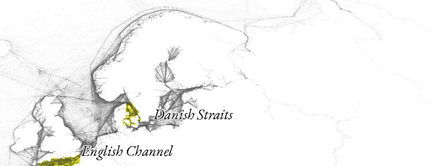
Bab el-Mandeb Strait

Suez Canal

Panama Canal

Strait of Gibraltar

1 million oil barrels



Danish Straits

English Channel

Gibraltar Strait

Suez Canal

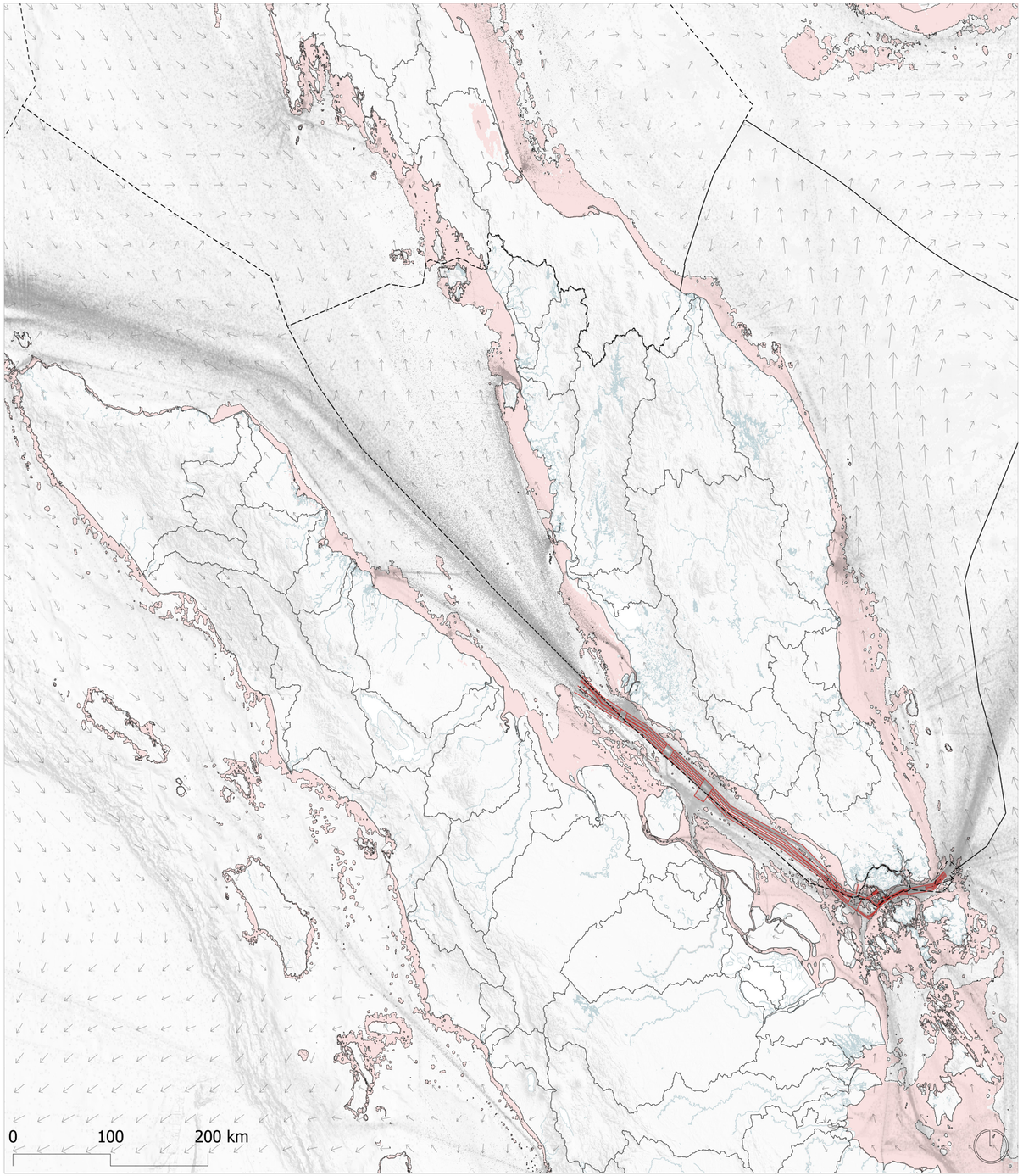
Strait of Hormuz

Bab el-Mandab Strait



Malacca Strait

Singapore Strait

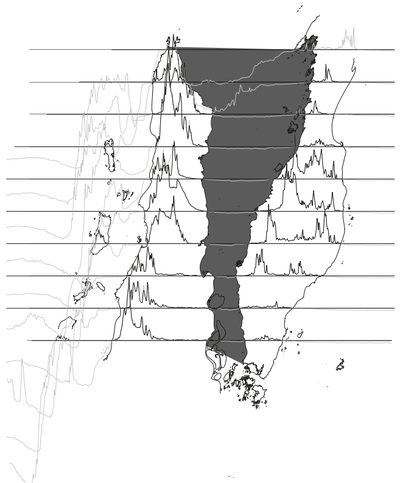


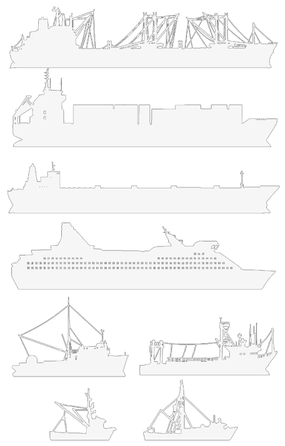
Bathymetry

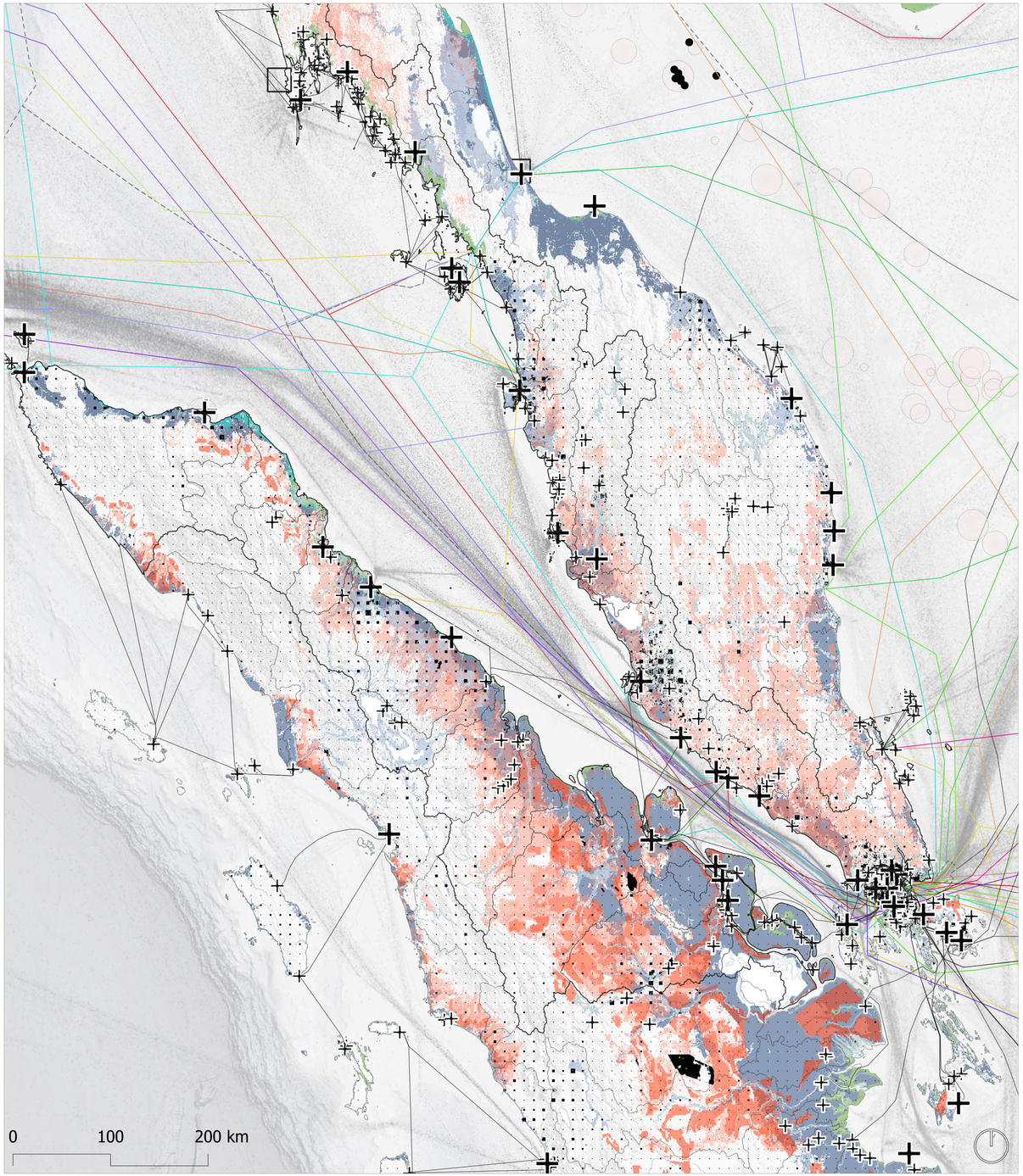
Within the continental Sunda shelf that contains the Malacca Strait, the depth rarely goes beyond a depth of 200 meters. The bathymetry of the Strait highlights in red the depth of 23 meters, the area that allows for industrial shipping to safely navigate the area.

Elevation sections on the right show the differences in depth between the Sumatran and Malayan side of the Strait. The shallow body of water requires ships of Malaccamax size to pass through the deepest areas of the Strait, which are dominantly towards the Malaysian coast. This is shown by the red lines, visualising the Traffic Separation Scheme (TSS) around Singapore.

Shipping sizes around the globe are restricted by the smallest bottlenecks it has to navigate, exemplified by names of sizes such as Suezmax and Panamax, indicating the maximum depth and width of ships to safely pass. Malacca Max ships are being speculated as a new possible biggest size of vessel, but would not yet suit current ports as infrastructure does not respond to that size (yet).





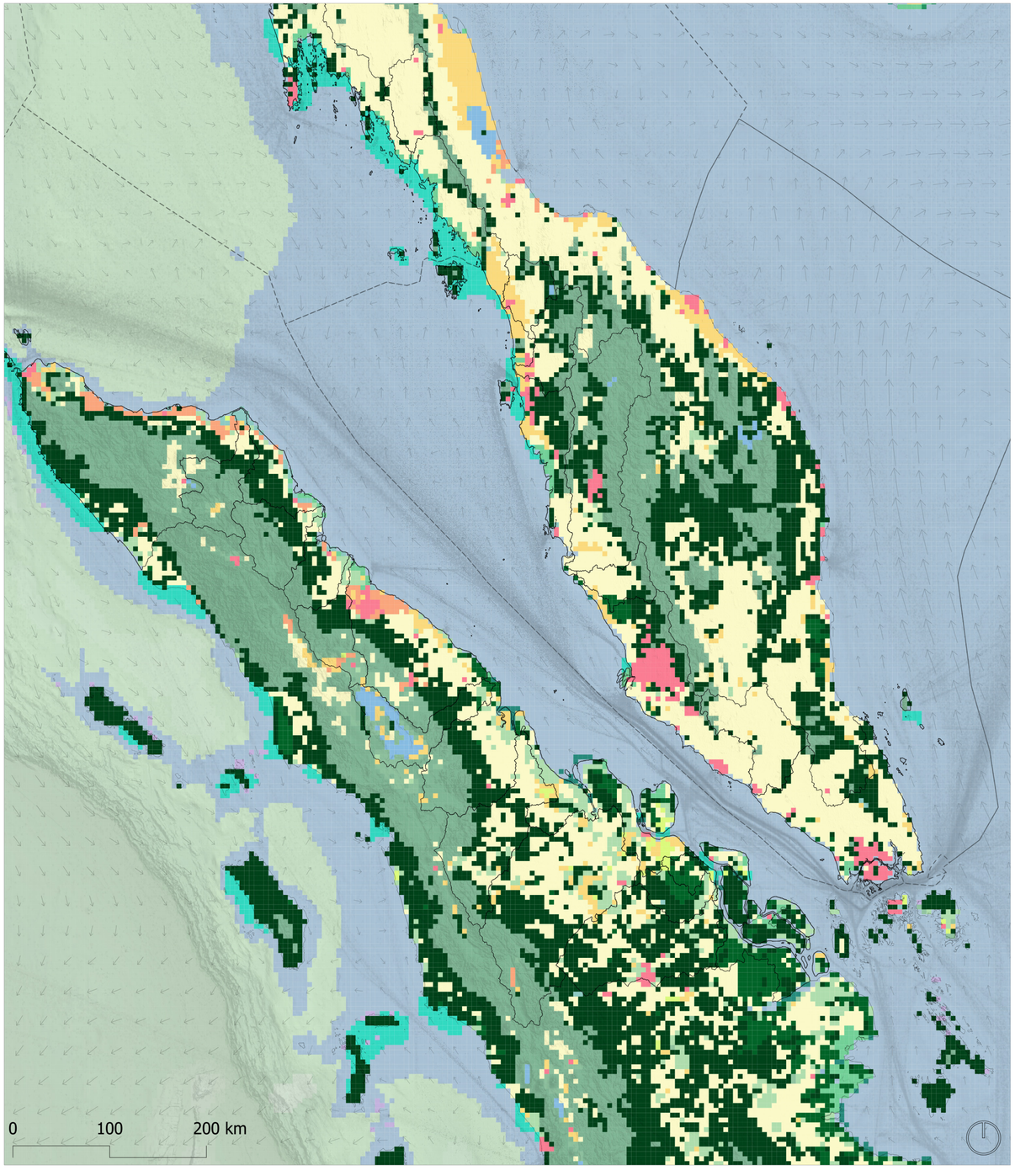


Land Use

The land usage around the Malacca Strait is defined by extraction, and has been like this for a long time, ever since colonialism. This includes ports, industrial areas, industrial agriculture but also infrastructure embedded within the Strait, clouding the perception of the water as a natural element.

The map highlights different water-related land uses either causing or receiving risk from system alterations such as pond aquaculture, mangroves, palm oil plantations and wetlands.

ferry_terminal
Ferry route
Palm oil plantation
Wetland
Mangrove
Pond Aquaculture
Commercial land use
Natural_Gas_Flaring_Detections
0 - 128
128 - 222
222 - 361
361 - 572
572 - 994
994 - inf
Offshore Platforms
Petroleum Terminals
Population Density
0 - 127
127 - 433
433 - 1228
1228 - 2962
2962 - 5847
5847 - 10741

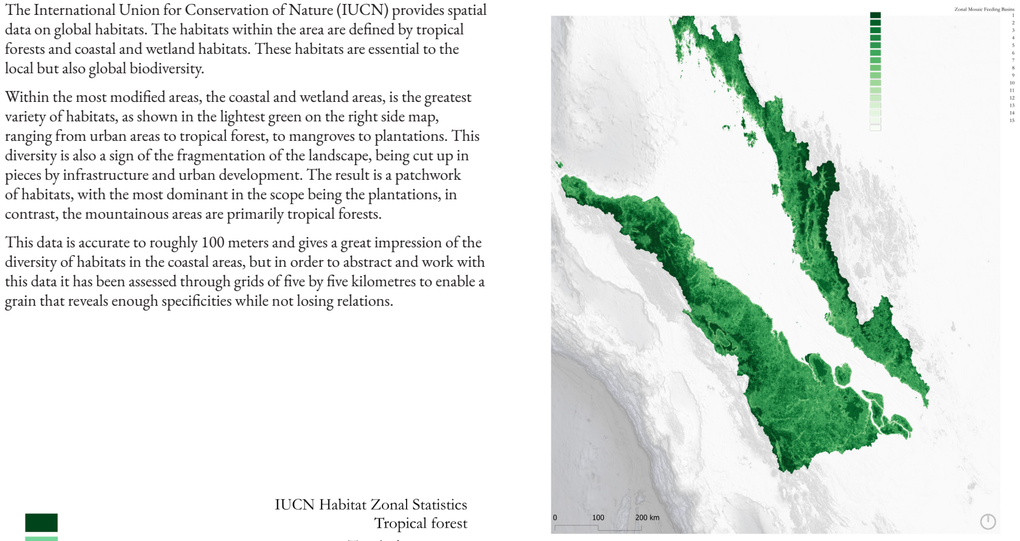


Habitat

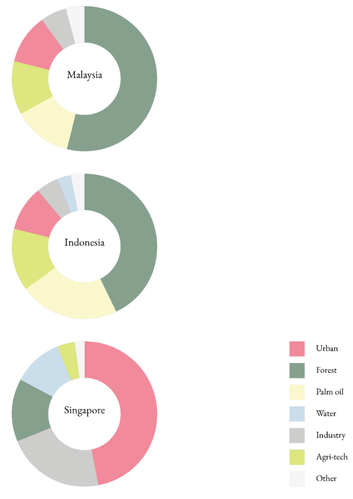
The International Union for Conservation of Nature (IUCN) provides spatial data on global habitats. The habitats within the area are defined by tropical forests and coastal and wetland habitats. These habitats are essential to the local but also global biodiversity.

Within the most modified areas, the coastal and wetland areas, is the greatest variety of habitats, as shown in the lightest green on the right side map, ranging from urban areas to tropical forest, to mangroves to plantations. This diversity is also a sign of the fragmentation of the landscape, being cut up in pieces by infrastructure and urban development. The result is a patchwork of habitats, with the most dominant in the scope being the plantations, in contrast, the mountainous areas are primarily tropical forests.

This data is accurate to roughly 100 meters and gives a great impression of the diversity of habitats in the coastal areas, but in order to abstract and work with this data it has been assessed through grids of five by five kilometres to enable a grain that reveals enough specificities while not losing relations.



IUCN Habitat Zonal Statistics
Tropical forest
Tropical mangrove
Tropical swamp
Tropical mountain forest
Tropical shrubland
High altitude tropical shrubland
Tropical grassland
Wetlands
Permanent rivers
Permanent freshwater lakes
Permanent freshwater marshes
Permanent inland deltas
Marine neritic
Coral reef
Seagrass
Continental slope/bathyl zone
Abyssal plain
Abyssal mountain
Seamount
Marine intertidal
Arable land
Pastureland
Plantations
Rural gardens
Urban areas



Land use per country



Ships near Dumai, Indonesia (Google Earth Pro, n.d.)



Dynamic coastline, Malaysia (Google Earth Pro, n.d.)



Reclamation project, Malaysia (Google Earth Pro, n.d.)



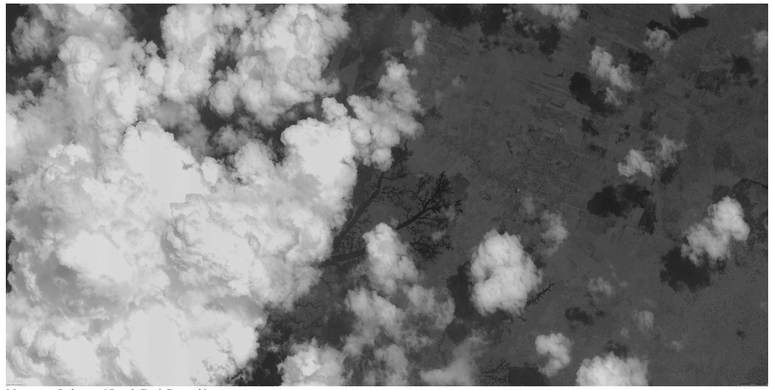
Agricultural fields, Malaysia (Google Earth Pro, n.d.)



Oil tankers off the shore off Malaysia (Google Earth Pro, n.d.)



River sediments, Indonesia (Google Earth Pro, n.d.)



Mangroves, Indonesia (Google Earth Pro, n.d.)



Mangroves, Indonesia (Google Earth Pro, n.d.)



Cleared palm oil plantations, Indonesia (Google Earth Pro, n.d.)



Coastal urbanisation, Indonesia (Google Earth Pro, n.d.)



Palm oil plantation drainage into the Strait, Indonesia (Google Earth Pro, n.d.)



Horseshoe remnants, Indonesia (Google Earth Pro, n.d.)



Contrast between urban and natural, Indonesia (Google Earth Pro, n.d.)



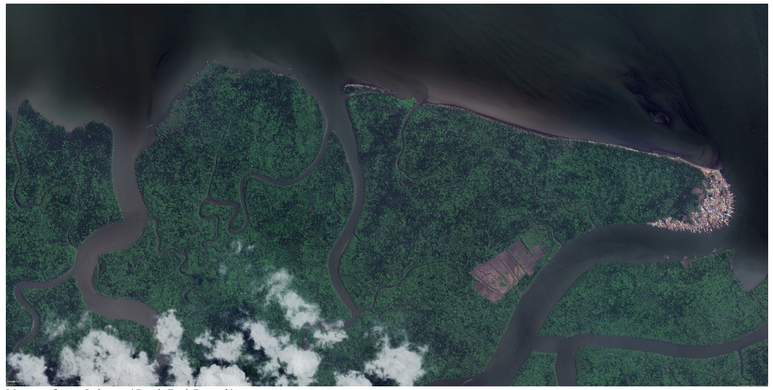
Mangrove forest, Indonesia (Google Earth Pro, n.d.)



Port of Belawan contrasts, Indonesia (Google Earth Pro, n.d.)



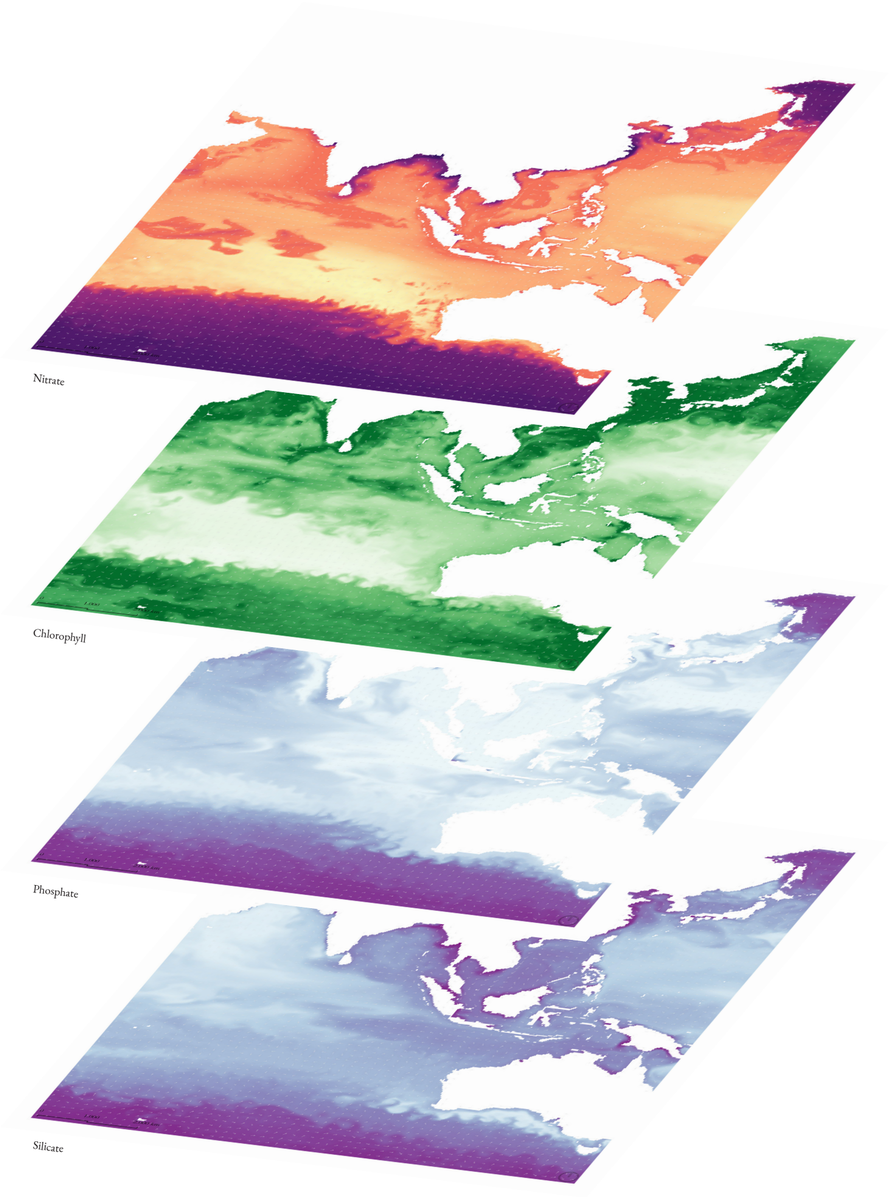
Aquaculture coast, Indonesia (Google Earth Pro, n.d.)



Mangrove forests, Indonesia (Google Earth Pro, n.d.)



Coastal urbanisation, Indonesia (Google Earth Pro, n.d.)



Global natural systems that enable life within the Malacca Strait

Malacca Strait as part of the Critical Zone

Various maps show how the Strait of Malacca is a part of the Critical Zone, which functions not only on the local, but also global scale. Life in the Strait is part of and defined by various natural systems. This criticality of the natural systems is vital but not spatial, although effects of disruption can be felt, the systems supporting the area are mostly overlooked and go unrecognised by its human inhabitants.

These maps show the various natural systems that enable life within the Strait of Malacca and the extended interconnected area. These systems and processes are being affected by the use of the Strait as a global infrastructure.

Conclusion

"How have anthropogenic activities altered the Malacca Strait's natural systems?"

Throughout history, ever since the start of global maritime trade between Asia and Europe, the Strait of Malacca has been altered for the sake of improving navigability. It has been altered continuously in service of a global infrastructure that prioritises navigability over ecological integrity.

The anthropogenic activities related to this globalist infrastructure, started by colonial powers reinforcing its strategic position through the construction of ports and territorial control, heavily affected the functioning of the natural systems as mentioned by Orr et al. (2021). This way of transformation, over centuries, has resulted in destructive consequences for natural systems that affect all inhabitants of the area.

From a global perspective, the Strait functions as a logistical bottleneck, where all interest have become secondary to the global economy. The related expansion of infrastructure on the coastal and further inland areas has resulted in a dependency of the countries on its success.

From the local perspective, the area is under mounting pressure from all sides. With coastal and wetland habitats such as mangroves, sea grass meadows, coral systems, estuarine wetlands and mudflats playing a major role not only on the local natural system, but also on a bigger scale of interdependent systems.

The pressures are not only from the shipping at sea but also come from the inland water system. With ever increasing amounts of palm oil plantations around the Malaysian Peninsula and Sumatra, it has completely transformed tropical forest and peat land areas into mono-cultural agriculture landscapes. Altering the hydrological systems that regulate the natural system.

In the current situation, the results of the consequences are unevenly distributed, with human and more-than-human values not represented within current usage of the Strait.



View on the Strait of Singapore (Batam, Indonesia)

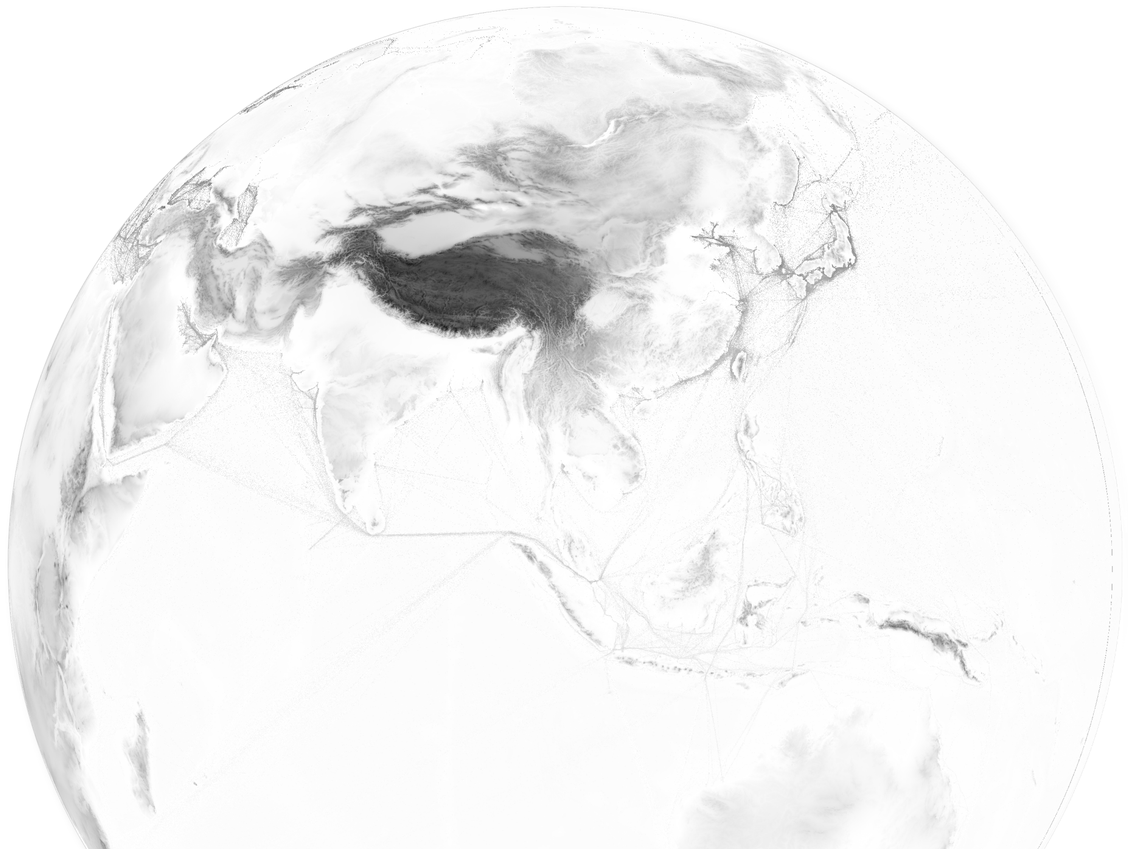






View from Penang Hill, with the reclamation of Andaman Island on the left (Penang, Malaysia)

Risk, for who?



Sub-research question 2

Ecological System Alterations
"How are disrupted natural systems affecting the inhabitants of the Malacca Strait?"

Previously discussed disruptors of natural systems are related to a global perspective of the Malacca Strait as a global infrastructure. The affected natural systems are mostly related to the transformation and maladaptation of the water systems, which in turn result in a variety of risk for all inhabitants of the area. Resulting in a cascade of risk, the multiplication and enhancement of various types of risk together, resulting in amplified risk for all. When talking about climate change and the disruption of various natural systems, intensification of land uses and more, these factors by itself are causing certain risks but when combined they become disastrous. To counteract this, a better understanding and management of risk is essential to go towards a robust system that has all of the inhabitants' interest in place.

Critical distance reveals relational (a)symmetries of risk and recognition of actors on different scales. Showing a clear prioritisation of global and supra-national interest over the interests of local communities and the more-than-human entities.

By using critical proximity, the local affectation as a result of this prioritisation is revealed, displaying the actors which are currently valued in governmental policies.

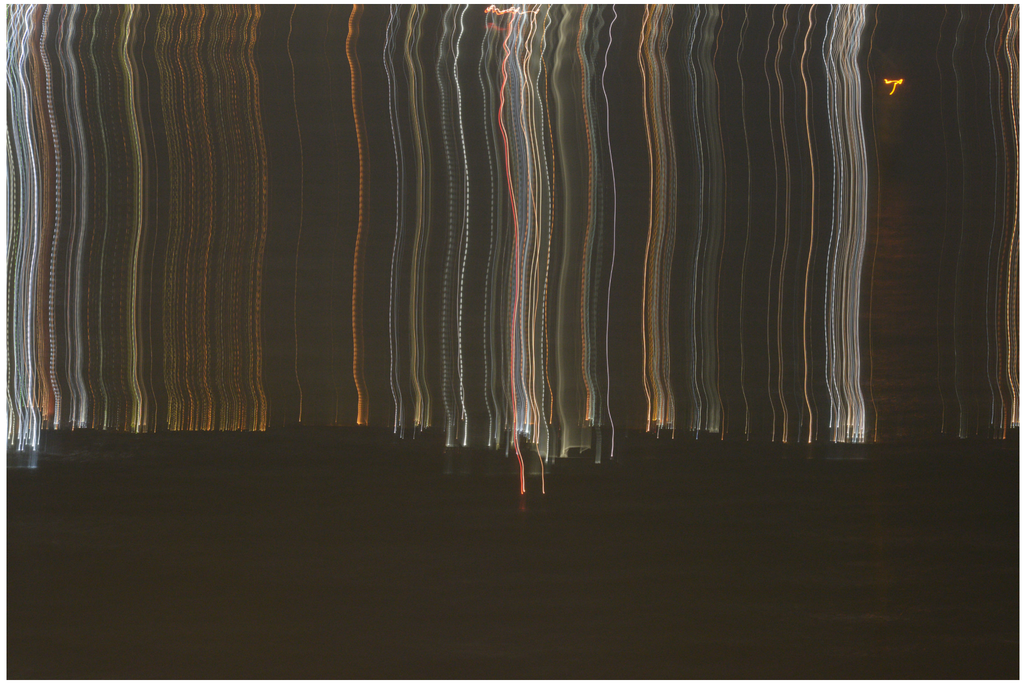
The next photographs will show the various anthropogenic disruptive practices within the area.

Care is not about fusion; it can be about the right distance

- Puig de la Bellacasa (2017)



Local fisherman walking to his boat, the George Town Port in the background (Penang, Malaysia)



Boats at night in the Singapore Strait (Singapore, Singapore)



Boats at night in the Singapore Strait (Singapore, Singapore)



Hard coastal defence against erosion (Batam, Indonesia)



Cut mangroves litter the reclaimed beach (Batam, Indonesia)



Palm oil plantation mill along the coast (Dumai, Indonesia)



The port of Bengkalis (Bengkalis, Indonesia)



Urbanisation along the coast (Bengkalis, Indonesia)



Industry along the coast (Dumai, Indonesia)



A remnant of nature amidst the palm oil plantation (Selat Panjang, Indonesia)





Construction of Silicon Island (Penang, Malaysia)



Singapore port seen from Ridge Park (Singapore, Singapore)



Singapore's petroleum island (Singapore, Singapore)



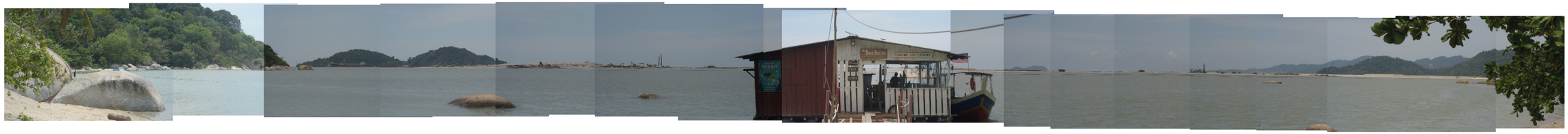
A lone mangrove in Malacca (Malacca, Malaysia)



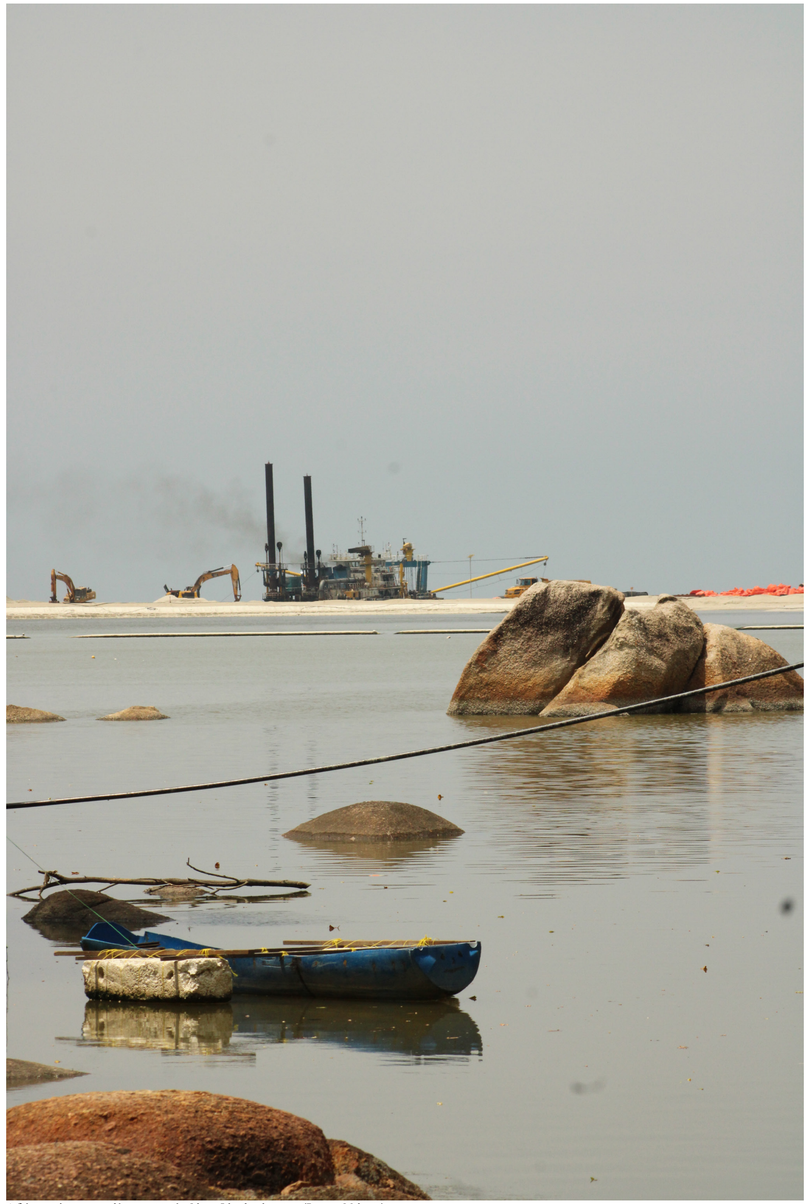
Banks of dredged sand in Malacca (Malacca, Malaysia)



Port industry next to residential housing along the coast (Butterworth, Malaysia)



A stitched image of the reclamation of Silicon Island seen from Essen Beach (Penang, Malaysia)



A fisherman's improvised boat next to the Silicon Island reclamation (Penang, Malaysia)

"This historical moment — rendered earlier by euphemisms such as "ecological crisis" or "climate change" — now would best be taken as an existential crisis, a matter of life and death."

- Latour



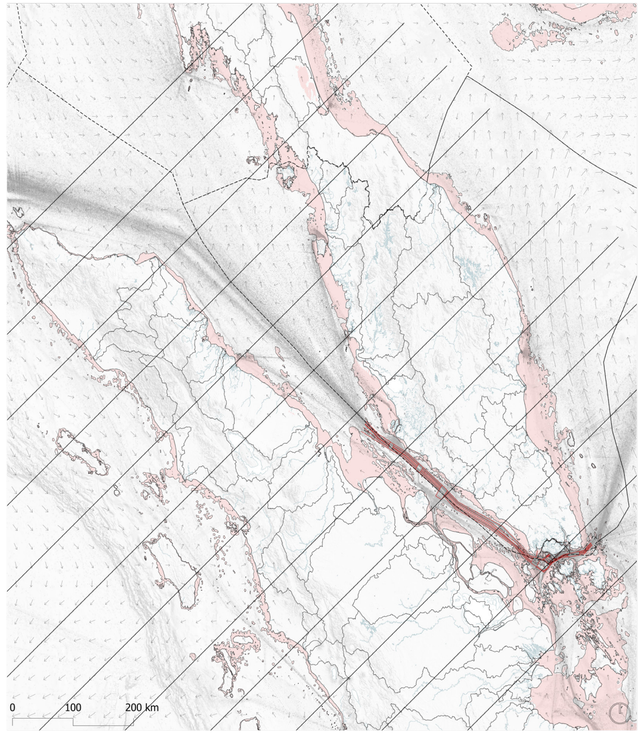
Andaman island reclamation at work, seen from Penang Hill (George Town, Malaysia)

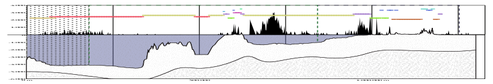
Fragmentation of the Strait

The sections show the various fragmenting elements, ranging from the Extended Economical Zone (EEZ) to the TSS, to the morphology of the Strait.

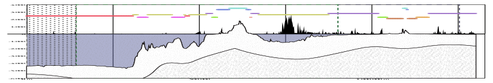
All these element have shaped or are currently shaping the differences between the littoral states of Malaysia, Indonesia and Singapore.

The importance of Malacca can be traced back to early global trade, this has fed a further dichotomy between the two countries of Malaysia and Indonesia. Reinforced by natural morphology that shaped optimal routes for navigability and possibilities for infrastructure.

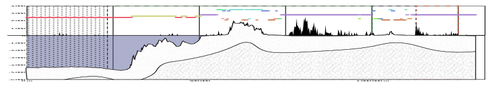




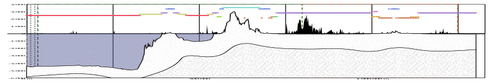
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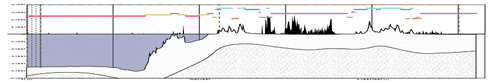
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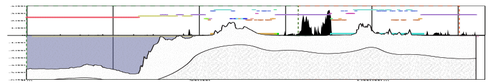
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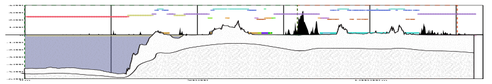
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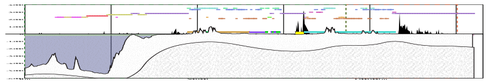
Section 5



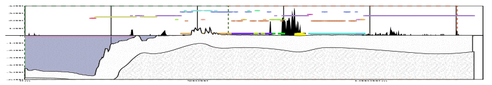
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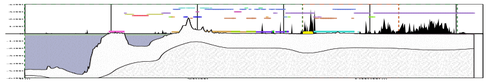
Section 7



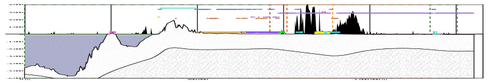
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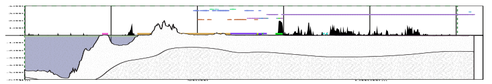
Section 9



Section 10



Section 11



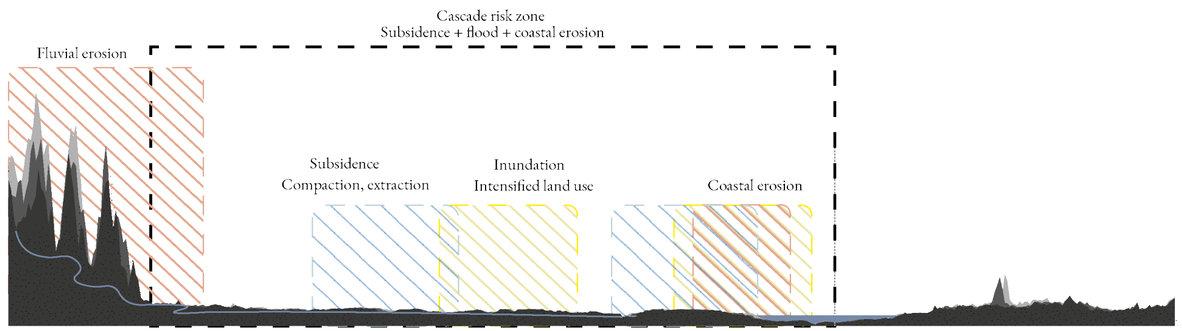
Section 12

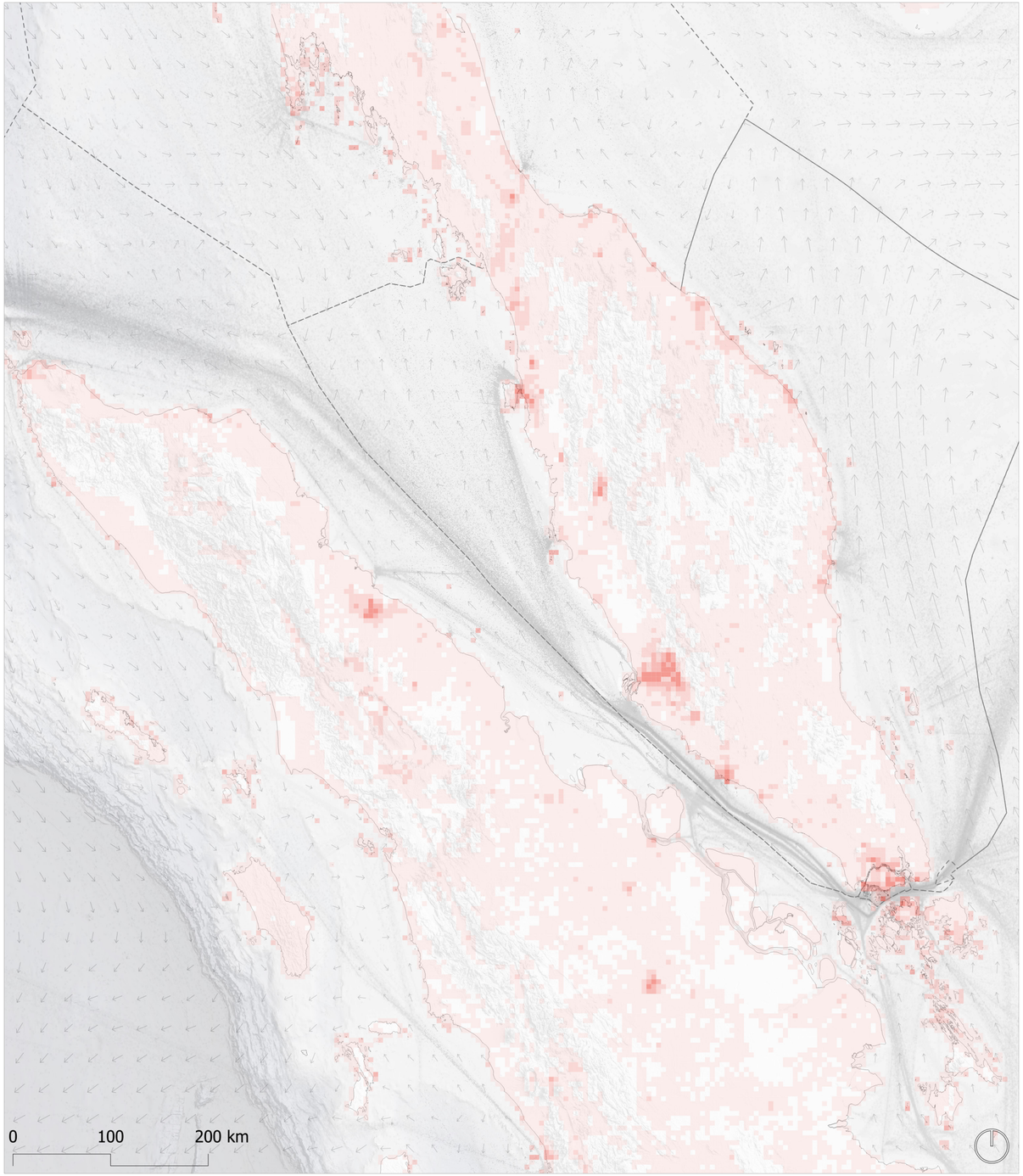
Water-related risks

Human modification is found mostly in the lower areas of the river basins, with the coastal modification in stark contrast with higher up located areas. Most of the modification is linked to urbanisation, industrialisation and agriculture.

And on the other hand, risk is also coming from the Strait itself, both from its users as well as the natural systems it contains.

Coastal areas are at the intersection of risk coming from both the terrestrial as well as the marine. Both of these dimensions bring about risk related to water, such as inundation, erosion and subsidence.





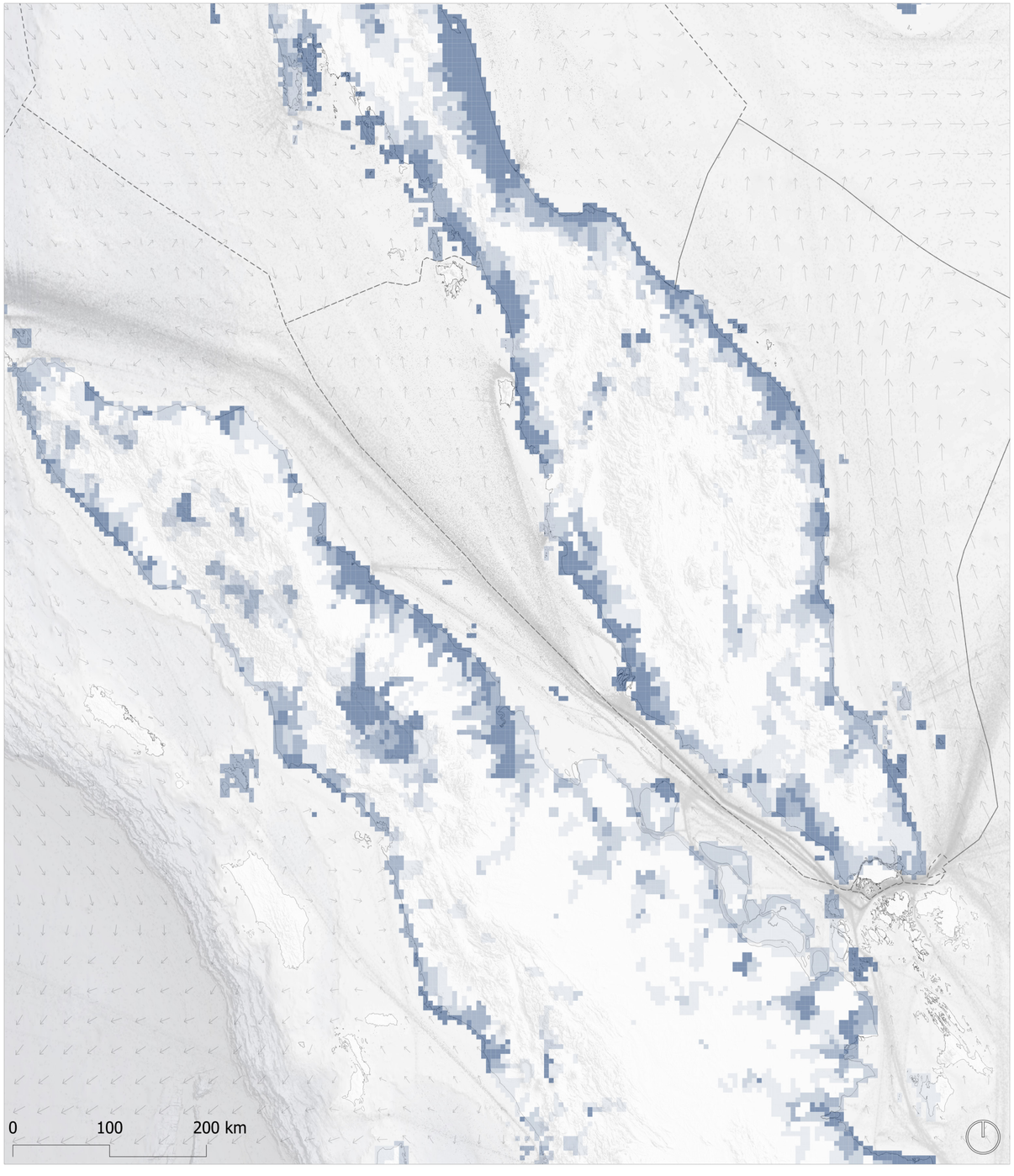
Erosion risk

Erosion is the risk of the likelihood of soil or land being worn away by natural and human activities. With natural causes such as tides, wind, waves, being amplified by human modification that diminishes natural protection and overexploitation of these areas.

Clear example of this risk can be seen in the Malaysian city of Malacca, where several coastal reclamation projects suffer from erosion due to a lack of protection from natural and human entities.

Erosion is seen around major urban centres in the area, such as the capitals of Medan, Kuala Lumpur and Singapore as well as further inland, likely related to the changes of land use to intense agriculture.

Erosion Zonal Statistics
0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1



Inundation risk

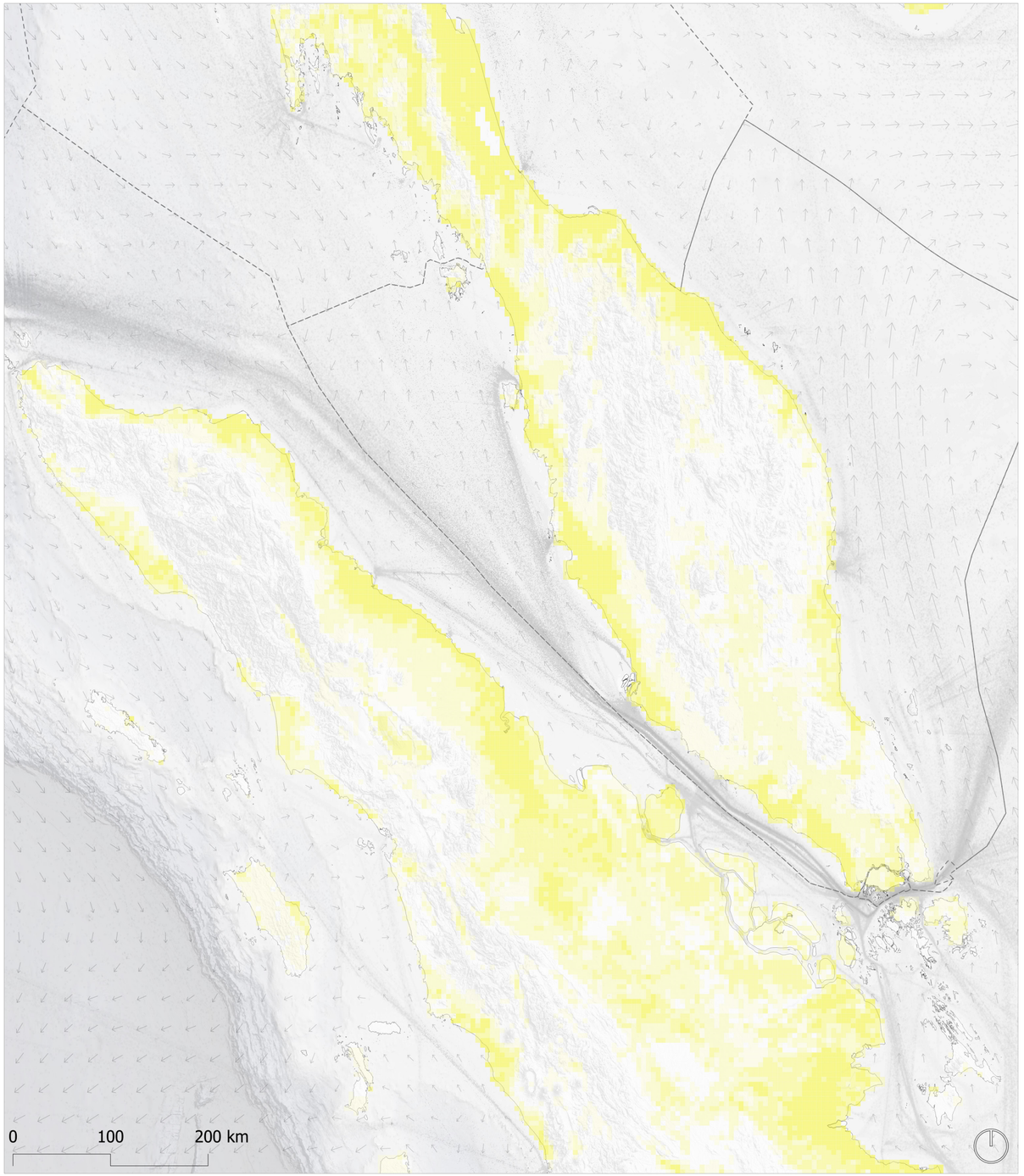
Inundation is a risk related to the likeliness of the submergence of an area by water. This risk and its potential harm depend on the geomorphology of a place as well as the proximity of coastlines, rivers or other water elements.

In the current management of the area, the issue of inundation is often overlooked, while it happens often that large areas flood, the intensity and occurrence are increasing. One of the main causes is the diminishing retention potential of the area by drainage of wetlands as well as the urbanisation of coastal areas that disrupt both human and natural flood defence systems.

Seen in the map is that most risk of inundation is located around the coastal areas, with wetland areas only faintly showing up due to retention capacity.

Inundation Zonal Statistics

0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1



Subsidence risk

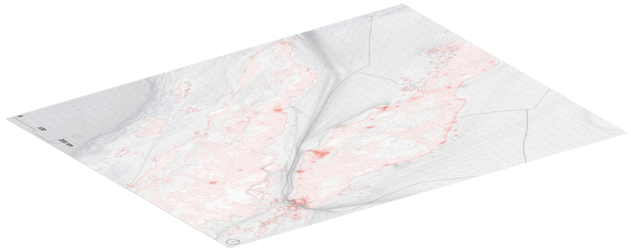
The risk of subsidence is caused by the sinking of soil due to extraction of groundwater, making it unstable and causing damage to infrastructure, urban areas and natural habitats.

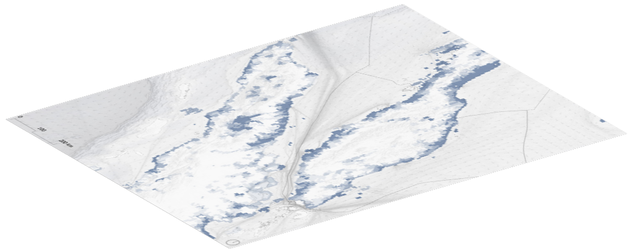
Many wetland and coastal areas are dealing with subsidence due to the intensified use of these areas.

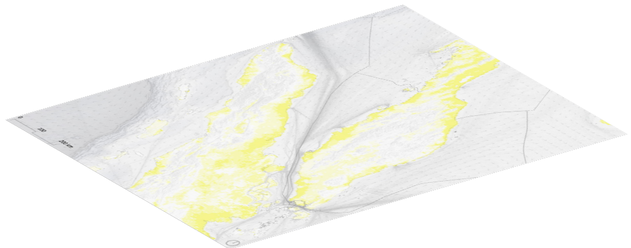
Subsidence most affected regions such as urban and industrial zones, indicating a strong correlation with anthropogenic activities as mentioned by Sidiq et al. (2025).

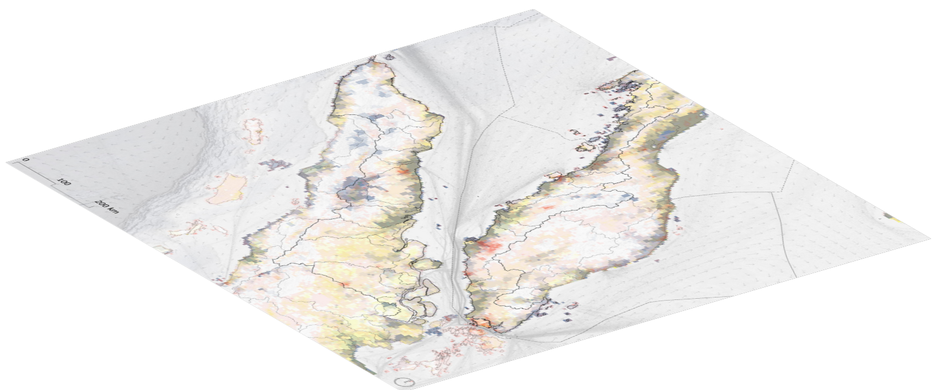
In the case of the Malacca Strait, subsidence is primarily caused by draining wetland and peat land areas for agriculture such as palm oil plantations, causing increased water management problems and flooding.

Subsidence Zonal Statistics
0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1



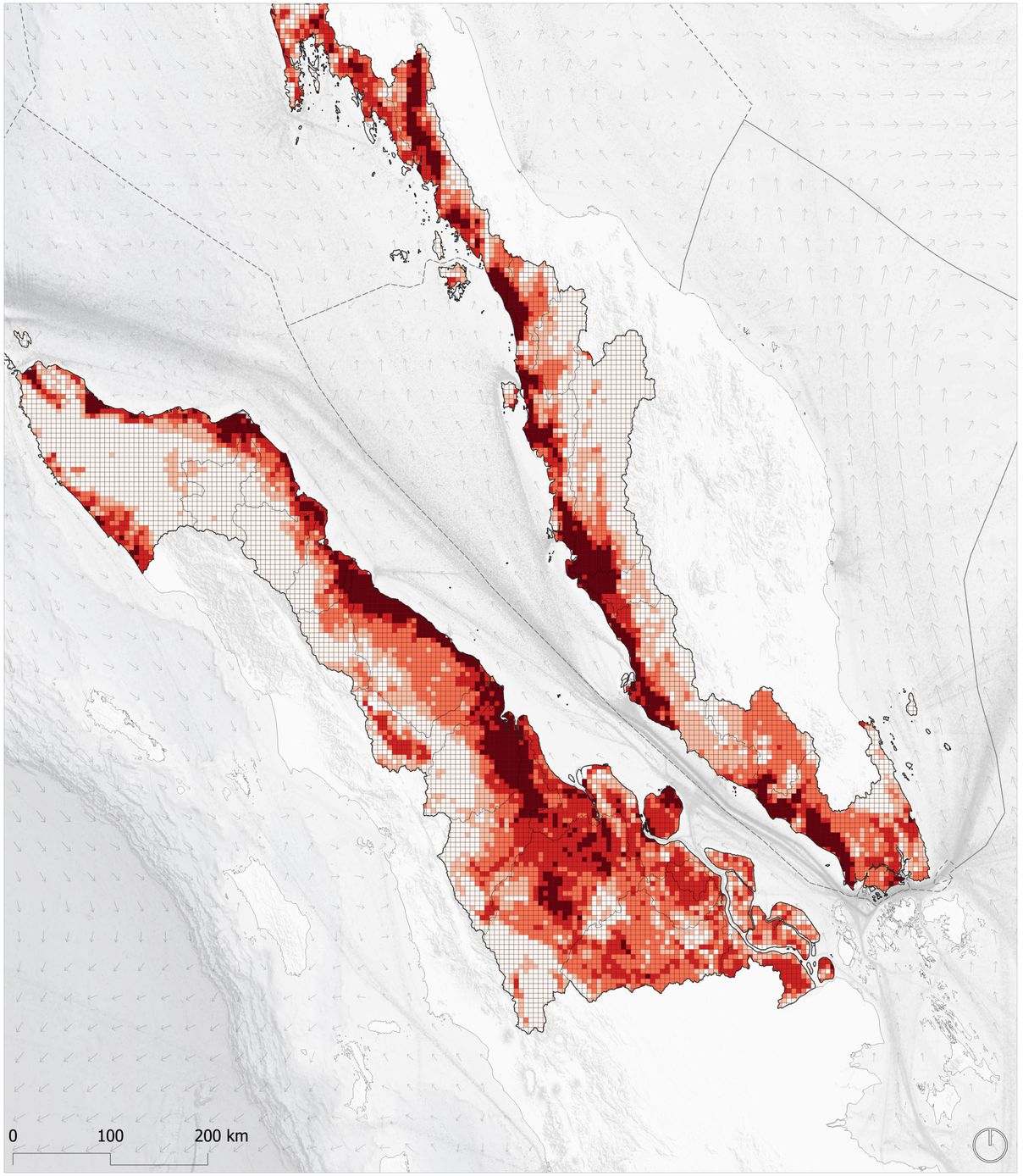






A cascade of risk, for who?

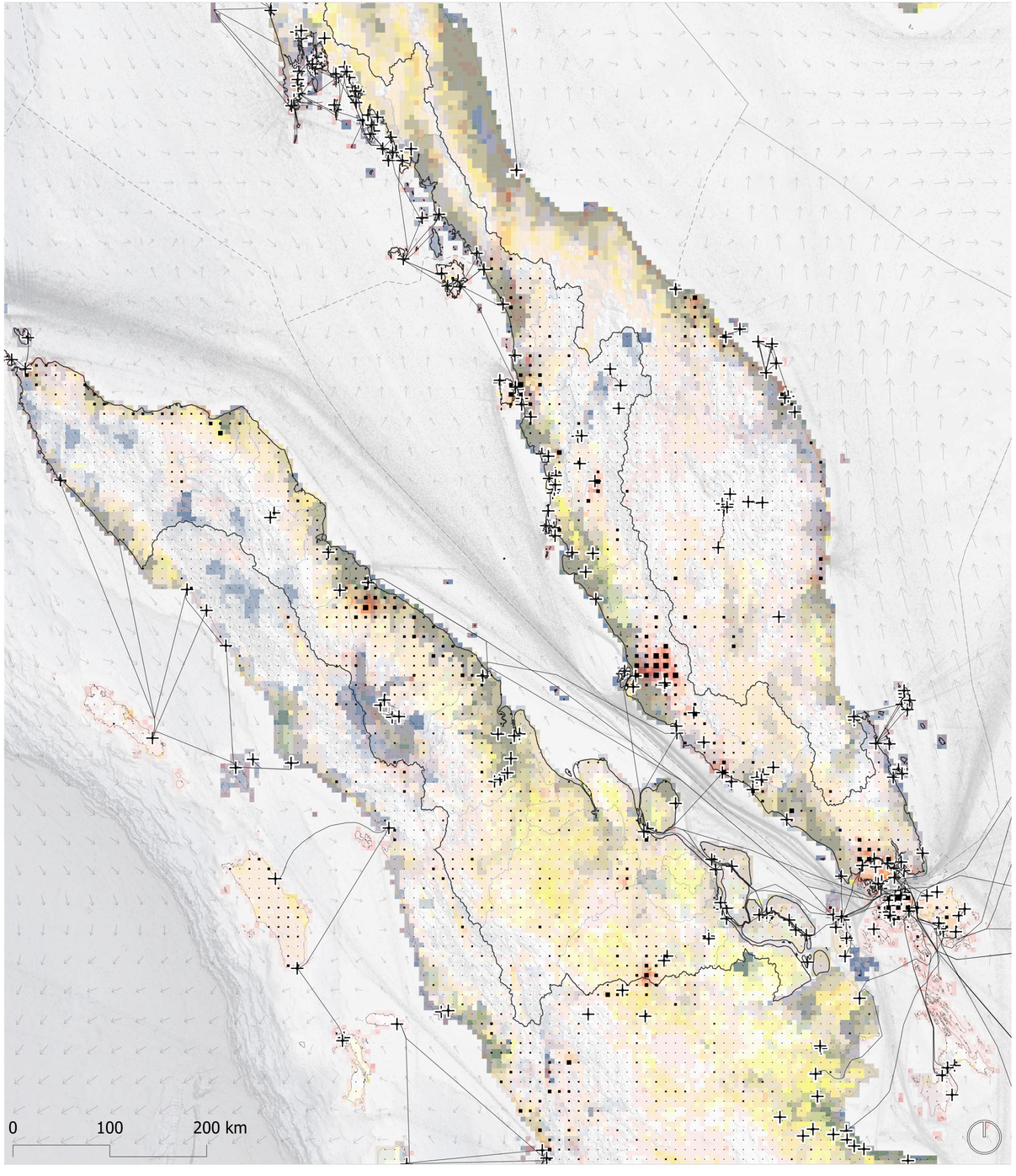
Every area is exposed to at least one type of risk, with some affected by a cascade of risk, amplifying the effects even further. This begs the next question, who is at the receiving end of this risk?



Total risk

This map shows the three risks overlapped and scored again from zero to one, showing the areas with the highest total risk mostly located around coastal and wetland areas.

Total risk Zonal Statistics
0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1



Risk types

Combined map of all the risks showing them related to the various uses of the coastal and wetland areas.

Ferry route

Erosion Zonal Stat
0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1

Subsidence Zonal Statistics
0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1

Inundation and Discharge
0 - 0,2
0,2 - 0,4
0,4 - 0,6
0,6 - 0,8
0,8 - 1

Population Density Grid 10km
0 - 127
127 - 433
433 - 1228
1228 - 2962
2962 - 5847
5847 - 10741

Feeding basins outline
FeedingBasins_MS_lvl6

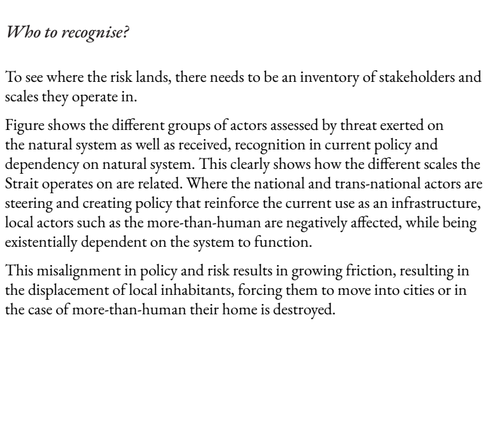
Who to recognise?

To see where the risk lands, there needs to be an inventory of stakeholders and scales they operate in.

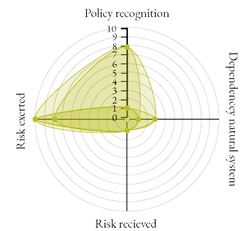
Figure shows the different groups of actors assessed by threat exerted on the natural system as well as received, recognition in current policy and dependency on natural system. This clearly shows how the different scales the Strait operates on are related. Where the national and trans-national actors are steering and creating policy that reinforce the current use as an infrastructure, local actors such as the more-than-human are negatively affected, while being existentially dependent on the system to function.

This misalignment in policy and risk results in growing friction, resulting in the displacement of local inhabitants, forcing them to move into cities or in the case of more-than-human their home is destroyed.

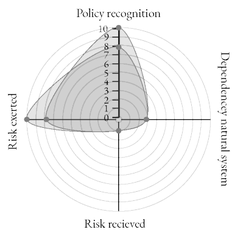
Actor



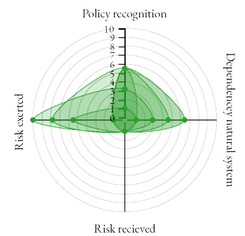
Private sector



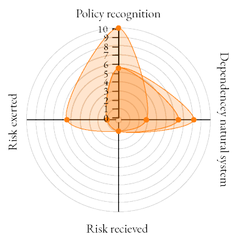
Private / public



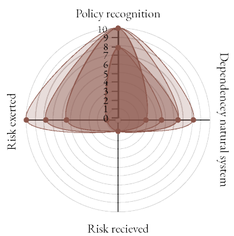
International governance



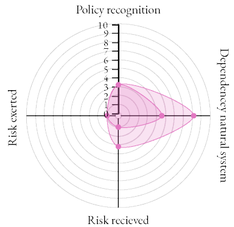
Intergovernmental



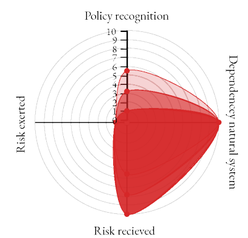
National government



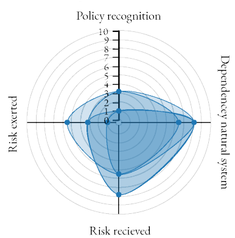
Non-governmental



More-than-human



Civil society



Actor diagram showing threat exerted, received, recognition and dependency on natural system per actor domain

Conclusion

"How are disrupted natural systems affecting the inhabitants of the Malacca Strait?"

Water-related risks, caused by human disruptions of the natural systems within the Malacca Strait, drive a further wedge between the local and global perspectives in the area, resulting in a cascading risk on the local while enforcing the status quo on the global.

The disruptive practices have to be reacted to in a way that recognises the local affectation and specificities.

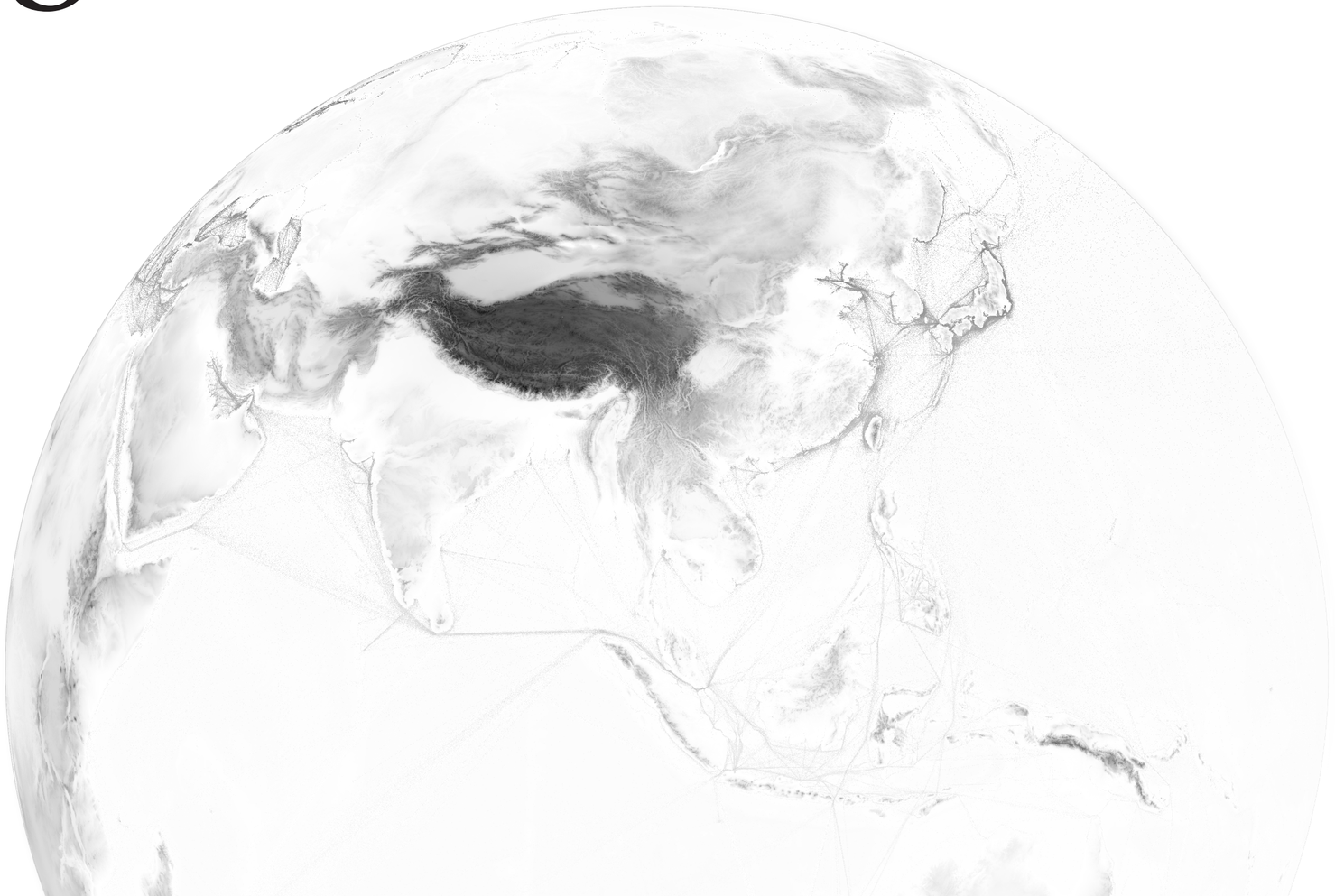


Rohingya informal settlement next to Silicon Island reclamation site (Penang, Malaysia)



Andaman island reclamation project (Penang, Malaysia)

How do we manage?



Sub-research question 3

Current governance systems and (mis-)alignment
"How are current policies managing the coastal and wetland areas and more-than-human systems?"

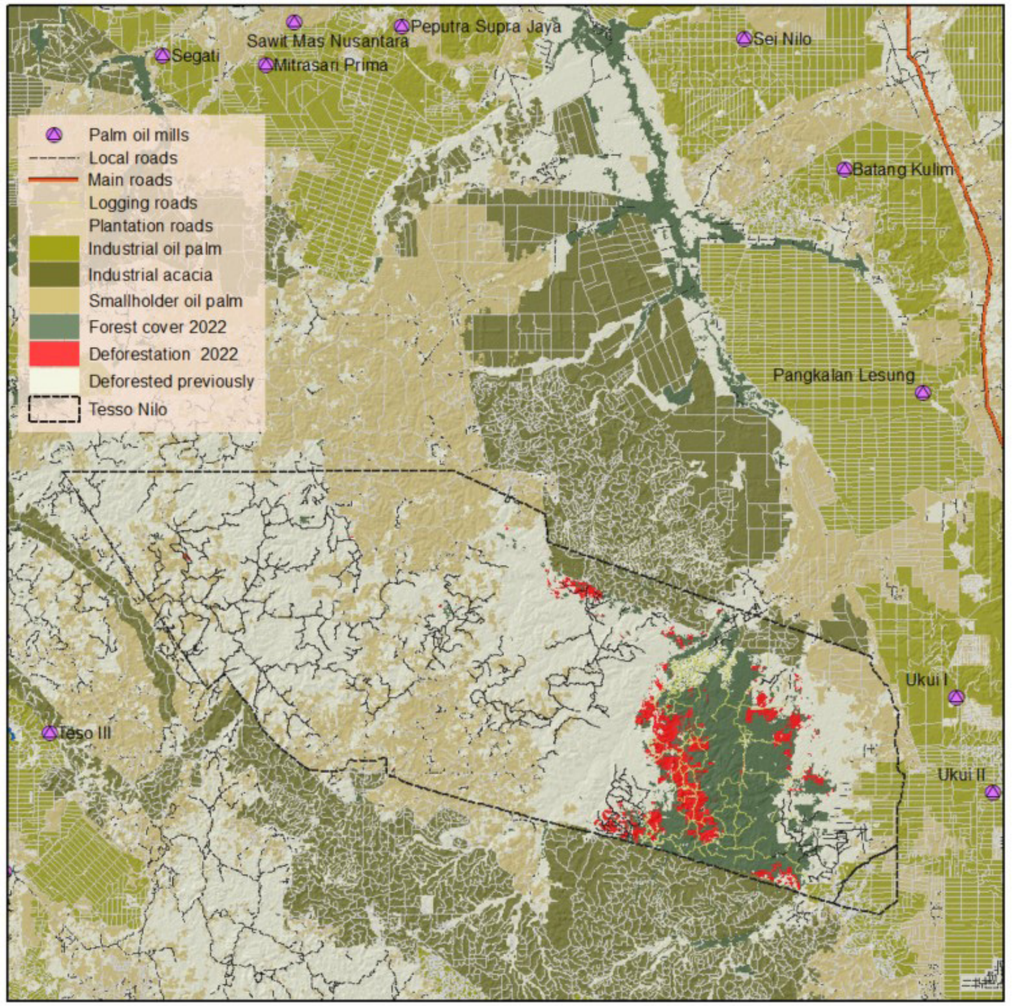
Within the Littoral States of the Malacca Strait there are plenty of policies that support the recognition of natural entities or systems in one way or another, but many of these frameworks still privilege territorial sovereignty, economic functionality, and human-centred utility over interrelated ecological systems that cross political borders. This chapter shows the interrelationships, power balances and recognition of actors within the current management of the area.

When looking at recognition of the more-than-human, most of the times it land in the protection of natural areas such as national parks or other conservation sites. One of those examples is Tesso Nilo in Sumatra, Indonesia. It was declared a National Park in 2004, created to protect one of the last remaining patches of natural forests on Sumatra. It contained multiple critically endangered species such as Sumatran elephant, tiger and more. But over the last 20 years, the park has lost 80 percent of its forest area due to deforestation, most of it used for illegal palm oil plantations.

This clear example of a moral ambition, with no actual physical effort to act on, shows there is a clear gap in a lot of policies related to recognition of the more-than-human.

Nations assign protected areas, according to the various values of supporting programs such as RAMSAR, WDPA and more. These programs assign areas with valuable ecological regions and conservation demands, they are however also limited in their goal. The protection of these areas is done on an international level but its execution comes down to local spatialisation of the policy, which often times holds back its effectiveness by not recognising effects of degradation outside of the designated areas. This results in further fragmentation of ecological networks that sustain them.

Assigned protected areas tend to prioritise segmented species or areas rather than interconnected systems and cycles. To expand the role these areas can play they need to be integrated into larger scale networks of interconnected systems as well as cross-boundary.



The Vanishing Forests of Tesso Nilo National Park (Nusantara Atlas, 2022)

Current policies and programs

Integrated River Basin Management (IRBM)

The concept of source-to-sea management is being piloted by several ASEAN countries, with one even being applied to the Peninsular Malaysian river basin of Kedah. Integrated River Basin Management (IRBM) proposes a holistic approach to the management of river systems by integrating land, water and resource management across a complete basin. This proposes a shift away from fragmented sectoral governance per administrative area such as a province or municipality, but recognises a relationship between upstream and downstream systems.

However, despite this acknowledgement of the hydrological importance, IRBM still remains human-centred and bound by administrative boundaries. River basins are mostly addressed as a resource to be managed for economic productivity and human security. The more-than-human actors and systems are overlooked and not recognised as actors with specific demands.

Source-to-sea ends at the mouth of the river, a proposal for the new spatial framework would be to extend the agency of the IRBM into the Strait and eventually across the EEZ, making it into a qualified scale to address the interconnected system instead of isolated variables. Water management inherently crosses administrative boundaries and needs to be dealt with effectively from both a transnational perspective.

It also proposes a shift in agency, seeing communities not merely as stakeholders, but as caretakers. By proposing communities as stakeholders, they are not given agency to take upon them the care of new implementations, Furthermore is does not touch on the Rights of Nature, recognising only the value to humans but not the intrinsic value.

Integrated Coastal Management (ICM)

The emergent framework of integrated coastal management is used to coordinate the sustainable development of coastal areas with overlapping administrative boundaries. It requires a high level of cooperation between various interests of sectors, stakeholders and government.

Various plans have been drafted along the Indonesian coast to bridge the governance of the terrestrial and marine, but in practice it has led to hard distinctions between them as well as failure to result into implementation. Territories are managed according to economic zoning and risk adaptation, while natural systems and entities are overlooked. The coast is seen as an edge to protect rather than a dynamic interface of land and water.

An expansion of the ICM model could provide recognition of the more-than-human actors and system that go beyond the administrative borders. Requiring a transformation of management, one that accounts for systems and processes such as seasons, sediments and multi-species habitation and migration. Rather than managing the coastline as a static element, the expanded governance should cooperate across borders and with recognition of interdependencies.

Nature based solutions (NbS)

Nature based solutions (NbS) address various societal challenges by applying different practices to protect, manage and restore natural and modified ecosystems. They are already being adopted by multiple supranational organisations such as the EU and ASEAN, posing as more durable solutions to the crises they are facing. But, NbS are mostly implemented in a top-down process, resulting in a lack of long-term effectiveness. It requires participatory frameworks in order to function and navigate competing interest as posed by Olivadese (2025).

In order to make NbS into drivers of systemic transformation, a long term system of care is needed. With both a shift in agency, as well as a governance structure that is dynamic. Recognising the changing conditions and more-than-human actors results in a situated implementation that connects to the local, while being supported by the (supra-)national.



Integrated River Basin Management Project (PEMSEA, 2023)

UNCLOS

United Nations Convention on the Law of the Sea, is a legal framework that has been established in 1982, that governs the maritime space. It has put forward legal structures on sovereignty, navigation rights and resource access for states bordering Straits such as that of Malacca.

The convention has provided the Littoral States of the Malacca Strait with the regulation of shipping routes and resolving of conflicts within the corridor.

At the same time, UNCLOS reinforces the system of global maritime infrastructure, enabling it by providing supportive legal articles such as the figure on the right. These articles state that Straits are bottlenecks within shipping and serve a global interest. It also states that shipping can be impeded when causing environmental damage, but this rarely gets enacted on because the main part of the economy of Littoral States is heavily reliant on the shipping industry.

While environmental protection exists, it remains secondary to economic functionality. This results in limitations when addressing ecological systems that go beyond boundaries, as well as within.

To expand and transform the legal framework of UNCLOS, alignment of policy, values and recognition has to be achieved between all member states.

The marine environment is not contained or limited to administrative boundaries such as EEZs, but are functioning on a wide range of scales. To enable the UNCLOS as a foundation for the transformative pathway to a robust system, the limiting articles on Straits and marine areas should be expanded to include recognition of cross boundary systems, going from the source of rivers to the various depths of the oceans. Such approach would go beyond the Strait as a global infrastructure, and towards the Strait as a part of the Critical Zone. Providing normative backing by policy on the local scales.

Article 40
Research and survey activities

During transit passage, foreign ships, including marine scientific research and hydrographic survey ships, may not carry out any research or survey activities without the prior authorization of the States bordering straits.

Article 41
Sea lanes and traffic separation schemes in straits used for international navigation

1. In conformity with this Part, States bordering straits may designate sea lanes and prescribe traffic separation schemes for navigation in straits where necessary to promote the safe passage of ships.
2. Such States may, when circumstances require, and after giving due publicity thereto, substitute other sea lanes or traffic separation schemes for any sea lanes or traffic separation schemes previously designated or prescribed by them.
3. Such sea lanes and traffic separation schemes shall conform to generally accepted international regulations.
4. Before designating or substituting sea lanes or prescribing or substituting traffic separation schemes, States bordering straits shall refer proposals to the competent international organization with a view to their adoption. The organization may adopt only such sea lanes and traffic separation schemes as may be agreed with the States bordering the straits, after which the States may designate, prescribe or substitute them.
5. In respect of a strait where sea lanes or traffic separation schemes through the waters of two or more States bordering the strait are being proposed, the States concerned shall cooperate in formulating proposals in consultation with the competent international organization.
6. States bordering straits shall clearly indicate all sea lanes and traffic separation schemes designated or prescribed by them on charts to which due publicity shall be given.
7. Ships in transit passage shall respect applicable sea lanes and traffic separation schemes established in accordance with this article.

Article 42
Laws and regulations of States bordering straits relating to transit passage

1. Subject to the provisions of this section, States bordering straits may adopt laws and regulations relating to transit passage through straits, in respect of all or any of the following:
   (a) the safety of navigation and the regulation of maritime traffic, as provided in article 41;
   (b) the prevention, reduction and control of pollution, by giving effect to applicable international regulations regarding the discharge of oil, oily wastes and other noxious substances in the strait;
   (c) with respect to fishing vessels, the prevention of fishing, including the stowage of fishing gear;

   (d) the loading or unloading of any commodity, currency or person in contravention of the customs, fiscal, immigration or sanitary laws and regulations of States bordering straits.
2. Such laws and regulations shall not discriminate in form or in fact among foreign ships or in their application have the practical effect of denying, hampering or impairing the right of transit passage as defined in this section.
3. States bordering straits shall give due publicity to all such laws and regulations.
4. Foreign ships exercising the right of transit passage shall comply with such laws and regulations.
5. The flag State of a ship or the State of registry of an aircraft entitled to sovereign immunity which acts in a manner contrary to such laws and regulations or other provisions of this Part shall bear international responsibility for any loss or damage which results to States bordering straits.

Article 43
Navigational and safety aids and other improvements and the prevention, reduction and control of pollution

User States and States bordering a strait should by agreement cooperate:
(a) in the establishment and maintenance in a strait of necessary navigational and safety aids or other improvements in aid of international navigation; and
(b) for the prevention, reduction and control of pollution from ships.

Article 44
Duties of States bordering straits

States bordering straits shall not hamper transit passage and shall give appropriate publicity to any danger to navigation or overflight within or over the strait of which they have knowledge. There shall be no suspension of transit passage.

SECTION 3. INNOCENT PASSAGE

Article 45
Innocent passage

1. The regime of innocent passage, in accordance with Part II, section 3, shall apply in straits used for international navigation:
   (a) excluded from the application of the regime of transit passage under article 38, paragraph 1; or
   (b) between a part of the high seas or an exclusive economic zone and the territorial sea of a foreign State.
2. There shall be no suspension of innocent passage through such straits.

The Rights of Nature has the potential to bring about transformative change, but its implementation reveals a very important challenge: how do you spatialise rights for something which is inherently dynamic, interconnected, and boundary-less? Nature does not consist of static fragmented objects but is in constant flux.

Current rights of nature frameworks too often grant rights to discrete natural elements such as a river, a forest, a species, while overlooking broader interconnected systems that define them. Granting a river rights, but not its catchment, results in the continuation of vulnerability. This fragmented view of nature results not only in limiting the transformative potential but also puts it in an increasingly vulnerable position, by failing the recognition of future uncertain conditions and connections.

This gap of understanding the natural sometimes results in a fixation on the return to the pre-Anthropocene, while natural systems have continued to evolved, despite disruption. This concept of evolutionary resilience is about coping with change by transforming, proposing a way of better considering socio-ecological interdependencies and dynamics (Haider et al., 2021). Attempting to restore a past state, ignores the adaptive capacity of nature and our understanding of it.

By situating rights of nature within the concept of evolutionary resilience, an effective pathway forward can be imagined. Steering the dynamic natural systems to a genuinely robust future, one that steers towards a new equilibrium.

Rights of nature applied in this manner, results in going beyond fixed legal boundaries, to an expanding instrument of recognition and care. It shifts the perspective of relationships between human and nature. Governing at the right scale is essential, risk should be dealt with on the scale it is caused, as well as related to the understanding of the bigger interconnected scales. Policy is not only abstract ambition but also creates the foundation for a covenant of care, a collective commitment to recognise nature as a living partner in a dynamic and equal relationship, with rights inseparable from our responsibility. This covenant of care is important, and needs to be nurtured and tended to, to take root and grow over time.

“Stasis is impossible, and we cannot stop or control the waves of change. The issue is how to navigate the waves of change so as to not be overturned and drowned.”

- Brooks and Agosta (2024c)



Dumai coastal piers, mangrove forest in the background (Dumai, Indonesia)

Malacca Strait Council

The Malacca Strait Council (MSC) was established in 1969 by Japan's Ministry of Transport as a public entity, financially supported by various organisations linked to the petrol and maritime industry. Its formation was driven by Japan's strategic interest in the Strait, as one of the biggest users of the bottleneck. Cooperation prioritised the navigability from its inception, mapping the risk for user vessels.

Following the UNCLOS in 1982, the EEZ was established, complicating claims over the body of the Strait and its seabed. In response, the Littoral States had several meetings to develop mechanisms and programmes to facilitate cooperation to keep the strait safe and open for traffic. This resulted in the Cooperative Mechanism, a framework between user states and Littoral States according to Article 43 of UNCLOS. This mechanism proposed six projects; the removal of shipwrecks, establishment of spill response centres, AIS expansion, tide, current and wind measuring systems for navigational safety, replacement and maintenance of aids to navigation and finally replacement of tsunami damaged aids. All of these projects, are about the reinforcement of the safe and uninterrupted passage of ships through the Strait. With measuring systems and spills response designed to manage the consequences of incidents rather than transforming ecological risk caused by shipping.

Navigation safety and marine protection in the Strait of Malacca are put forward as an ambition by the organisation but the nature of the various projects tell another story. The stakeholders are contributing to the maintenance of a global infrastructure rather than restoration of marine habitat.

The value of the cooperation is not met when it comes to the natural systems, however is does demonstrate that cross-border cooperation is possible in a highly contested space, and that a supra-national actor can serve as an activator for change.

The management of the Strait has to shift away from one that maintains the global infrastructure and towards a future that prioritises long-term perspectives for all inhabitants, which have been treated as expandable until now.



Kuala Lumpur Meeting On The Straits Of Malacca And Singapore: Enhancing Safety, Security And Environmental Protection (2006)

Conclusion

"How are current policies managing the coastal and wetland areas and more-than-human systems?"

Current policies are reinforcing the global perspective of the Strait as an infrastructure, affecting inhabitants on the local scale while also undermining initiatives that try to transform the management from a short-term adaptive one to a long-term transformative future.

What is needed to enable a transformative pathway is to combine initiatives and enable the river basin management to go beyond its current extent, driving change through a dialogue of scales by proposing recognition of the local perspectives of both human and more-than-human inhabitants. While on the scale of governance, to go beyond administrative boundaries and represent the values of the local in a normative way, providing a backbone to the practice of care on each scale.

Policy recommendations:

- River basin management should be implemented to adequately react to risk related to water, in future steps it should aim to also include the marine environment of the Malacca Strait and cooperate across national boundaries.
- Water management should aim to minimise risk for all of the inhabitants, resulting in urbanised areas to retreat in some cases from the riverbanks.
- Policy makers should operationalise the roles of people and organisations on the local scale to practice care. Raising awareness on how and why practices and policies are required to change and their role in this transformation, to carry responsibility to make it happen.
- UNCLOS has a role to play, to include the natural system alterations into the convention, enabling Littoral States to impede traffic whenever they are affected.
- The Malacca Strait Council should be used as a platform to enable trans-littoral cooperation, with a foundation already put in place it has the ability and credibility to enable this transformative way of planning.



Petroleum storage and industrial port area disconnect the urban from the coast (Dumai, Indonesia)



Palm oil plantation in Sumatra (Pléiades © CNES 2018, Distribution Airbus DS)



Strait of Singapore traffic (Singapore, Singapore)



Recreation on the reclaimed beach (Singapore, Singapore)



Informal settlement in front of Silicon Island reclamation (Penang, Malaysia)



Silicon Island reclamation seen from Essen Beach (Penang, Malaysia)



Silicon Island reclamation with sand dredging going on in the distance (Penang, Malaysia)

Reconfiguration

Sub-research question 4

Post-Anthropocentric Framework
"How can critical proximity inform the spatial reconfiguration of the Strait of Malacca?"

With the risk mapped and gaps in current management revealed, a reconfiguration of the current management can be envisioned. This reconfiguration starts out from the principal put forward by de la Bellacasa on the practice of care, articulating that: "... the dimensions that join to generate an "integrated" act of care: the affective and ethical dispositions involved in concern, worry, and taking responsibility for other's well-being, such as "caring about" and "taking care of," need to be supported by material practices—traditionally understood as maintenance or concrete work involved in actualizing care, such as "caregiving" and "care receiving" (Tronto 1993, 105–8; Sevenhuijsen 1998). The distinction does not separate these modes of agency. What it allows is to emphasize a politics of care engages much more than a moral stance; it involves affective, ethical, and hands-on agencies of practical and material consequence." (Puig De La Bellacasa, 2017). Driving the idea that conventional "care" is understood in a way that limits natural recognition such as the reinforcement of shipping infrastructure by funding maintenance that favours navigability instead of compensating for misalignment of agency on the local scale.

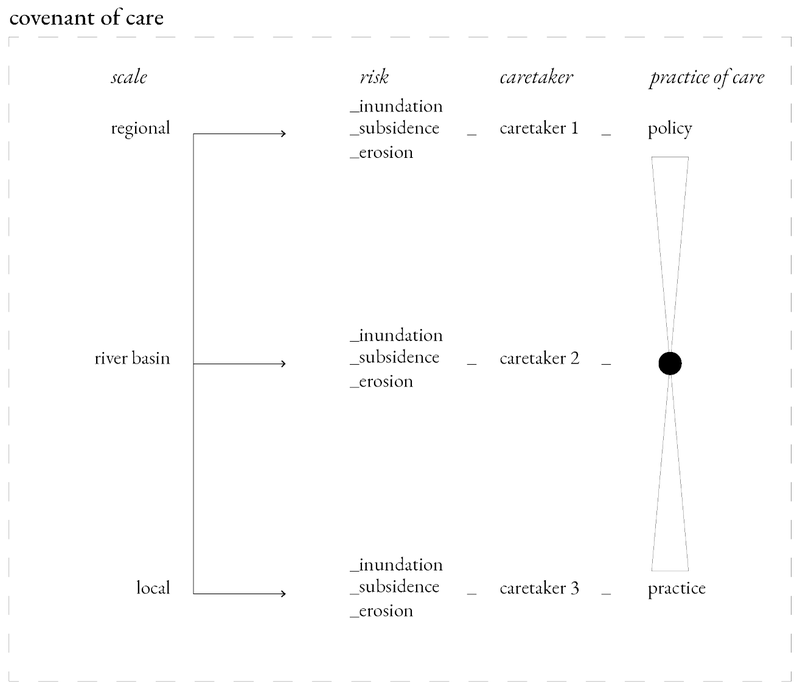
The transformation in perceiving how to care lands in the translation of abstract moral stances such as policies into actual physical manifestations of care that resonates with its surroundings. Possible caretakers are not limited to only policy but are encouraged to reach the level of critical proximity by providing the tools of an inventory of situated practices of care.

In order to effectively address the water-related risks and the policy gaps, going through scales is necessary. As Puig De La Bellacasa (2017) put forward that care can be about the right distance, the reconfiguration is about finding a right balance of critical distance and critical proximity. Being able to connect abstract connections on larger scales while also reaching the substrate of the interdependent more-than-human beings on a local scale, a new scale of management is introduced; the river basin. This scale of management enables dialogue between local and (inter-)national caretakers. It provides a level of management which is in line with natural systems, shaped and supported by water.

Phasing will be applied to provide a timeframe for the transformation to succeed, the change of systems requires mutual understanding and trust of actors and systems. It builds onto existing practices and initiatives, and tries to combine and expand on them where synergies are revealed.

"... the dimensions that join to generate an "integrated" act of care: the affective and ethical dispositions involved in concern, worry, and taking responsibility for other's well-being, such as "caring about" and "taking care of," need to be supported by material practices—traditionally understood as maintenance or concrete work involved in actualizing care, such as "caregiving" and "care receiving". The distinction does not separate these modes of agency. What it allows us to emphasize is that a politics of care engages much more than a moral stance; it involves affective, ethical, and hands-on agencies of practical and material consequence."

(Puig De La Bellacasa, 2017)



Reconfiguration phasing

The reconfiguration proposes a new spatial and governmental dimension, enabling new relations across time and space. Connecting the critical proximity to critical distance in a newly recognised systemic scale of management represented in the cross-border river basin scale. The foundations of a covenant of care are laid, a dependency of policy to be carried by possible caretakers. A human responsibility to care.

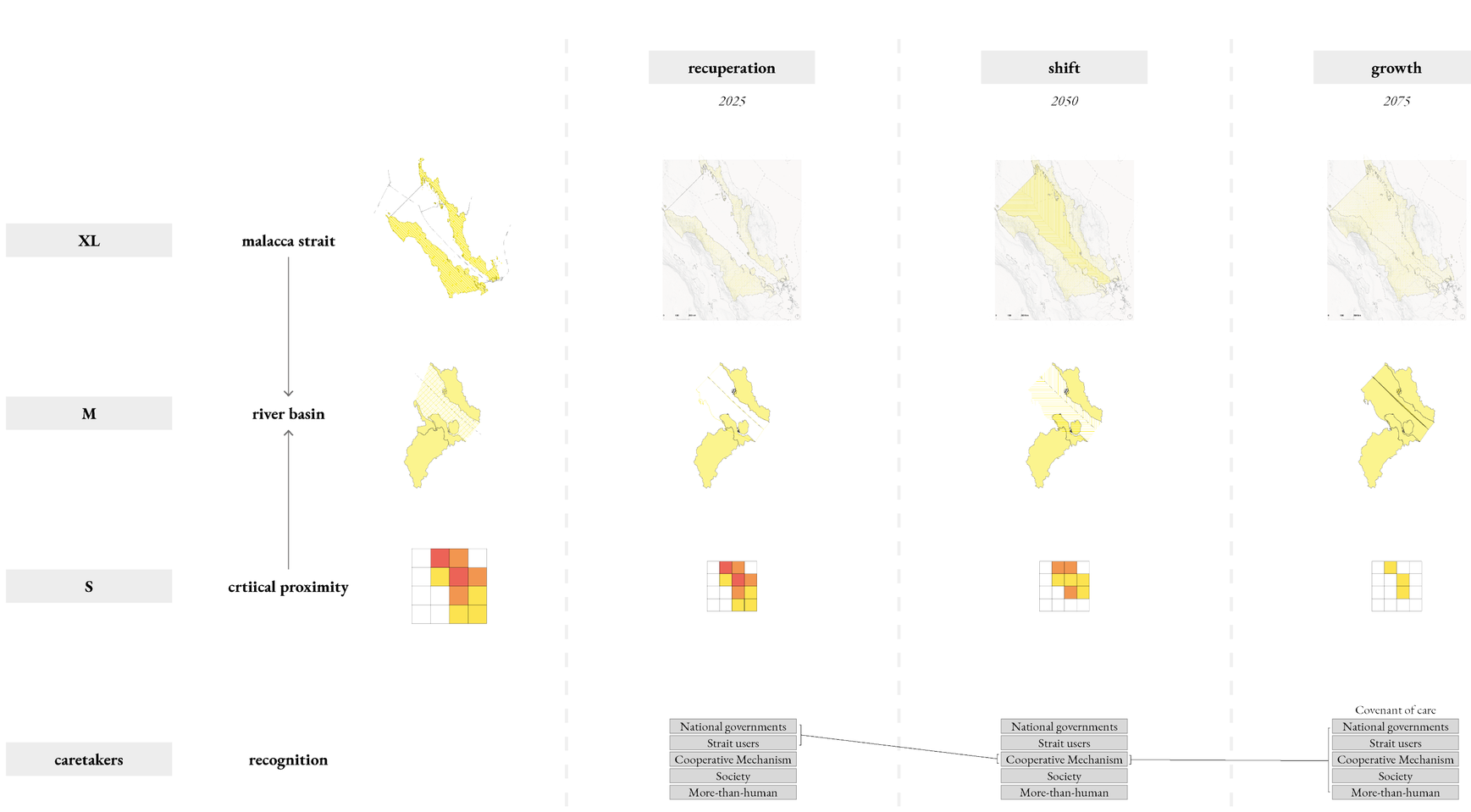
To arrive at a covenant of care, which can not be put into legislation at once, it must be cultivated through phases. The first phase is about identifying and phasing out disruptive activities, by governing with recognition of the scale that is most affected, the local. The inception of river basin management as a new scale of governance requires the Littoral States to align in the assessment of risk and management, laying the foundation for the next phases of trans-boundary cooperation. This scale of management, expands by increments of phasing. Going from the terrestrial rivers in the first phase, to the EEZ in the second, to finally bridging the borders of the Littoral States, resulting in a management spanning both the river basins and the Strait. All this while the system on both the regional scale and local proximity are showing a re-equilibration of risk in dialogue with the more-than-human.

By counteracting the various risks on all scales, a second phase of shift becomes possible. It transforms governance frameworks, relationships between the terrestrial and marine and agency across actors. It confronts the current misalignments within the individual nations and puts a first step towards the confrontation with the governmental boundaries in the Strait.

The final phase of growth goes towards progressive recognition of interconnected systems and results in a robust system that re-equilibrates the many users and inhabitants of the Strait of Malacca. The values of the natural systems and inhabitants on the local scale are embedded within policy and are in constant dialogue throughout scales.

This phasing does not provide a final solution, it proposes a clear path forward but requires constant adjustments, to changing natural conditions but also new balances of human disruption.

The final form of this collaboration fosters a more inclusive way of co-management of the Strait, shifting from prioritising human interests to also include more-than-human interests. This growing system of care starts out by recognising the more-than-human as an actor and to provide it with agency in all scales of management.



Practices of care

Risk is situated and counter-acted on various scales, ranging from the direct effects and physical counter measures on the local scale to the causes of the risk on regional level which requires a policy approach.

Situated practices of care translate the measures per type of risk into physical site specific implementations that counter-act the risk on the local scale or into area specific policy implementations which counter-act the risk on a larger scale.

Important are the potential caretakers, those who are enabled and given agency to care for a practice, which can range from practice to policy, to drive the transformation of the place. Both are essential in order to achieve the transformation towards a robust system, where actors are recognised in a socio-environmental justified way. These actors are linked to certain typologies of care, enabling policy to address them appropriately.

The potential caretakers are different per scale and also per typology, resulting in a widely carried covenant of care.



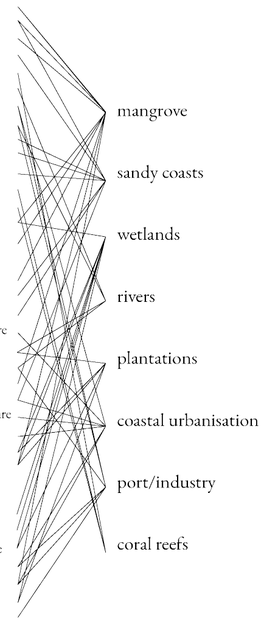






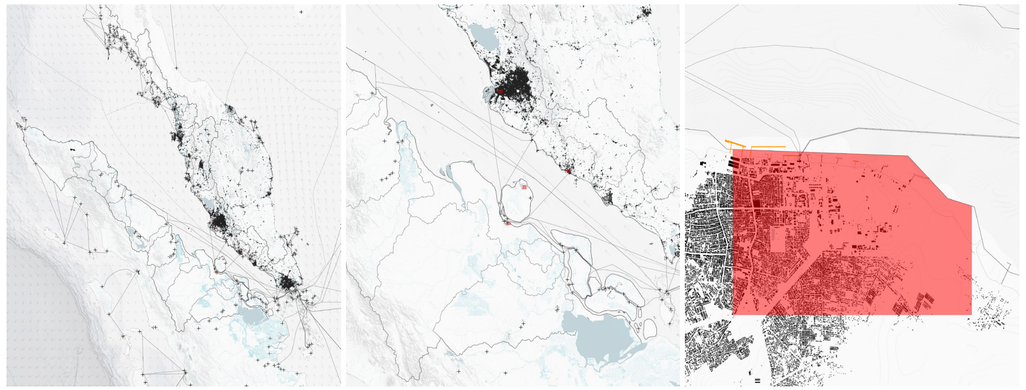
		regional	river basin	situated practices of care
practice	erosion	disruption gradient: no-go medium low robust shared coastal monitoring adaptive port infrastructure living shoreline ecological corridors	seasonal sequencing hydrological restoration riparian forest buffers agroforestry transition river meandering restoration	mangrove pioneer planting brush weir managed mangrove rotation no-anchor zone no-trawl inshore zone channel desiltation coastal setback urban retreat windbreak planting dune restoration reinforced and artificial dunes coral propagation artificial reef substrate silvofishery floating structures
	inundation	setback zones transboundary mangrove protection blue-green infrastructure wave protection	reforestation and afforestation floodplain reconnection wetland restoration peatland rewetting riparian buffer restoration	mudflat restoration dune restoration reinforced and artificial dunes urban coastal green infrastructure hydrological restoration urban retreat wave action protection living shorelines floating community infrastructure stilt infrastructure bund and sluice management paludiculture
	subsidence	transboundary peatland protection regional groundwater governance regional coastal resilience blue-carbon cooperation	integrated water governance peatland rewetting wetland restoration sustainable plantation drainage	peatland revegetation peat no-burn maintenance controlled groundwater recharge urban retreat partnerships with aquaculture peat canal blocking floating structures
policy		rights of nature framework risk policy alignment msc cross border management unified risk assessment unclos alignment knowledge transfer	rights from source-to-source recognition of ecosystems river basin policy alignment unified basin assessment knowledge transfer	community stewardship knowledge transfer

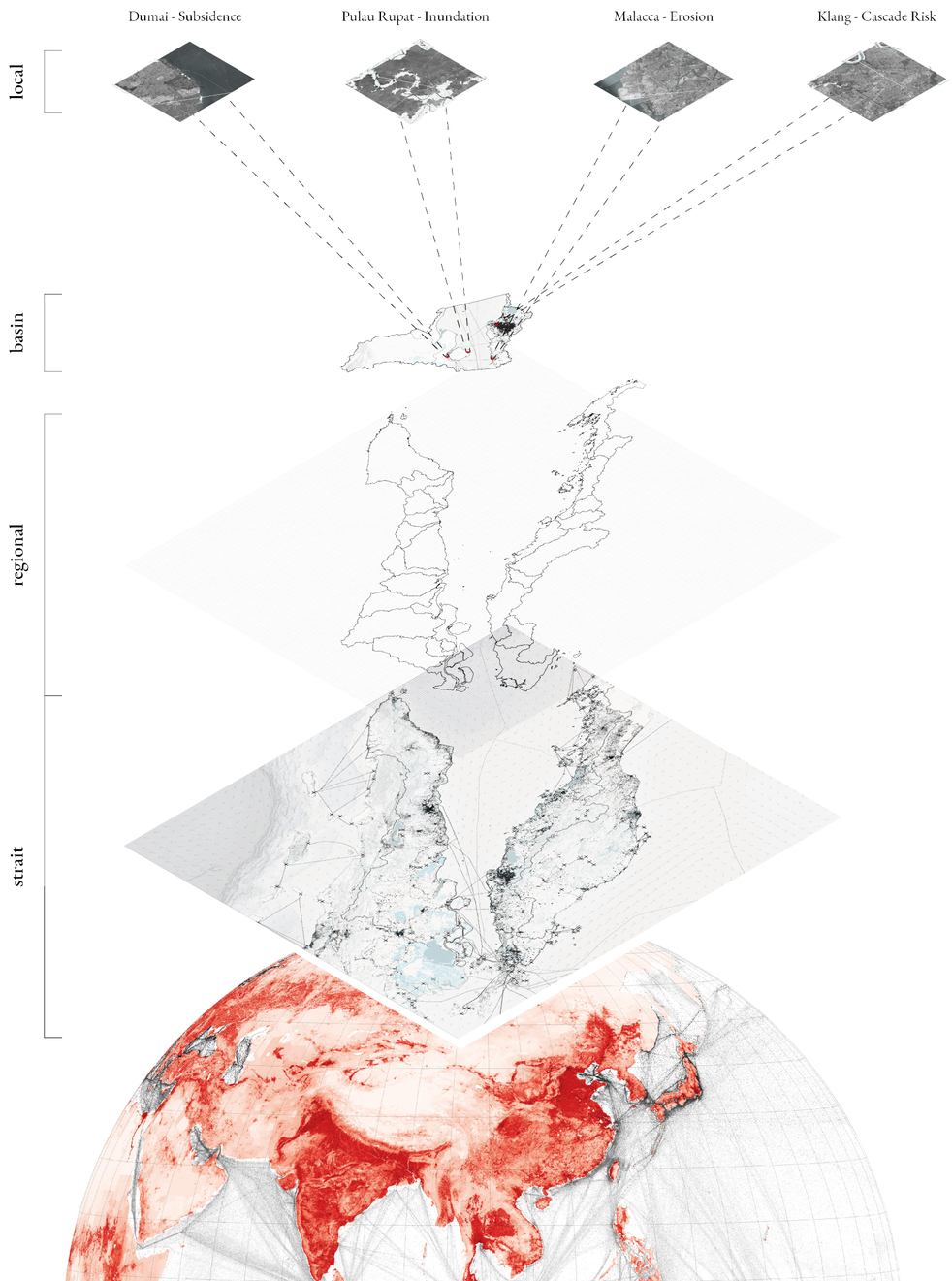
typology



Recognising the scales

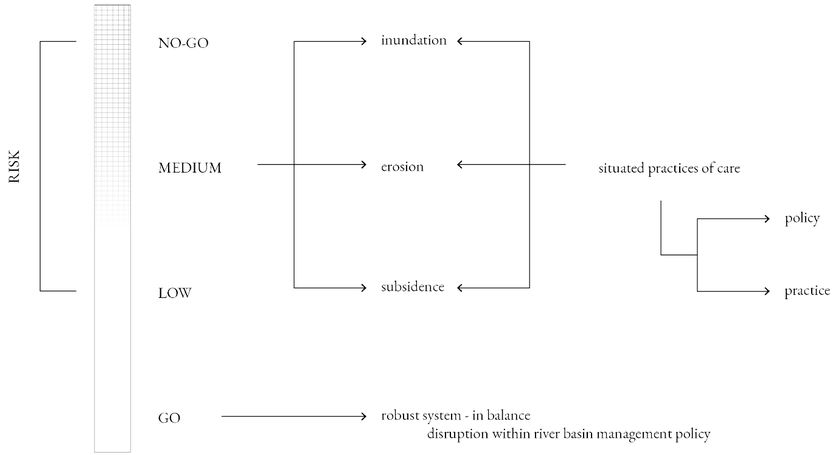
In order to drive the transformation that is needed, there must be an acknowledgement of all the scales that are within the area, this is urgent in order to address the various risks on all interlinked scales. From the trans-national Malacca Strait region to the individual river basins feeding into the Strait, to the level of critical proximity on the local scale, all scales are relevant and inform decision-making together.



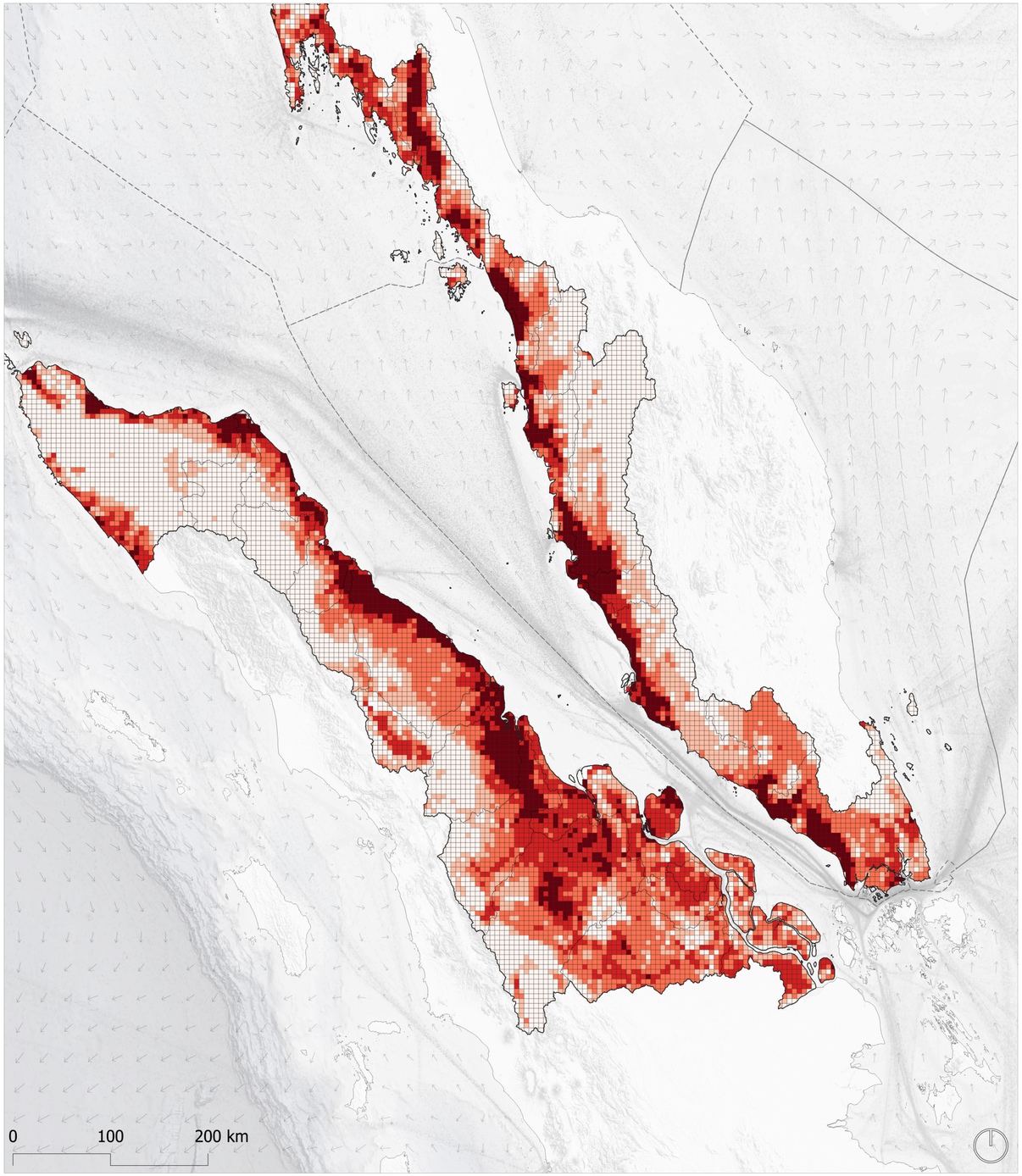


Gradient of disruption - regional scale

Within the risk areas, there is a gradient of risk. Per type of risk as well as the combined amount, resulting in a cascade effect. The relation of this gradient is related to a degree of counteractive practices in order to allow disruption.





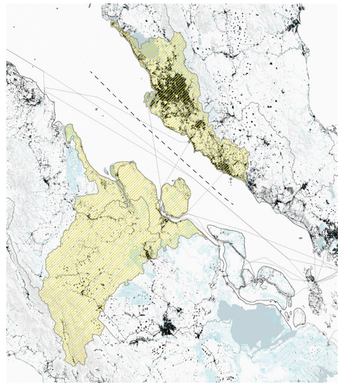


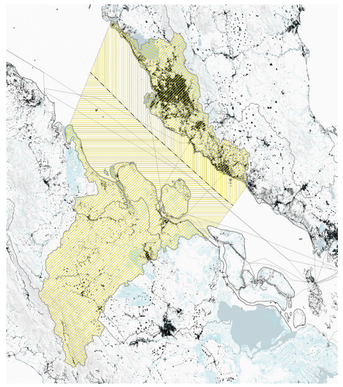
Basin scale

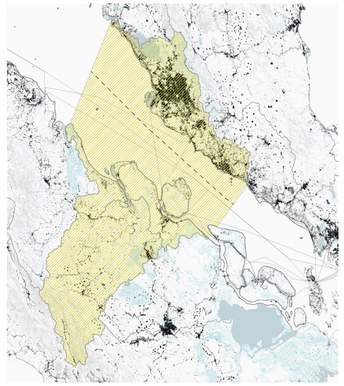
The concept of source-to-sea is already being slowly introduced in the area, with the pilot of the IRBM also being implemented in Malaysia.

Where source-to-sea stops at the mouth of the river, the proposal of the basin scale would go from source to source, across administrative borders such as the EEZ dividing the Malacca Strait between Indonesia and Malaysia. This river basin scale is in line with natural systems, dependent and shaped by the water, and provides a platform for dialogue between critical proximity and critical distance, between policy makers and caretakers.

Phasing of the expanded integrated river basin management makes sure to first implement river basin management and align assessment of risk and regulations, to then expand its capacity beyond the coastline into the water of the Strait, to finally cross the EEZ and align fully. Making it possible to respond to risk on the various scales it affects.



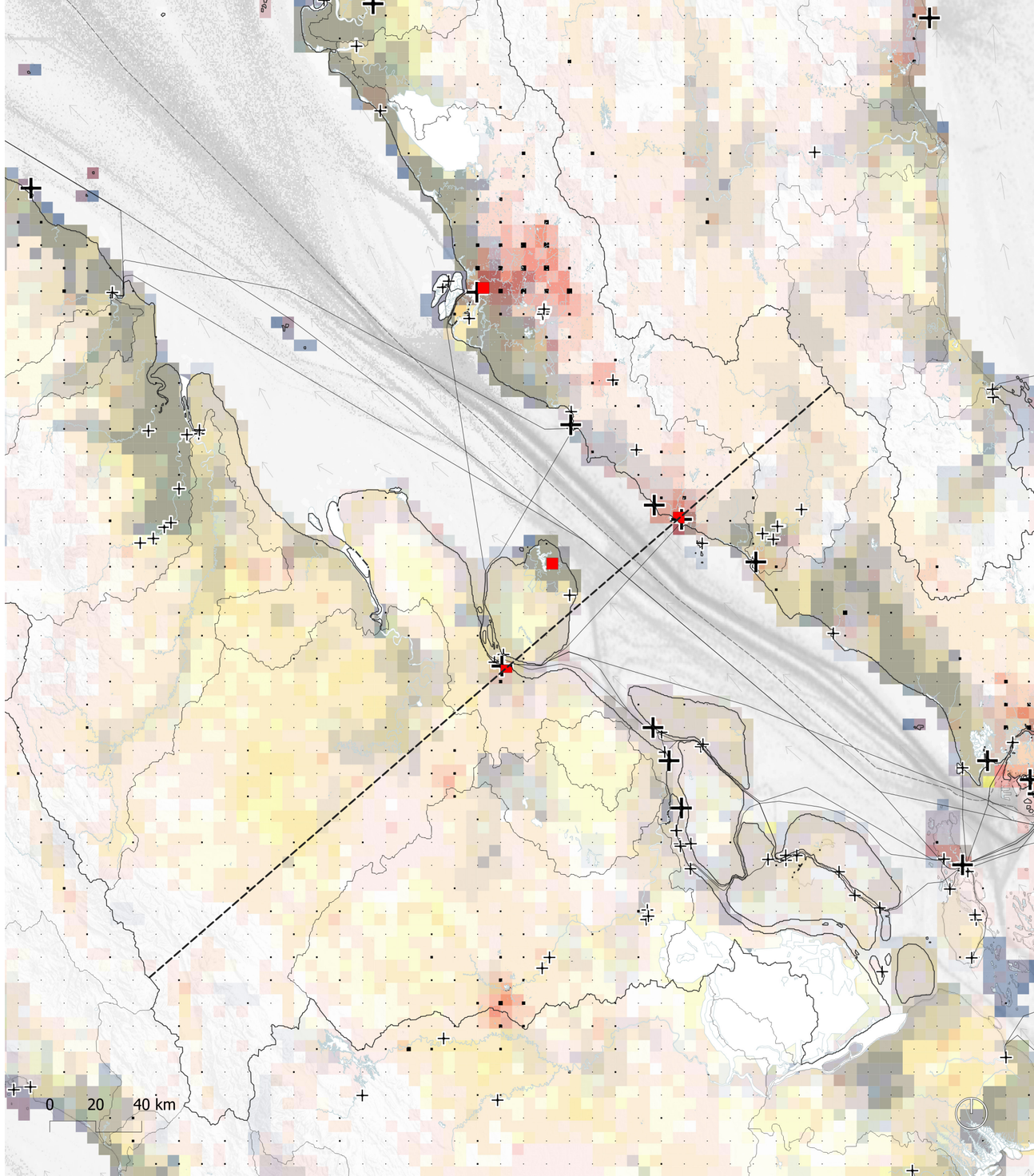




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Inundation and Discharge copy
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Erosion Zonal Stat copy
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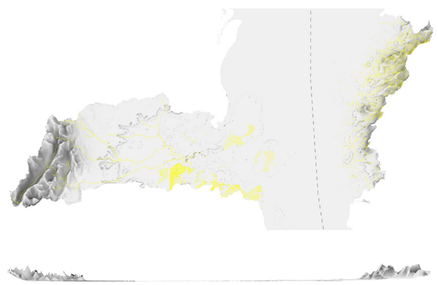


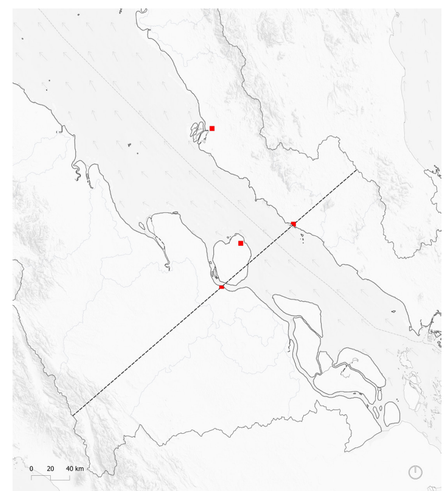
Basin section

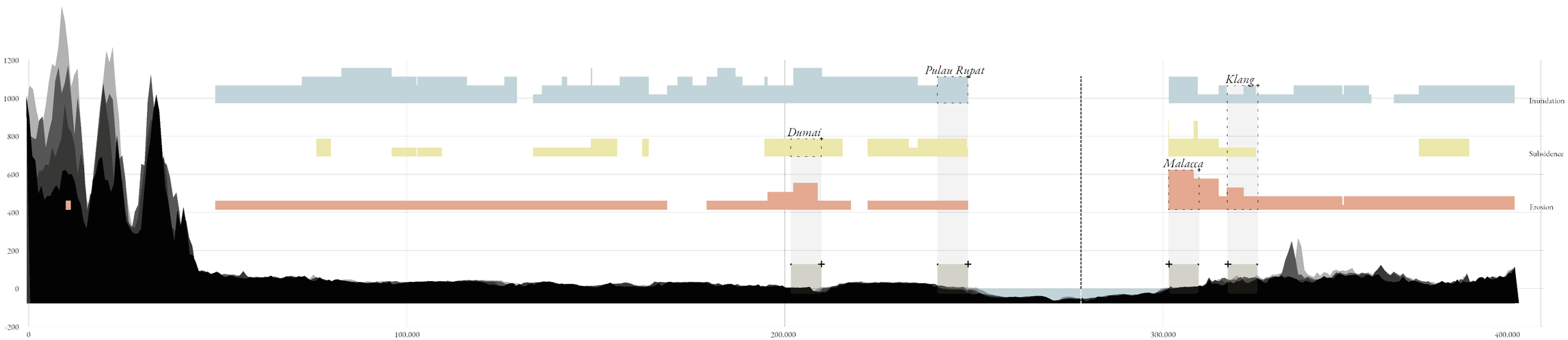
The section below shows a section of the proposed river basin management system as a prototype. Within it, the various types of risk can be seen in abstract, ranging in score from zero to five, with most high risk scores being located around the coastal and wetland areas. This results in zoom in locations most at risk in these areas.

Between the basin of Sumatra on the left and Peninsular Malaysia on the right, the EEZ boundary can be seen dividing the two systems of management. The reconfiguration proposes to finally bridge this in the ultimate phase, extending the proposal of source-to-sea to source-to-source.

The zoom in locations are chosen, based on a distinct type of risk as well as an overlapping location where the cascade risk is situated. All of the locations will be assessed according to the prominent risk and possible implementations of practices of care on the local scale.







Zoom in locations



Dumai, Indonesia - subsidence risk



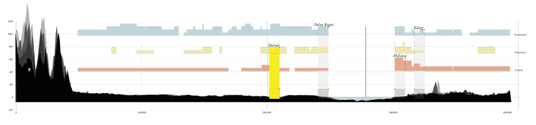
Pulau Rupat, Indonesia - inundation risk

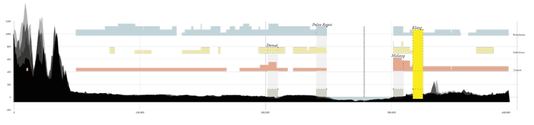


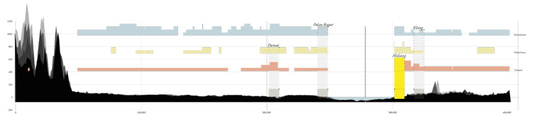
Malacca, Malaysia - erosion risk

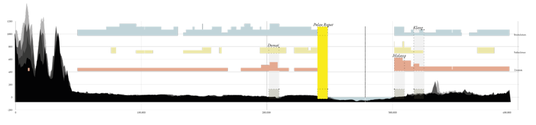


Port Klang, Malaysia - cascade risk

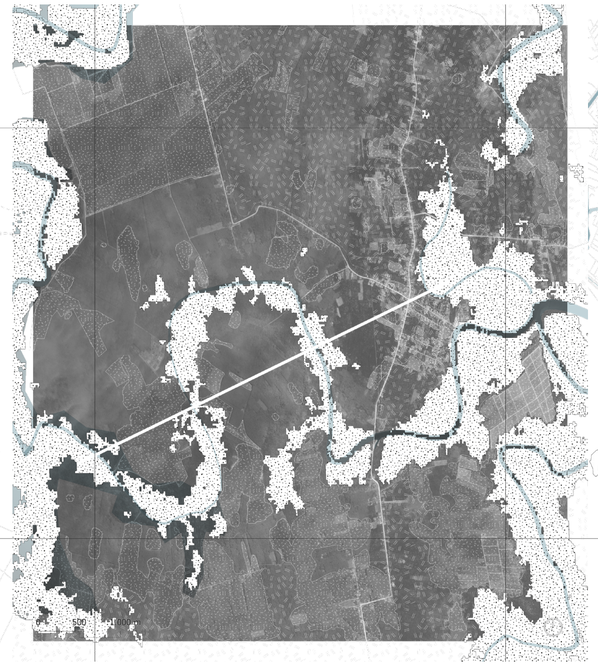









0 500 1.000 m


0 500 1.000 m


0 500 1.000 m


0 500 1.000 m









Dumai

Dumai is a city in East Sumatra, situated in Riau province, close to the Malacca Strait. It's identity is linked to its major role as a petroleum and palm oil export hub.

The main water related risk in the area is subsidence, where peat-lands used to serve as a way to counteract natural water retention, now palm oil plantations have been established, causing the soil to compact and increase the risk of flooding and habitat loss.





Dumai, 2014 (Google Earth Pro, n.d.)

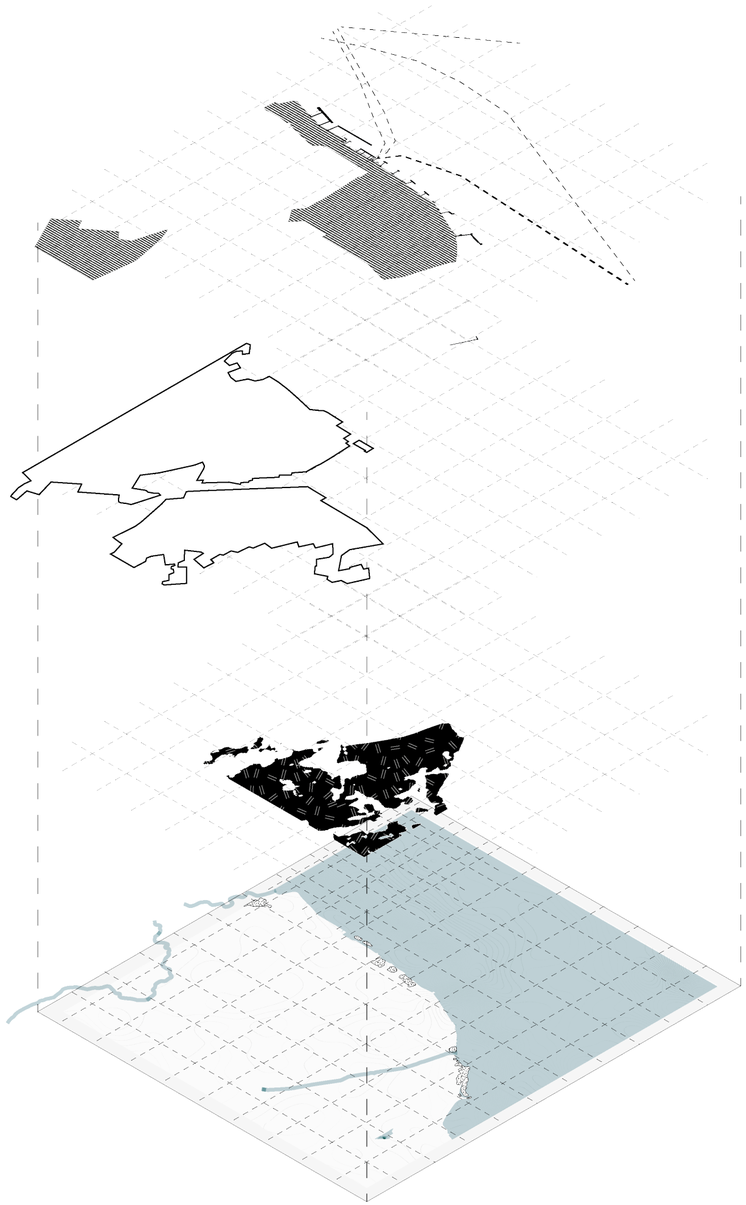


Dumai, 2026 (Google Earth Pro, n.d.)

Shown here are the various scales on which the actors linked to the land use operate. Maritime shipping and its deeply intertwined industries respond to governance on a higher scale, usually linked to Port Authorities or other governmental agencies. This spatialisation of different values, creates a hard distinction between the local urban fabric and port industries. The port blocks the people from the coast.

With local systems such as mangroves and river systems being restricted and disrupted by the industrial expansion, industrial agriculture and urbanisation along the coast, they result into a intensified risk.

To enable change in this location, the actors dependent on the natural systems have to be enabled to care, through policy that provides alternative industries to flourish such as silvofishery and paludiculture, this would counteract the risk of subsidence by providing water retention areas while also enabling mangroves to reduce flood risk.



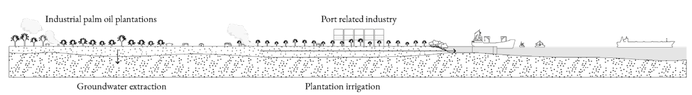
Dumai phasing

Overflow area
Overflow area
Forest/park
Forest/park water retention
Industry

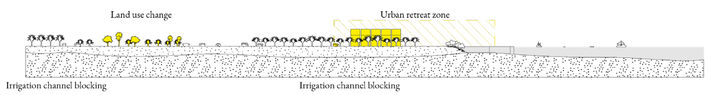
Room for the river
Mangrove
Silvofishery
Plantation
Industrial plantation
Plantation rewetting
Seagrass zone



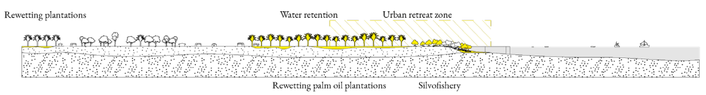
Intensified land use

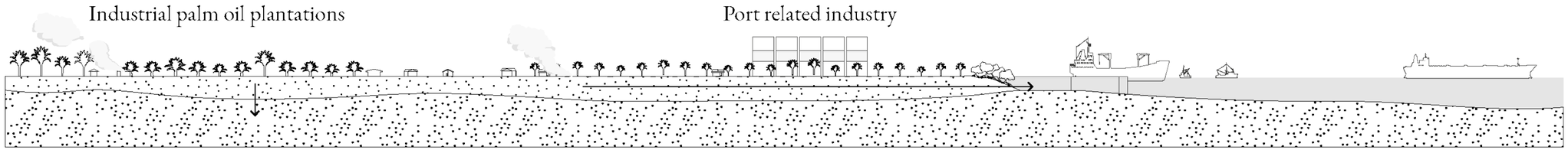


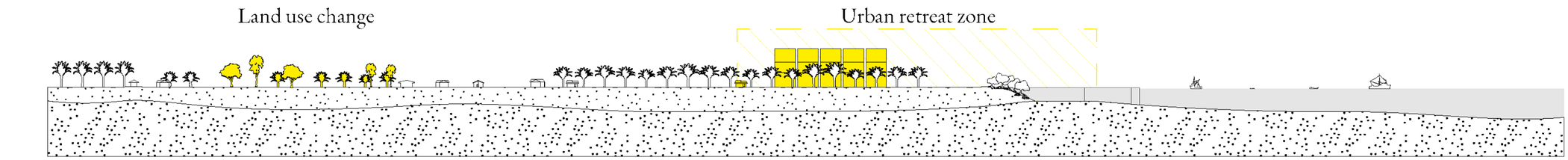


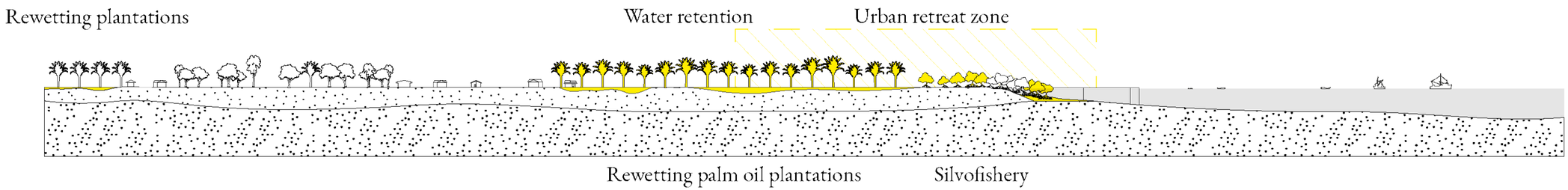


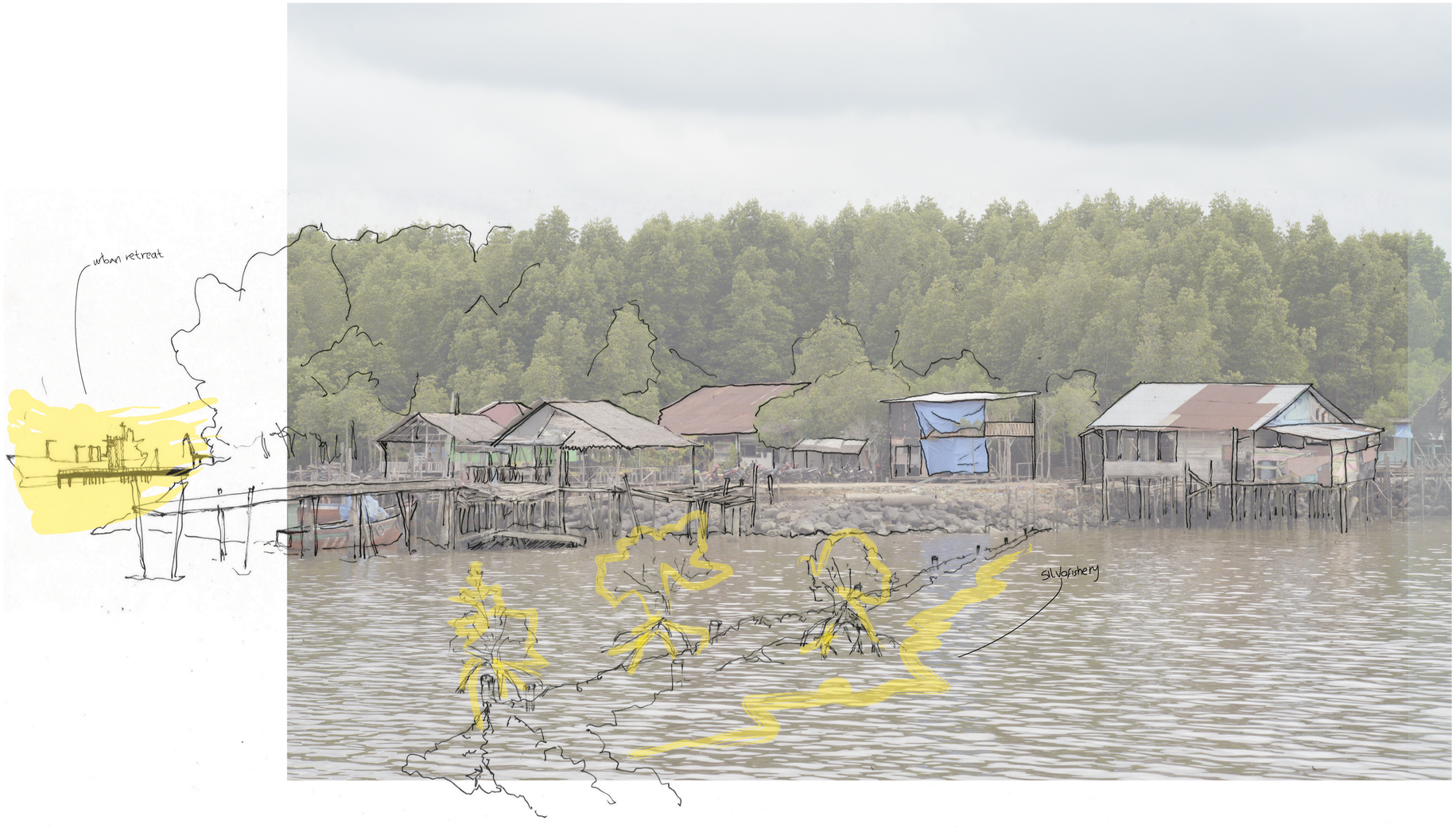





Industrial palm oil plantations
Port related industry
Groundwater extraction
Plantation irrigation


Land use change
Urban retreat zone
Irrigation channel blocking
Irrigation channel blocking


Rewetting plantations
Water retention
Urban retreat zone
Rewetting palm oil plantations
Silvofishery


urban retreat
silvofishery

Pulau Rupat

Pulau Rupat is an island off the coast of Dumai, located in the Riau province in the East of Sumatra, is in stark contrast with Dumai. Where the port and related industries dominate the coast of Dumai, Pulau Rupat is defined by large scale agriculture, primarily palm oil plantations. The island is sparsely populated and remaining natural vegetation is severely diminishing across the area due to intensifying agriculture.





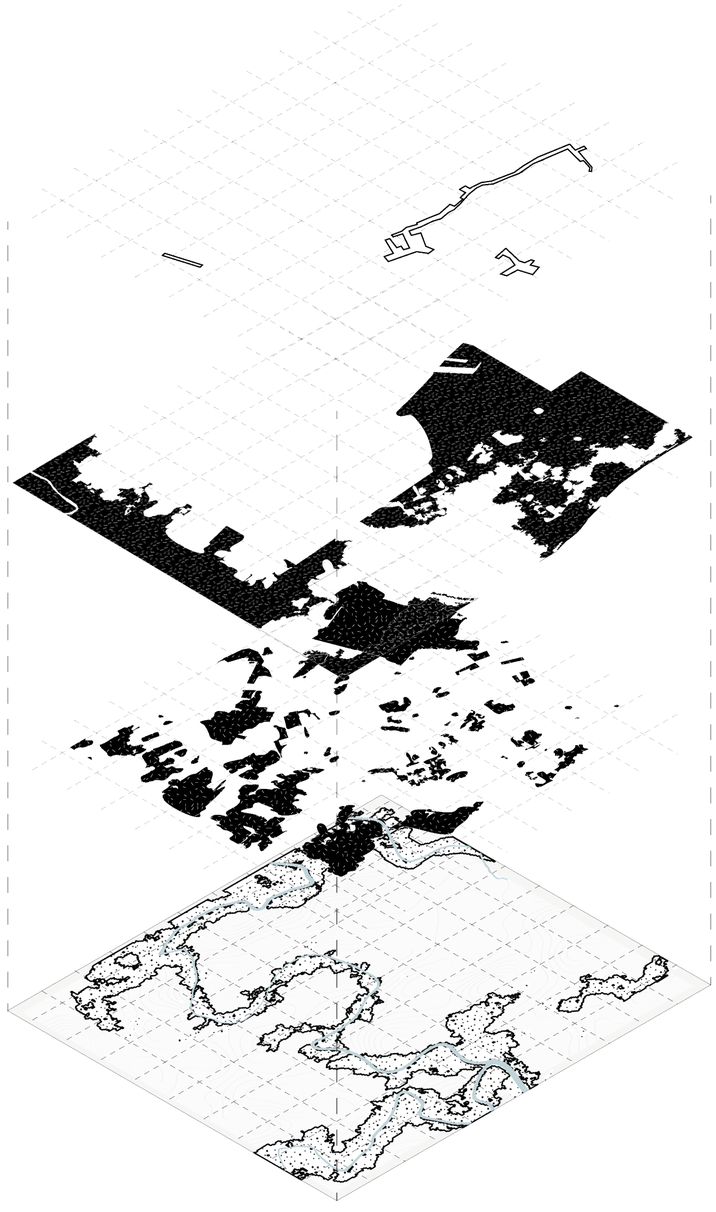
Pulau Rupat, 2015 (Google Earth Pro, n.d.)



Pulau Rupat, 2026 (Google Earth Pro, n.d.)

Shown here are the various scales on which the actors linked to the land use operate. Pulau Rupat is a sparsely populated island and used to house diverse land uses, now the peat and mangroves are being drained in order to make room for palm oil plantations. These industrial plantations respond to national governance goals set for sustainability but is not enforced on the local level. Informal smaller scale plantations often times operate illegally and further fragment habitats and retention capacity of the landscape.

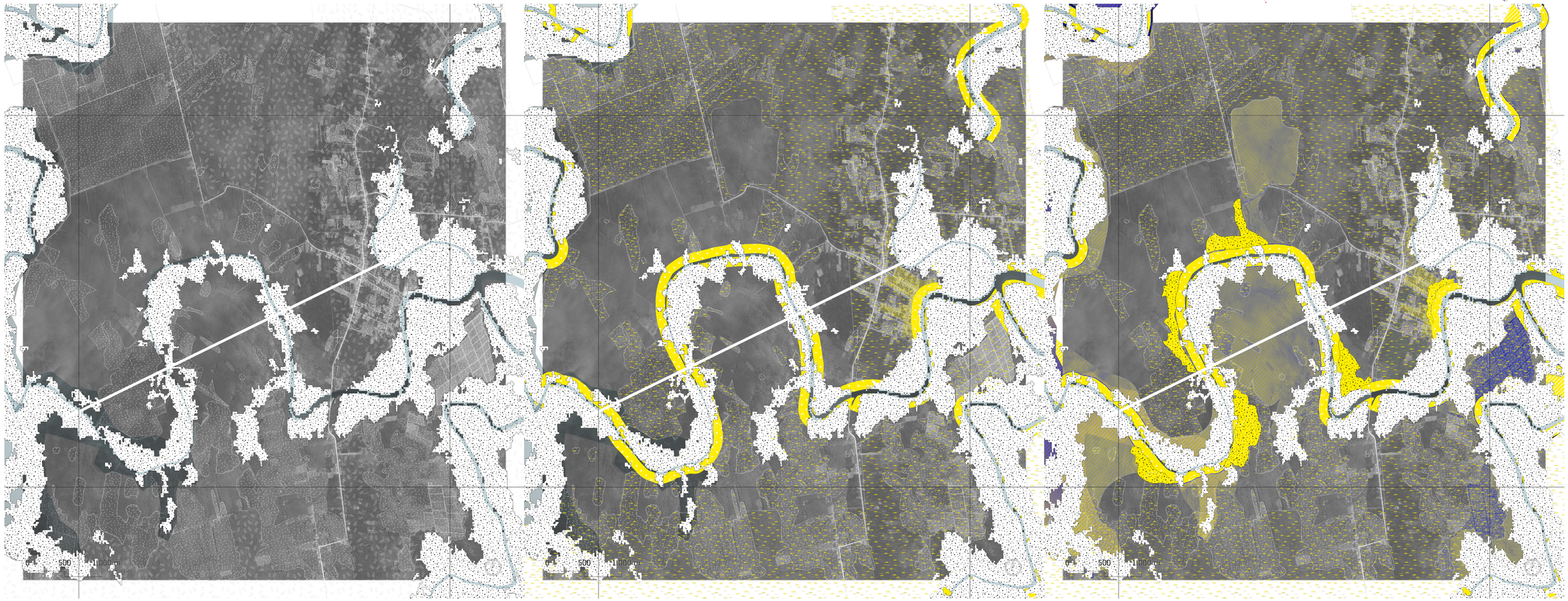
The main risk of inundation can be counteracted by proposing the guardianship of actor groups such as the plantation owners, with industrial plantations steered by a change in policy and local owners by a change in physical practice, from draining peat-lands to re-wetting the plantations and practicing paludiculture. This together with the urban retreat from possible overflow areas around the rivers, drives a future that counteracts risk and minimises the hazard to its inhabitants.

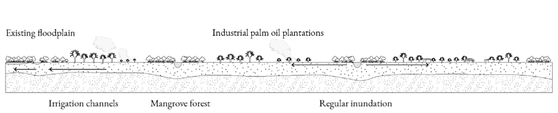


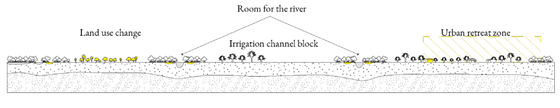
Pulau Rupat phasing

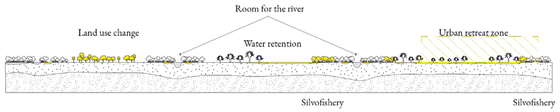
Overflow area
Overflow area
Forest/park
Forest/park water retention
Industry

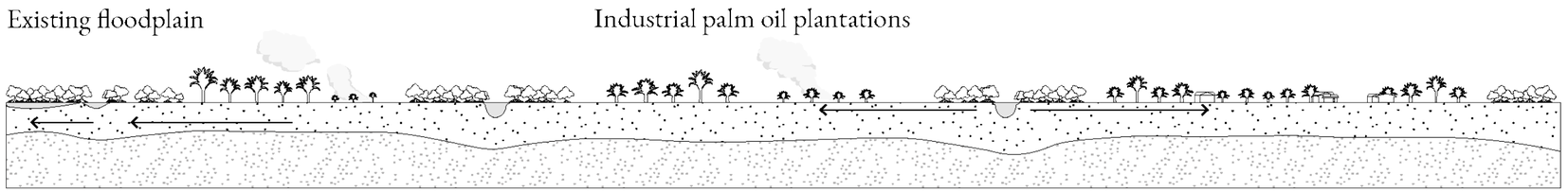
Room for the river
Mangrove
Silvofishery
Plantation
Industrial plantation
Plantation rewetting
Seagrass zone

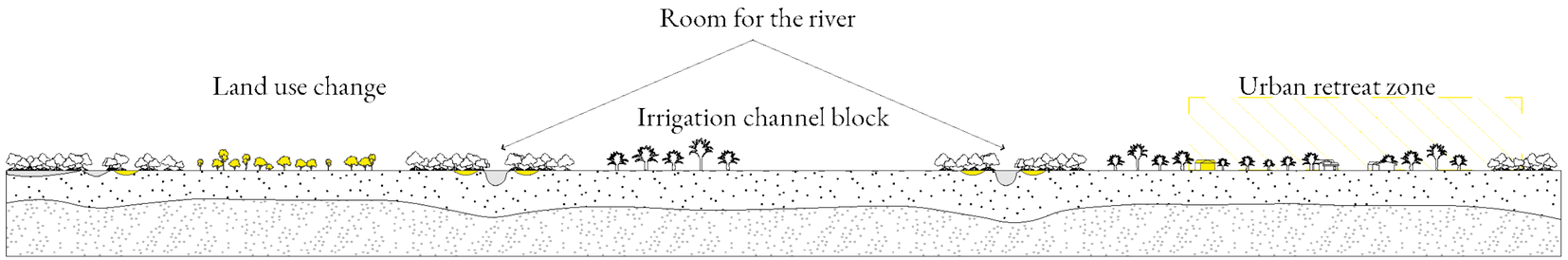


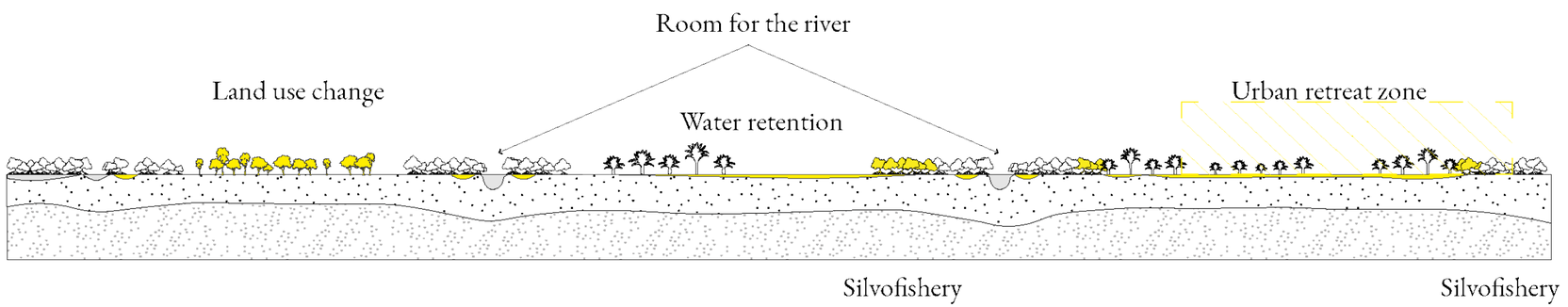


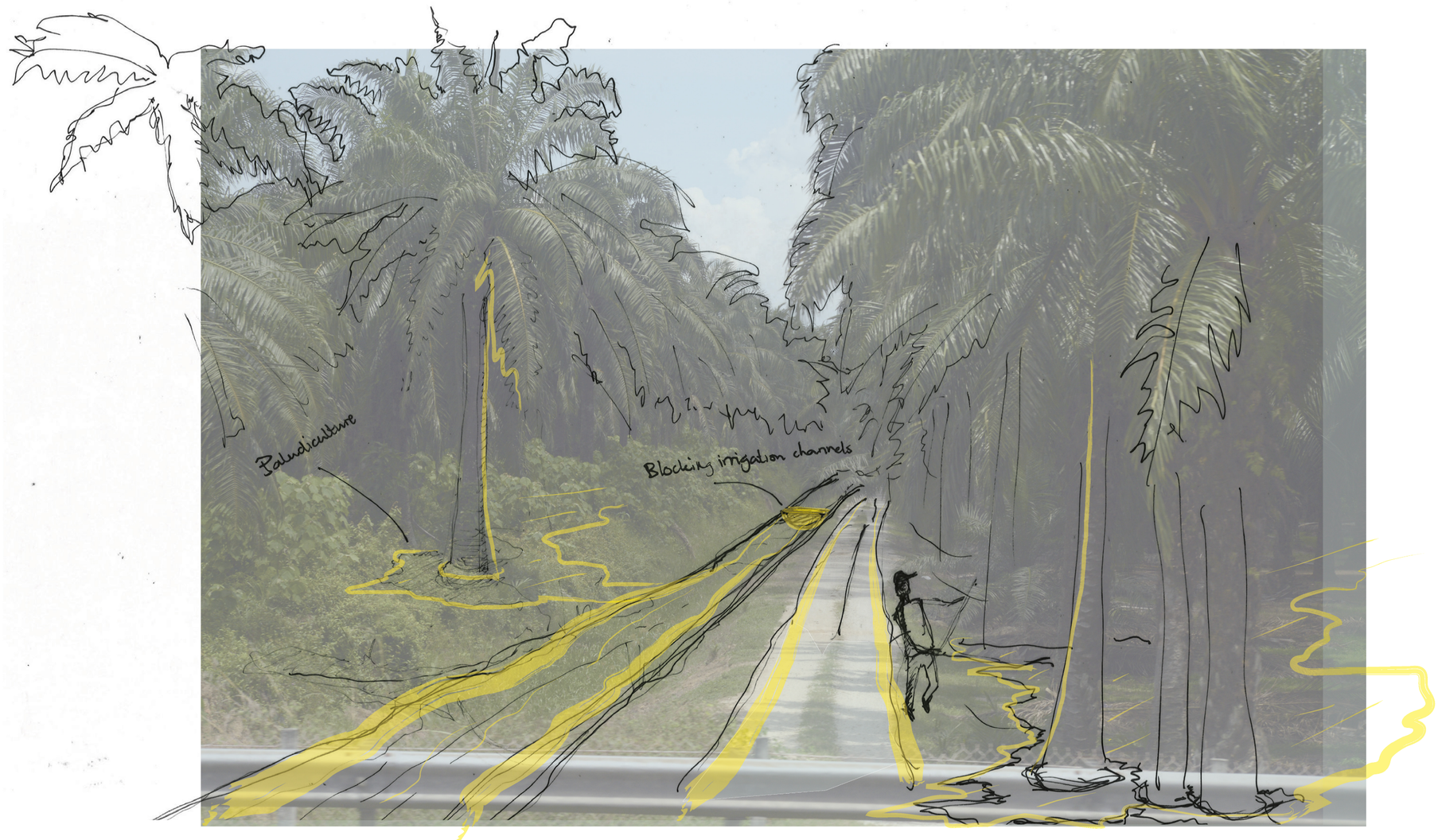





Existing floodplain
Industrial palm oil plantations
Irrigation channels
Mangrove forest
Regular inundation


Room for the river
Land use change
Irrigation channel block
Urban retreat zone


Room for the river
Land use change
Water retention
Urban retreat zone
Silvofishery
Silvofishery


Paludiculture
Blocking irrigation channels

Malacca

Malacca is a recognised UNESCO World Heritage city, due to its historical identity as the central trading hub connecting Asia with Europe, but its rapid development also results in primarily coastal erosion due to coastal reclamation, dredging, deforestation and pollution. The erosion risk is linked to the land reclamation, rapid expansion of the urban area and coastal deforestation. Together they are harming both the identity of the place and future generations of its inhabitants.





Malacca, 2003 (Google Earth Pro, n.d.)



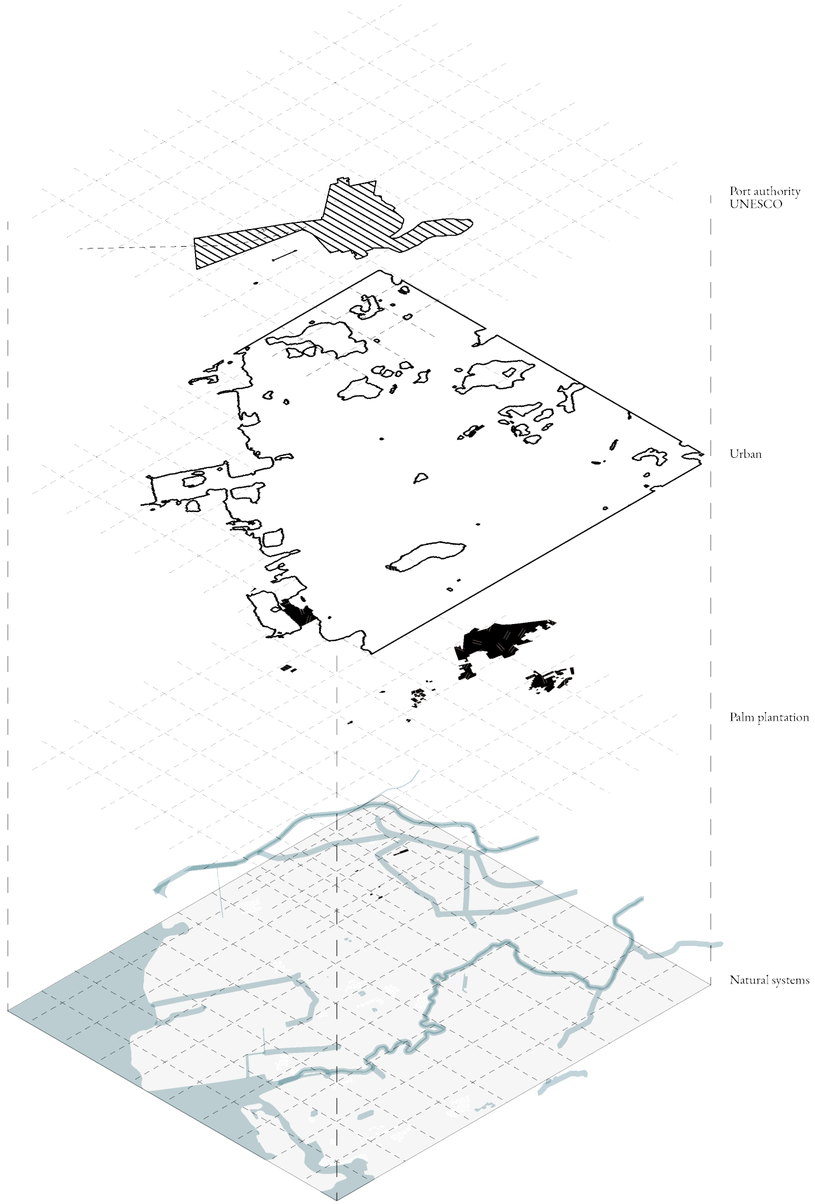
Malacca, 2023 (Google Earth Pro, n.d.)

Shown here are the various scales on which the actors linked to the land use operate.

Within the historical city of Malacca, UNESCO heritage is clearly defined with a buffer zone around the historical centre and its historical connection to the Strait. Nowadays this connection is eroding, just like the reclaimed coast around it, what once used to be the centre of trade in the region has now become a sandy wasteland.

Shipping used to dominate the shores of Malacca, but now only some ferry lines remain, these lines operate on an international level, between Dumai and Malacca.

In contrast with the local actors, they have been pushed away from their coastal environment, with coastal reclamation projects disrupting livelihoods linked to the Strait. The risk of erosion has to be driven by policy from governing bodies, to let nature take back parts of the reclamation projects, in order to restore natural systems and their historical connection with the coastline. While also changing the conditions upstream, to return the natural flow of sediments, currently restricted by dams and other disruptions of the water system. On the local scale transformation can be driven by practicing new ways of aquaculture, such as silvofishery within mangroves, and the introduction of t-shaped weirs to protect the original coastline from eroding, protecting both the natural ecosystem along the coastline and its inhabitants.

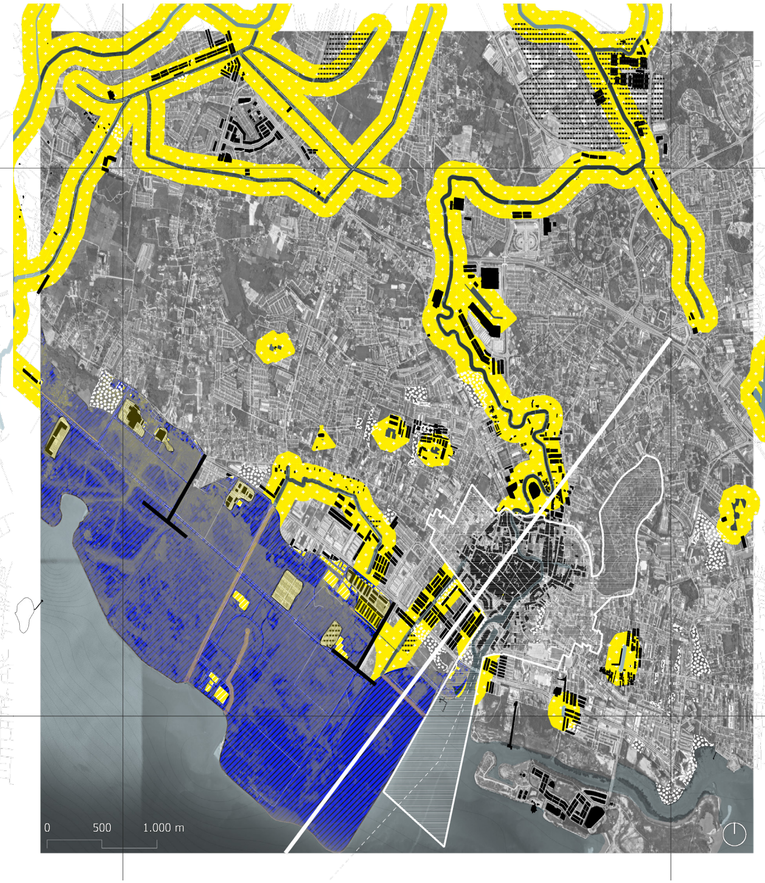


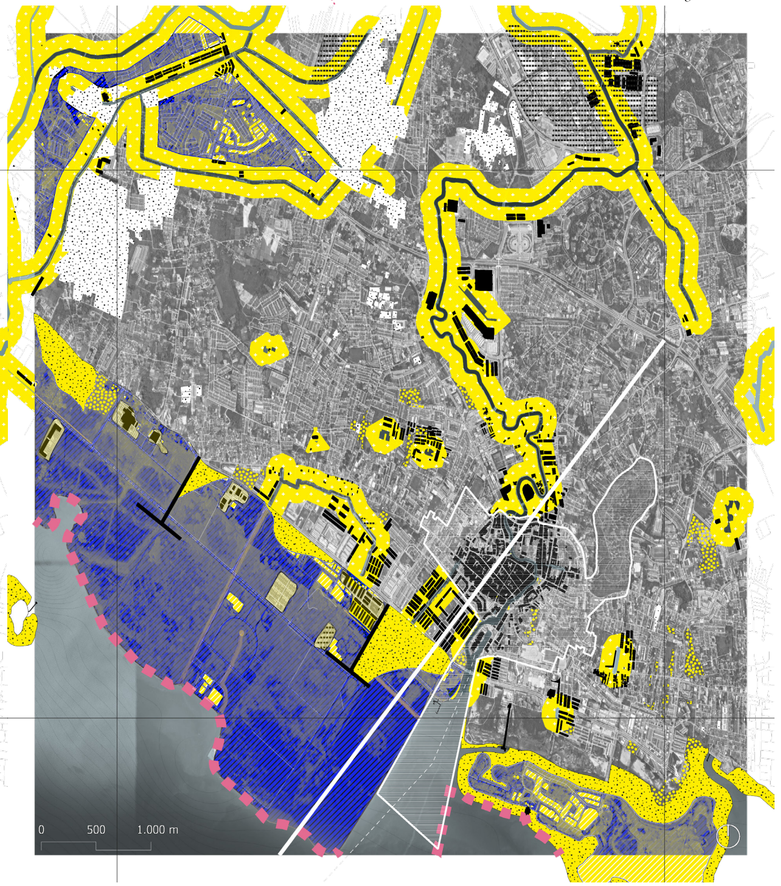
Malacca phasing

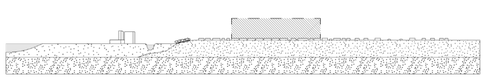
Overflow area
Overflow area
Forest/park
Forest/park water retention
Industry

Room for the river
Mangrove
Silvofishery
Plantation
Industrial plantation
Plantation rewetting
Seagrass zone

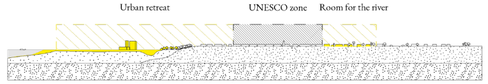






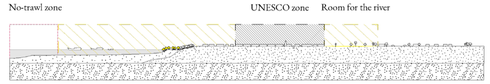


Urban retreat UNESCO zone Room for the river

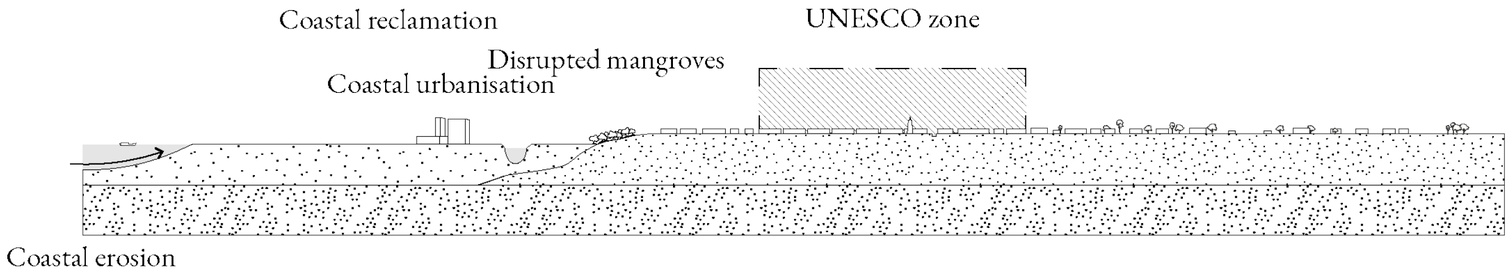


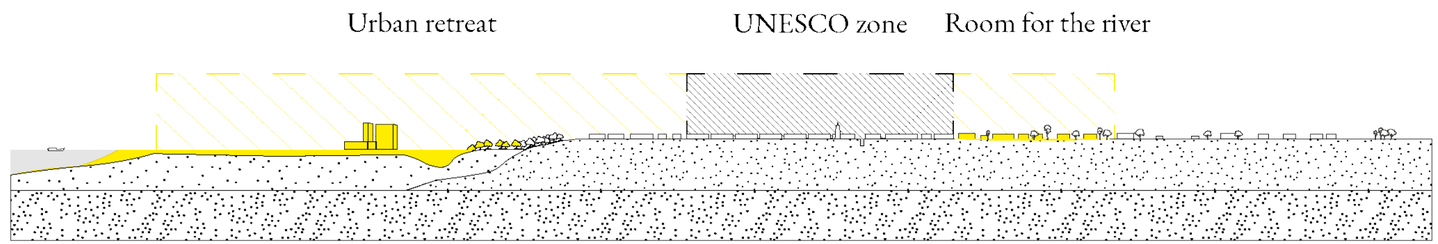
Returning to the old coastline

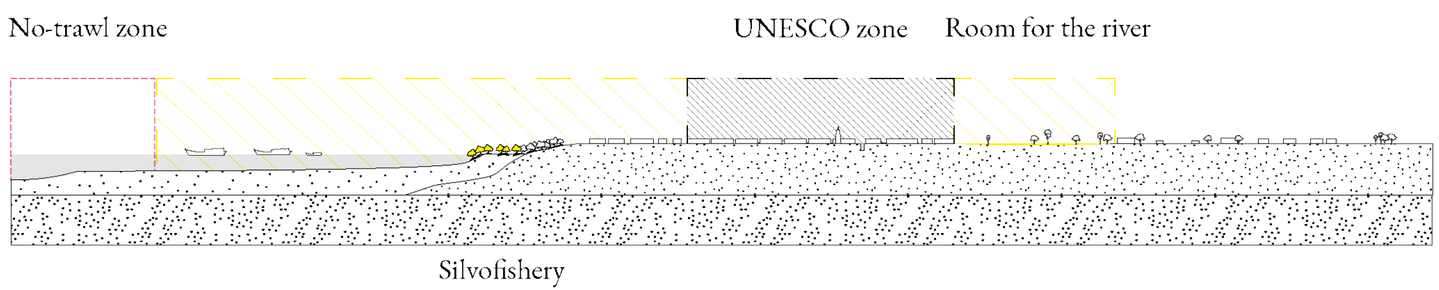
No-trawl zone UNESCO zone Room for the river

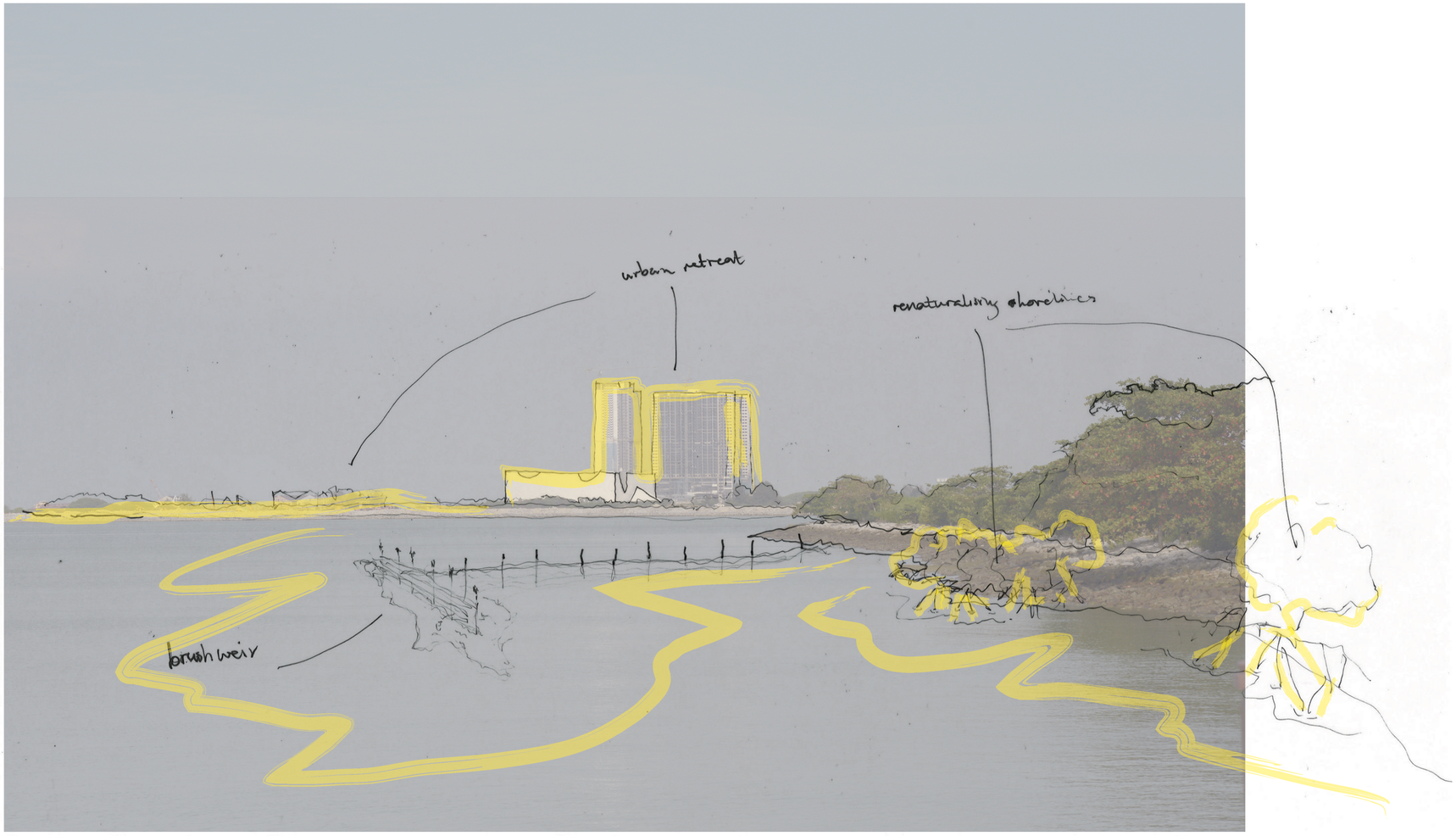


Silvofishery


Coastal reclamation
UNESCO zone
Disrupted mangroves
Coastal urbanisation
Coastal erosion


Urban retreat
UNESCO zone
Room for the river
Returning to the old coastline


No-trawl zone
UNESCO zone
Room for the river
Silvofishery


urban retreat
renaturalising shorelines
brush weir

Klang

Klang is a historical city near Malaysia's capital city of Kuala Lumpur, but mostly known for its current 14th busiest container port in the world.

The area is prone to sea level rise, combined with drainage problems and erosion, resulting in a cascade effect of risk to the area. Port Klang faces one of the highest projected losses of development area with roughly 40% being lost due to one meter sea level rise (Ehsan et al., 2019)

The identity of the city is dictated by the major industrial port adjacent to the city, the Klang river and some of the last surviving mangrove forests in the area.





Klang, 2010 (Google Earth Pro, n.d.)

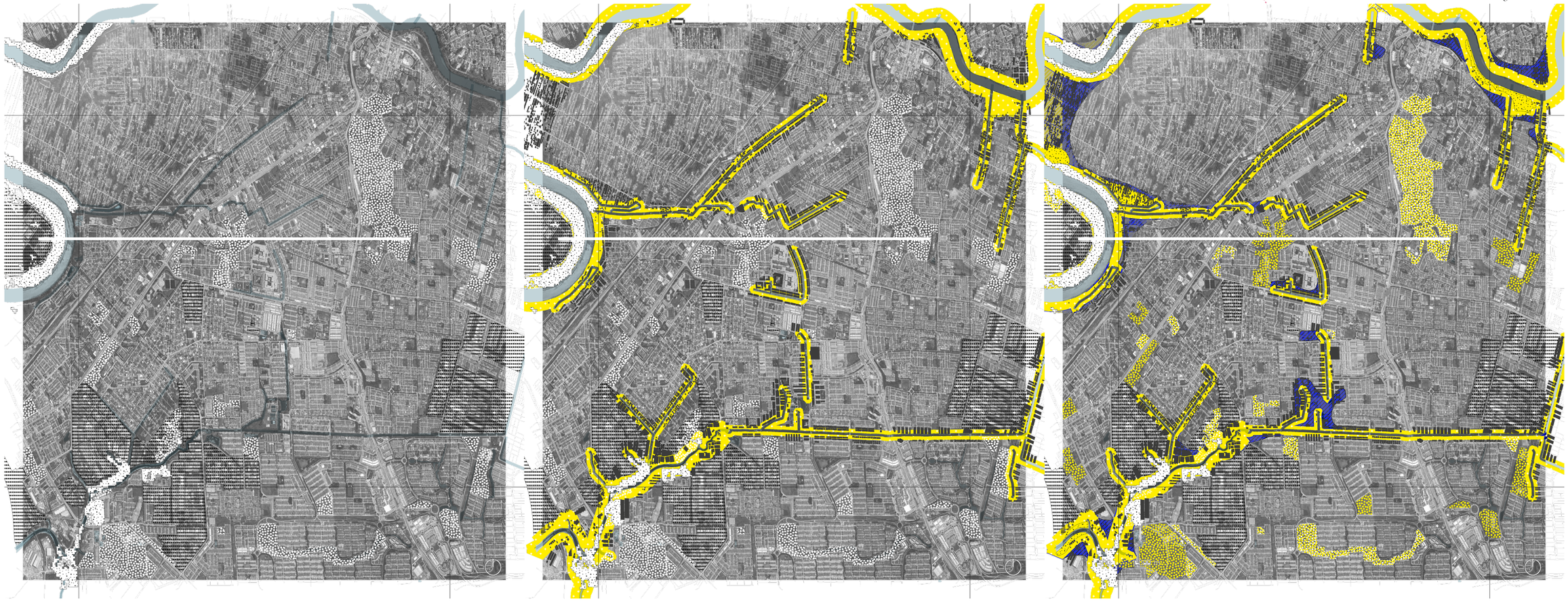


Klang, 2025 (Google Earth Pro, n.d.)

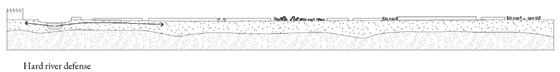
Klang phasing

Overflow area
Overflow area
Forest/park
Forest/park water retention
Industry

Room for the river
Mangrove
Silvofishery
Plantation
Industrial plantation
Plantation rewetting
Seagrass zone



Port industry Fluvial flooding Urban park Urban park



Hard river defense

Room for the river Urban retreat

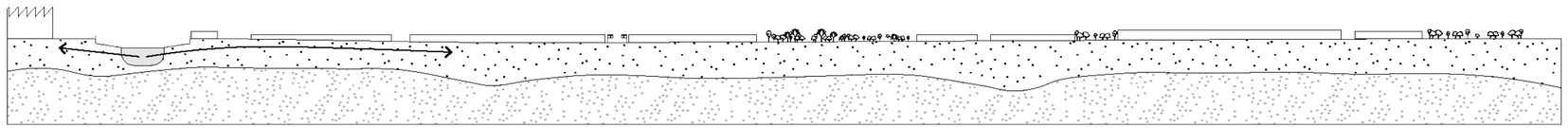


Renaturalising banks

Overflow area Urban retention Urban retention

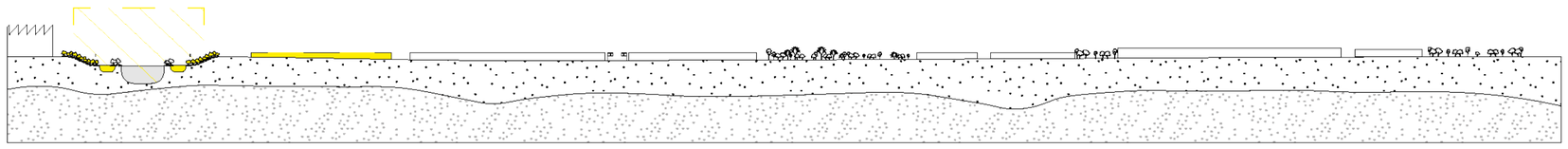


Port industry Fluvial flooding Urban park Urban park



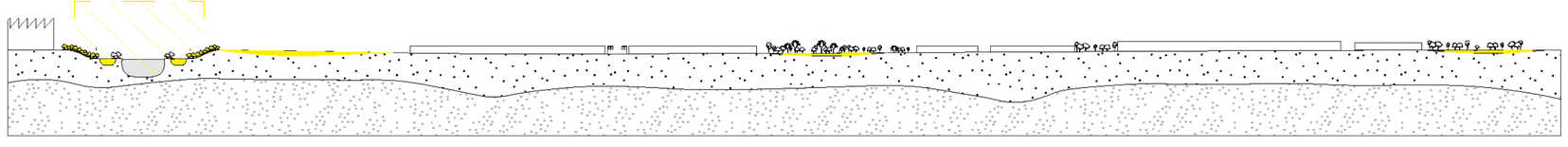
Hard river defense

Room for the river Urban retreat



Renaturalising banks

Overflow area Urban retention Urban retention



The diagram exposes how certain perspectives, represented in land use, impose on others. With the natural, local systems such as rivers and mangroves continuously being overlooked and further disrupted by global or international interests such as the port related industries within the location.

Maritime shipping and its deeply intertwined industries respond to governance on a higher scale, usually linked to Port Authorities or other governmental agencies, but negative effects become reality on the local scale.

With the local urban fabric experiencing regular flooding from the Klang River due to inadequate control and retention upstream, together with the inability for natural protection due to the hardened river banks. It results in a cascade of risk, with a high hazard due to the high density of housing in the area. To assign caretakers in this area, which is very disconnected from the natural systems, requires a transfer of knowledge about the intricate natural systems that provide both livelihoods and risk. Local and regional authorities should create awareness and practice urban retreat from the urbanised riverbanks. Together with the re-naturalisation of river banks, the introduction of urban parks as water retention could be introduced.

The industries, linked to global infrastructure, are able to practice care in a way of finding new synergies with future practices in the area, such as aquaculture, or possibly retreat from risk areas.

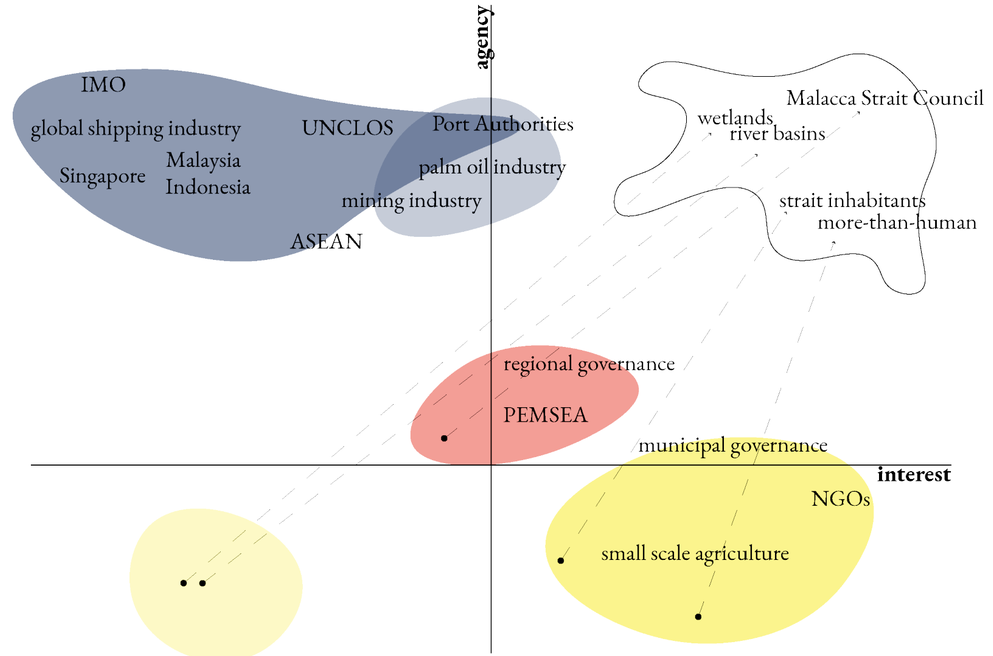


urban retreat
overflow area
overflow area

From stakeholders to actors

Stakeholders have to be enabled to care for the change that is needed, but in order to this they have to be given tools and recognition, this shift in agency and recognition is proposed by recognising the more-than-human within the Strait as well as assigning humans as a covenant of care, which are given a responsibility to practice care, both on the level of critical proximity as critical distance.

This diagram shows the shift in interest and agency per stakeholder throughout the reconfiguration, signifying a significant shift for the local interests of human and more-than-human, coming into balance again with the global actors that drive policy.

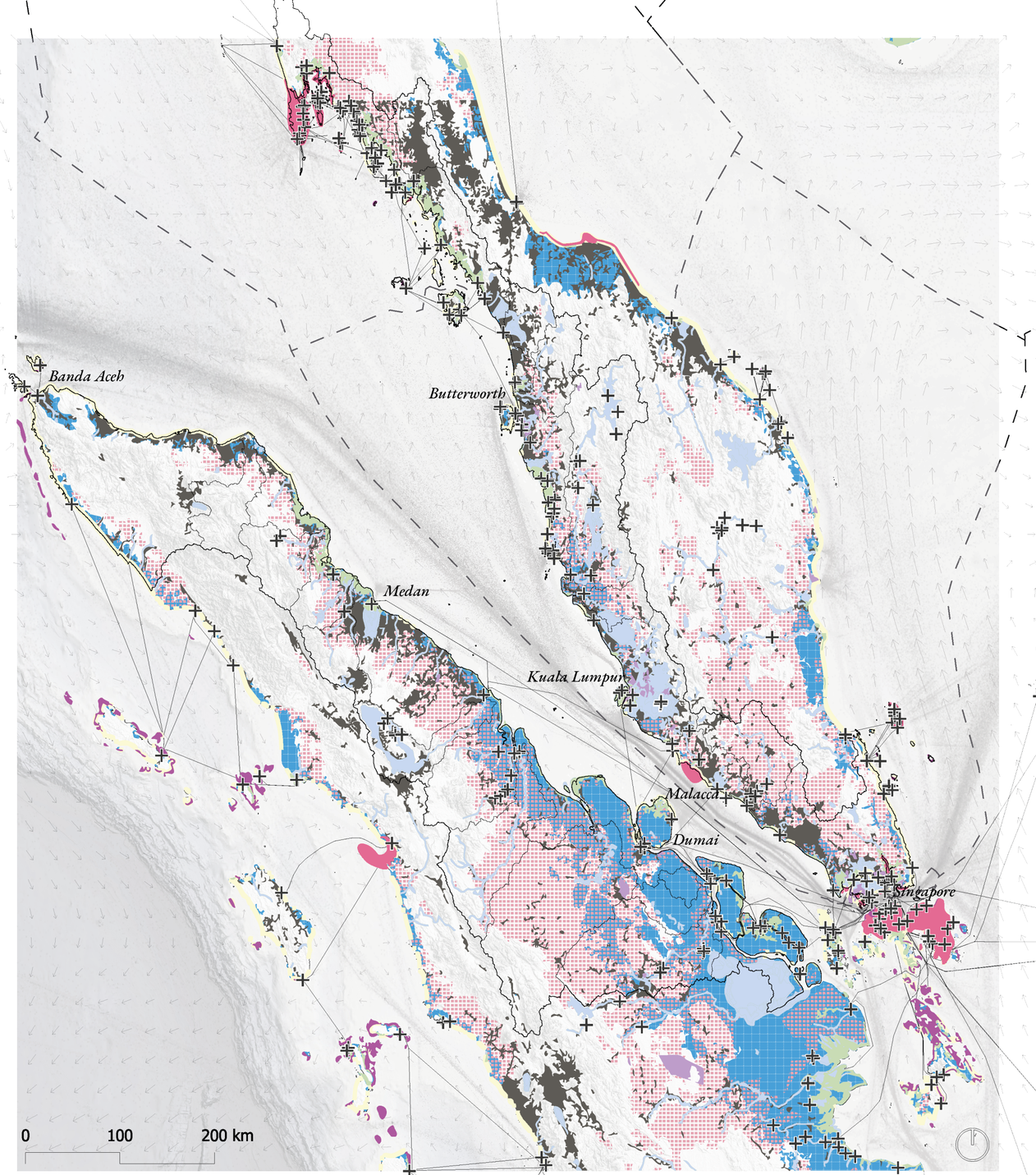


Typologies of care

To link the practices of care to the scale of the Strait of Malacca, requires an inventory of the typologies which are linked to practices and types of risk. This shows possible areas of care implementation.

Shown are the typologies of wetlands, mangroves, urban areas, industrial palm oil plantations, ports and industries, water bodies, sandy beaches, sea grass and coral reefs.

Wetlands
Urban
Industrial plantation
Mangrove
Water
Seagrass
Coral reef
Sandy beach
Ports



A vision of care

Vision for the future of the Malacca Strait, without administrative boundaries holding back cooperation through scales, and most importantly, enabling care.

It proposes a new dynamic future balance, not a set outcome that is fixed but one that will find a new equilibrium between the global and local.

A future that re-evaluates the EEZ, enabling cooperation across the Strait and operate from a governance system that is in line with natural systems.

It proposes new types of industries.

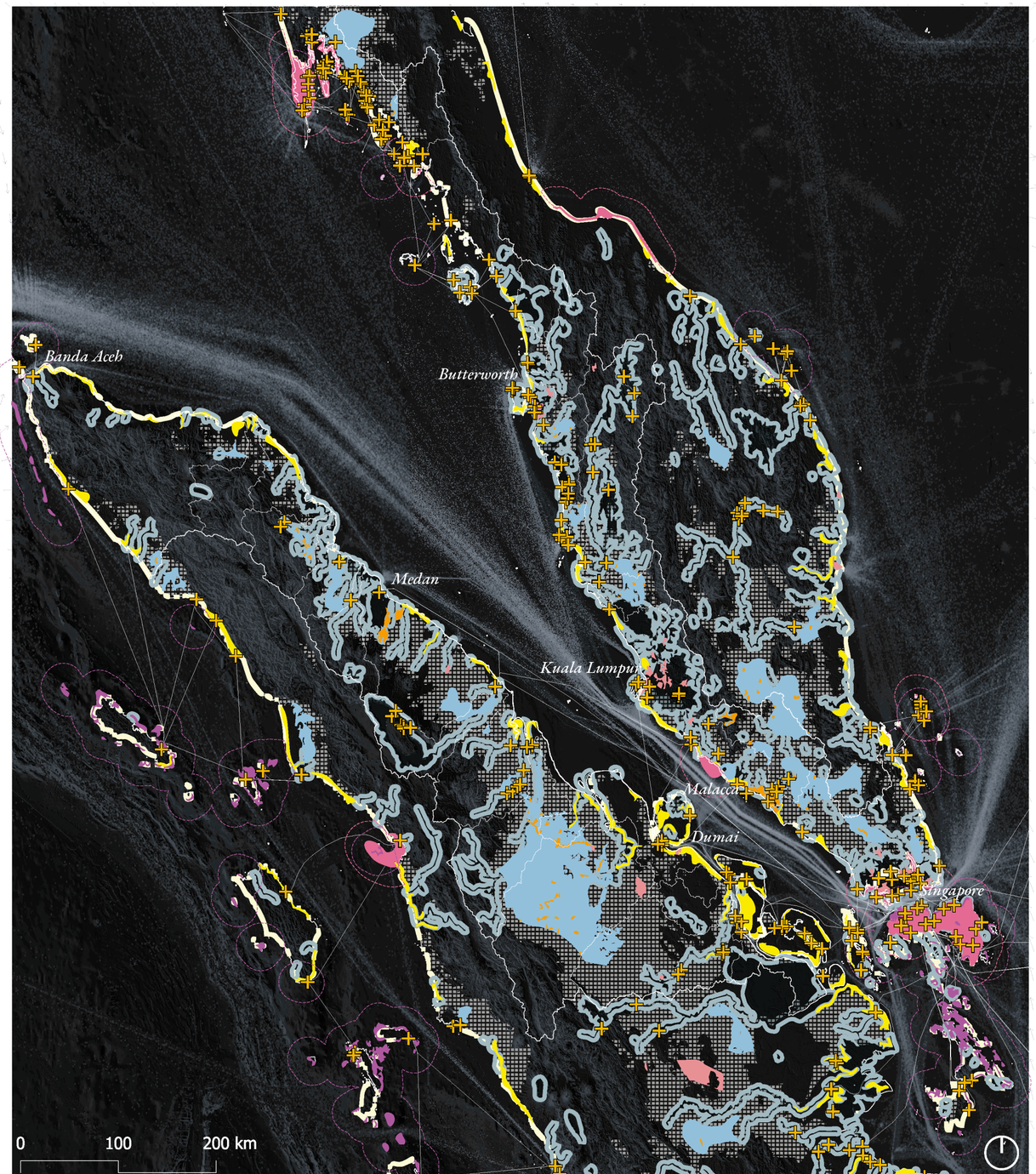
Rethinks the scope and nature of ports.

Enables natural systems to recuperate ecosystem services that counter risk.

Change the way industrial agriculture shapes water systems.

Transform the distribution of agency.

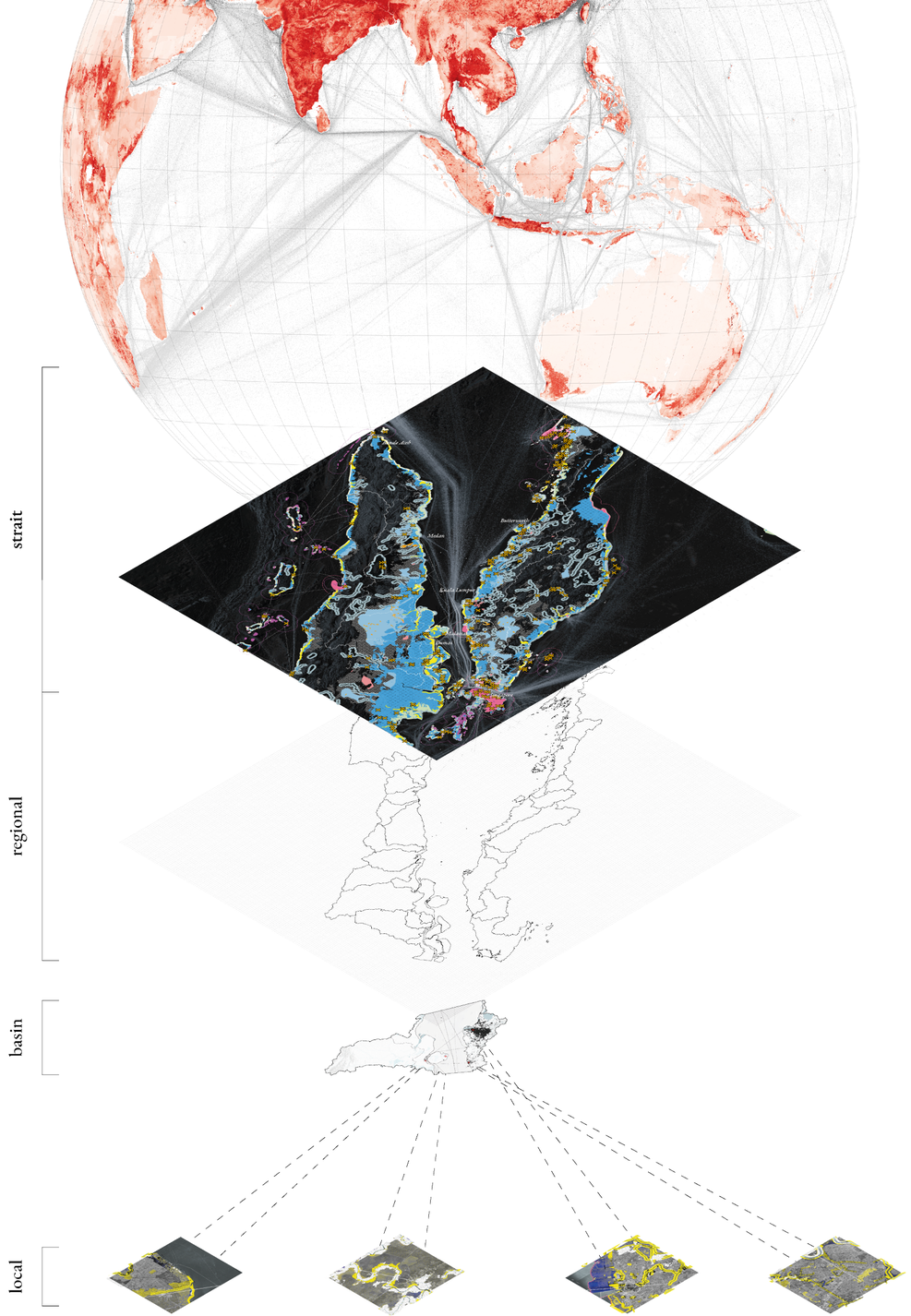
Rewetting
Coral zone
Seagrass zone
Coastal re-naturalisation
Rewetting plantations
Ports
Room for the river
Urban retreat



Enabling recognition

Reconfiguring the management of the Strait of Malacca enables agency on the local scales with encouragement and backing by the normative frameworks that dialogue through the river basin scale.

Transforming policy from an ambition to actually landing in reality, with backing from a covenant of care.



Chapter Conclusion

Post-Anthropocentric Framework
"How can critical proximity inform the spatial reconfiguration of the Strait of Malacca?"

The reconfiguration of the Strait of Malacca lands in the recognition of the critical proximity, by proposing practices of care on both policy and physical practices, they enable its inhabitants to counteract risk effectively in a way that recognises the specificities of place.

These various local realities within the landscapes of the Malacca Strait require a deep understanding of their interrelations with connected systems, and for this the enabling of local practitioners of care are essential. This asks policy to land in various sectors, with each their own responsibility towards nature, related to the various scales of governance.

A sense of care has to be cultivated, and in realising this, phasing as a tool is proposed. To first align ways of managing through scales, integrating the river basin as a new layer, to then extend this management into the marine, again seeking alignment in the methods, to finally reach over the boundaries within the Strait to align fully, and adequately respond to risk from source-to-source.



Lunar New Year celebration (Singapore, Singapore)



A boy playing around a barren beach in front of the Strait (Malacca, Malaysia)

Conclusion

To come back to the main research question of: "How can a reconfiguration of the Malacca Strait drive a new future, shifting from a contested infrastructure to a critical zone, which is ecologically robust and socially equitable, by recognising critical proximity?"

The Strait of Malacca is one of the most important and busiest maritime corridors in the world, yet the inhabitants and natural processes that provide the area with life have been subjected to the management of the Strait as a global infrastructure.

Hundreds of years of re-enforcing its position as a global infrastructure have shaped the management to prioritise the global maritime trade over the local interests, resulting in failure to co-operate across borders, institutions and interests that fragment the shared identity and ecology which have produced a landscape that is subject to cascading risk.

Human modification of lower river basin areas have generated cascading water-related risks made up of inundation, subsidence and erosion. These risks do not occur only in isolation but also in reinforcement of one another, threatening the very existence of coastal inhabitants and the ecological cycles on which the region depends. The areas where these risks overlap, cause the possibility of recuperation to diminish, with the destruction of habitat not merely displacing but also affecting the greater area. The critical proximity has to be balanced once again with the critical distance.

The origin of this risk lies in a failure to recognise the more-than-human actors and processes. The inhabitants of the Strait and its coastal areas, both human and more-than-human, are not seen by the frameworks that claim to manage the area in a sustainable manner. The extractive processes that operate on a global scale leave the biggest marks at the local scale, on the habitats, the livelihoods and overlooked processes which are not represented in the governance of the Strait as a global infrastructure. Any meaningful response to the current issues must start out by addressing this distance to the natural, the Earthly. A new spatial framework for the coastal mosaic of the Malacca Strait therefore cannot be a mere adaptation of the current way of management, it must be a transformation of the very way that nature and the interface of the terrestrial and marine are valued, perceived and inhabited.

Critical proximity as developed by Bruno Latour (2005), insists on the importance of the local and situated, offering a principle to transform the way we perceive the world. Critical proximity is about being embedded in a system, understanding it from within, rather than to make abstract and manage from the outside, something that academia has tried to provide as objectivity. Proximity is not simply physical but also ethical and political commitment to recognise the specificities of place. When applied to the coastal and wetland areas, it enables the framework to go through scales, from the more abstract and intangible regional geopolitics of the Strait, to the river basins that provide life, down to the smallest of scales, landing on Earth and becoming tangible.

The spatial framework that is proposed, is based on the interconnectedness of the scales, and structured across three interdependent scales. Each with its own instruments, actors and spatial practices, enabling a transformative pathway together.

At the regional scale it addresses the structural misalignment between the governance of the Strait as an infrastructure and the ecological realities that cross administrative boundaries. It builds upon the Malacca Strait Council as a transnational instrument to drive cooperation, but shifts its perspective beyond one that prioritises short-term adaptation to enable shipping, but to transform its governance and enable a long-term dynamic dialogue with natural systems.

With the introduction of the new river basin scale, it connects upstream decisions and resulting disruptions, to the coastal and marine vulnerability downstream as well as across the borders within the Strait. This instrument can be used to react to risk downstream by acting on them effectively from within the complexity of the river system.

And finally at the scale of critical proximity, it empowers and identifies the caretakers who are already embedded within the network, to provide care. These caretakers are not passive recipients of a final solution, they are actively shaping a transformation of the systems they are a part of by being provided agency to dialogue with (inter)national management layers. Both ends of the scales are connected through the river basin scale, balancing critical distance with critical proximity.

Across all of the scales, Rights of Nature drives as a normative instrument that provides nature with legal standing, growing recognition of the intricate systems that are built up of many specificities. This transforms the legal movement into a tool that transforms how policy and practice can care for the more-than-human.

The dialogue between the local and regional is essential to align the normative with the physical implementation, to facilitate long term alignment in policy, accounting for dynamic natural processes, that supports the practices of care.

To facilitate this dialogue, the intrinsic value of nature has to be embedded, shifting away from the perspective on nature as a commodity to humans. This value, represented by local society and NGOs, has to be clearly communicated to governing bodies to finally land in policy that represents nature in an accurate way that also functions as a backbone for the caretakers on the local level of implementation. This creates a solid foundation for the Rights of Nature which plays a central role in this framework. In the current state its incorporation is hard, with the instrument tending to make complex and dynamic systems into abstract and static elements, far removed from the reality it operates in. These shortcomings however do not diminish the urgency of granting nature with rights. What is needed is a situated, embedded version of the principle, one that does not speak of nature as an abstraction but gives standing to the specificities that have enabled it to become as well as the inhabitants that depend on them. In this way, Rights of Nature becomes more than a legal abstraction, it becomes a tool for transforming the way policy, governance and people perceive and relate to the more-than-human world.

The emergent framework is not a fixed solution, but a growing system of care, constantly in dialogue and dynamic, responding to the various conditions the future will pose. The Strait of Malacca is not a problem to be solved, but a system to be tended to, the framework proposes pathways, principles and instruments to provide this care. It is an open dialogue on rethinking how humans balance their life with nature, one in which contested infrastructure of the Strait of Malacca does not yield to nature, but finds a new balance to operate, becoming one with the critical zone that is Earth, an ecologically robust, socially equitable equilibrium that is grounded in reality, which has been ignored for too long.



Sand dredgers in the background while trucks drive around sand for the Silicon Island project (Penang, Malaysia)



Essen Beach offering a contrasting view of nature and a sand dredger docking for the Silicon Island (Penang, Malaysia)

Discussion

With the proposal of the spatial framework, phasing and operationalising of the thesis, new pathways forward are becoming possible. Some of these related research topics could be further researched to embed the proposed concepts better.

One of the main topics that need to be further researched is the epistemology of nature, how we map, talk, write, show and overall perceive nature, is based on knowledge that is restricting the perceived value of something so essential to all of us. To give more insights, more research should be done on the natural systems, on various scales, from global to local, their interrelations and very important, how we spatialise this. If this is enabled, a much more in depth analysis could be made of what "nature", really does and how we are disrupting it. It could take planning from recognising general green areas to recognition of systems that shape and sustain them, effectively transforming the value urbanism could bring to natural systems.

Data was at first a limiting factor, with accurate data provided by the governments hard to encompass, also partially due to the language barriers. While global and regional data exist, they are often related to specific sectors of industry and limited in their comprehensive representation of the natural systems. To address the natural systems in a way that reflects the complexity, is hard, with global data being coarse, it is hard to analyse the connection to the local perspective.

River basins are also in a way, limited in perception, due to its visualisation and mapping. The representation of the physical extent should not be seen as a fixed border but a dynamic border that is able to change in the future, requiring to assess its functioning and system extent over time.

Evolutionary resilience could be further researched, as it is something essential to determine how nature changes, despite the efforts to bring it back to how it was. Urbanists and planners should adapt, to see possibilities of what a future, new balance would look like, not trying to restore it to how it was. This also ties in together with how planning practices should become more flexible, not proposing one final outcome but diversifying and transforming, making sure they are given the tools to react to changing future conditions.

Providing a final solution does not take into account the various dynamic systems of nature and also our dependency on those systems. Therefore a shift is necessary, providing a solution for a single element of a complex issue, should go towards proposing a strategy or framework that enables flexibility, to constantly transform and dialogue needs of all actors within a system, to adequately react to a system that is failing.

Related to this solutionism, the concept of phasing as introduced in this thesis, is a tool to drive a more realistic way of planning. Taking into account the rigidity of current planning and policy, requires planning proposals to drive change in phases, to propose alignment first and transformation second.

Existing initiatives such as the Rights of Nature and Nature based Solutions can enable positive change but they are currently restricted by the socio-technical perspective on management. This also leads to great ambitions failing and it resulting in a sense of a failing movement. To enable these movements they have to drive intrinsic values of nature and be able to translate these clearly, linking systems to local perspectives for people to start caring. It also needs to recognise intricate systems in order to adequately react to disruptions of natural systems.

The implementation of the river basin as a new scale of management, enabling dialogue between the critical distance and critical proximity. This builds onto the concept of IRBM, and could contribute to the fields of water management and possibly bio-regionalism, assigning new ways of management that are interlinked with the spatialisation of the natural.

This thesis has prioritised the socio-environmental perspective, about how more-than-human and human are not aligned and how to provide a pathway forward. But to enable this, more research has to be done on the socio-cultural dimension of the Strait. In order to make the people into caretakers, they need to be seen in historical, cultural and economic dimensions. There should also be an evaluation of the current use of the Strait, as a global highway, reinforced by a system that should make us question whether we are really in the Anthropocene, or perhaps in the Capitalocene.

Another limitation of the research is of representative guardians, to assign caretakers to practices per scale. This important next step for guardianship to land both in abstract policy and physical practice is essential to operationalise the human actors, enabling them to care. Future steps could further the specification of actors per typology or sector of port related industries, agriculture, aquaculture, fishing, urban and altered nature. This could drive a more specific approach for policy to assign responsible parties and address better the needs for them to care based on the sector and location.



People fishing from atop a concrete pier (Batam, Indonesia)

Reflection

The project is one that touches many topics relevant to the subject of Rights of Nature, but in doing so it can also overcomplicate a single outcome for transformation to happen. This issue has returned throughout the project multiple times, in various ways, showing how many projects like this one have had great ambitions to enable a new perspective that recognises the natural as an equal, but they have all resulted in minimal effects in planning. I have seen multiple plans, made by ports and other transnational organisations, to try and transform planning in the area, many with very similar approaches to mine, but they all end up as a reminder that commodification of nature is not an easy thing to "fix".

The functioning of planning is still deeply troubled by this and in doing so, constantly undermining the positive effects Rights of Nature and other related movements have. The contribution of this research to the Rights of Nature is to go beyond administrative and visible boundaries of perceived nature, to recognise interconnected systems and link them to people to practice care, landing ambition in reality.

This current shortcoming is on the one hand saddening to see, but there are also a lot of positive things I have seen. By using critical proximity, visiting the place, a new reality has opened up to me, one that shocked but also inspired. With hours of palm oil plantations, also came local people that expressed their care for the place, how people feel connected to their location and how the extractive practices are affecting them all. People really do care, but they are only to practice care when they are enabled to. If they can not meet their own basic needs, how will they care for someone or something else?

Going on fieldwork, touching down and experiencing the places I have seen on satellite images, expanded the way I thought of the place. Seeing the immense scales of human disruptions and the way people are imposed on by this gigantic connected system of global infrastructure is stunning. But the variety of places that also amazed me was incredible, the jungles of Sumatra, hills of Penang and islands full of mangroves in Riau Province, gave me an insight to what this place used to be. Reaching this level of critical proximity is not easy and also not a fixed solution to planning, it is about more than recognising the worth of the local, it is also about valuing the things which are not tangible, these "invisible" natural systems that work on a global and local scale are easily overlooked as too general but are in reality, determining the living conditions.

Relating back to the role of an urbanist, the question rises on how to enable care for this? How do we translate local values? How can we change the way policy perceives these intricate systems?

To me, this relates to the role of the urbanist as the first caretakers, to experience a place and to not merely translate values and impressions, but to also listen to people and understand why they care. This is the first step to shifting the perspective of society, which is urgently needed.

This made me think a lot on this quote of Escobar (2018): 'How can a designer be designed to be a provider of care via the designing of things that ontologically care?". It shows how designers should gain an understanding of the scales and impacts of their designs, to transform their way of practice, to be aware of what their design makes into reality and their roles in the past.

Society is seemingly ever more connected, but there seems to also be more fragmentation and distance, especially to the direct surroundings of oneself. This disconnect with our surrounding and the natural is a worrying one, something so inherently human is becoming a luxury, a commodity. Nature is not a luxury to care for and it should not be, it is and always has been a system we have to tend to.



Construction along an empty Coastarina amusement park (Batam, Indonesia)



Contrasting values on Penang Hill (Penang Hill, Malaysia)



Tan Jetty (George Town, Malaysia)



Fishing with a backdrop of Andaman Island reclamation (George Town, Malaysia)



Fishing village seen across the water from the port town of Belawan (Belawan, Indonesia)



Strait of Penang (George Town, Malaysia)

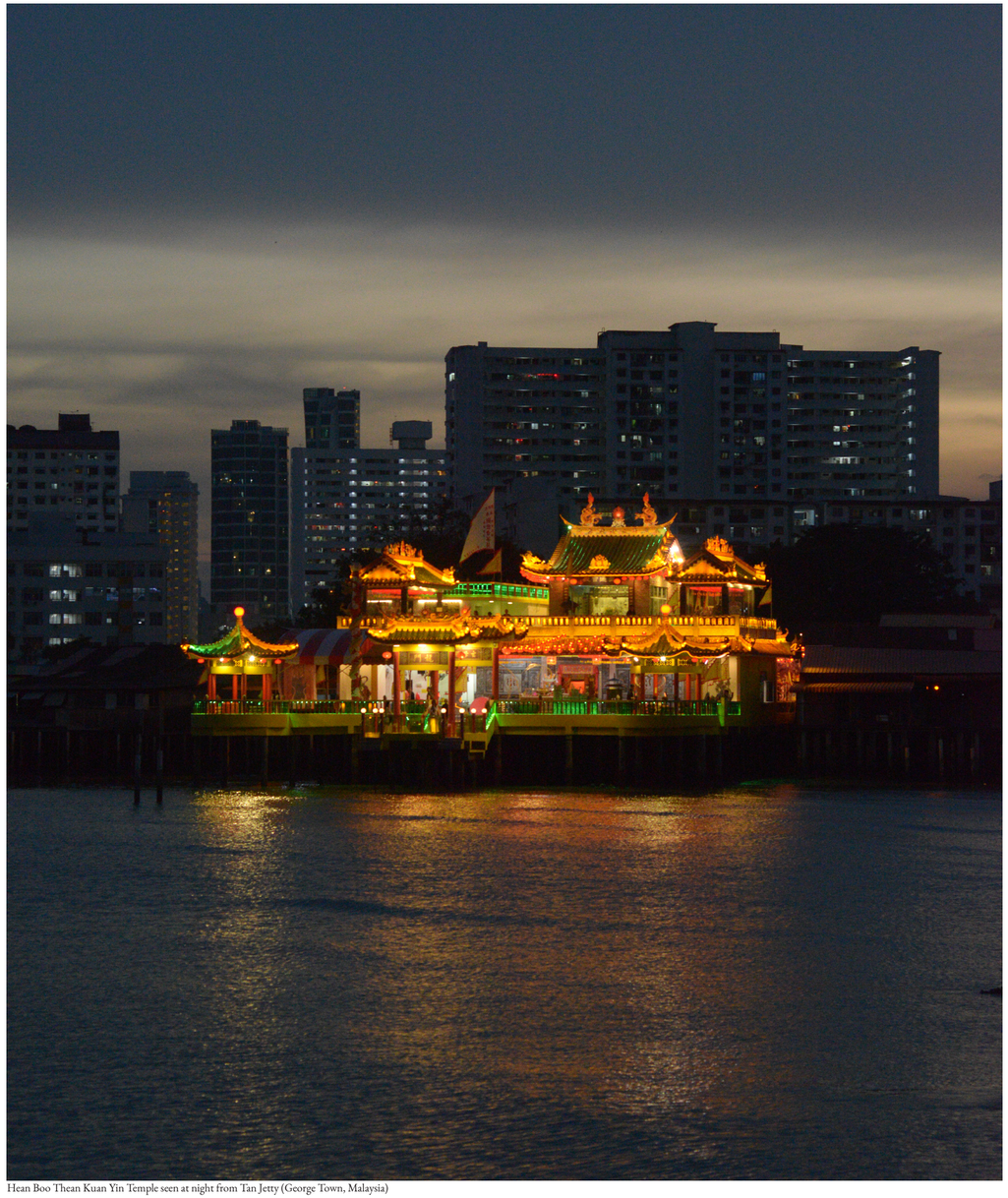




View from Tan Jetty (George Town, Malaysia)



Singapore port and industry seen from the reclaimed beach (Singapore, Singapore)



Hean Boo Thean Kuan Yin Temple seen at night from Tan Jetty (George Town, Malaysia)



Tan Jetty (George Town, Malaysia)







Fishermen with a backdrop of Andaman Island reclamation (George Town, Malaysia)



Butterworth port by night (Butterworth, Malaysia)



Butterworth port (Butterworth, Malaysia)

References

Literature

30 arc second DEM of Southeast Asia | Data Basin. (n.d.). Retrieved 24 November 2025, from https://databasin.org/datasets/b9e89fa05cbe412cae21d5054d463ff3/

30 arc-second DEM of Asia | Data Basin. (n.d.). Retrieved 24 November 2025, from https://databasin.org/datasets/366a1bef53344c02bcd7d7611d5f61f7/

A descriptive method for analysing the Kra Canal decision on maritime business patterns in Malaysia. (n.d.). Retrieved 18 November 2025, from https://ocean -archive.org/view/1417

Abdi, K. (n.d.). A resident's home was hit by a massive flood and suffered extensive damage. The powerful current tore down walls and swept away parts of the building in Uyem Beriring Village, Tripe Jaya, Gayo Lues. iklimku.org. https://iklimku.org/perceiving -disasters -the-great-sumatra-flood/

Abdul Maulud, K. N., Selamat, S. N., Mohd, F. A., Md Noor, N., Wan Mohd Jaafar, W. S., Kamarudin, M. K. A., Ariffin, E. H., Adnan, N. A., & Ahmad, A. (2022). Assessment of Shoreline Changes for the Selangor Coast, Malaysia, Using the Digital Shoreline Anal ysis System Technique. Urban Science, 6(4), 71. https://doi.org/10.3390/urbansci6040071

About. (n.d.). Eco Jurisprudence Monitor. Retrieved 19 November 2025, from https://ecojurisprudence.org/about -2/

Agrawal, S., Bebbington, A., Imhof, A., Maimunah, S., Royo, N., Sauls, L., Sulaiman, R., Toumbourou, T., & Wicaksono, A. (2018). Impacts of Extractive Industry and Infrastructure on Forests: Indonesia.

Ai, L., Liu, S., Cong, S., Zhang, H., Cao, P., Wu, K., Ye, W., Mohamed, C. A. R., & Shi, X. (2024). Spatial variability of surface sediments in the Malacca strait and its implications for sedimentary environments. Journal of Asian Earth Sciences, 259, 1059 22. https://doi.org/10.1016/j.jseaes.2023.105922

Airbus. (2018, July 23). Palm Oil Plantation, Sumatra, Indonesia high resolution satellite image. https://space -solutions.airbus.com/resources/satellite -image-gallery/pleiades/palm -oil-sumatra/

AIS coverage map | AISHub. (n.d.). Retrieved 19 November 2025, from https://www.aishub.net/coverage

Alves, F., Costa, P. M., Novelli, L., & Vidal, D. G. (2023). The rights of nature and the human right to nature: An overview of the European legal system and challenges for the ecological transition. Frontiers in Environmental Science, 11. https://doi.org/ 10.3389/fenvs.2023.1175143

Aqua Monitor —Monitoring surface water changes from space. (n.d.). Retrieved 23 December 2025, from https://aqua -monitor.appspot.com/

Aquaculture Data Download. (n.d.). Geospatial Analytics. Retrieved 12 December 2025, from https://www.clarku.edu/centers/geospatial -analytics/aquaculture -data-download/

Arderne, C., NIcolas, C., Zorn, C., & Koks, E. E. (2020). Data from: Predictive mapping of the global power system using open data [Data set]. Zenodo. https://doi.org/10.5281/zenodo.3628142

Arnez, M. (2020). Reclaiming the sea from the Melaka Gateway.

Arènes, A., Latour, B., & Gaillardet, J. (2018). Giving depth to the surface: An exercise in the Gaia-graphy of critical zones. The Anthropocene Review, 5(2), 120 –135. https://doi.org/10.1177/2053019618782257

Ashley Roach, J. (2013). Straits of Malacca. In Oxford Public International Law. https://opil.ouplaw.com/display/10.1093/law:epil/9780199231690/law -9780199231690 -e1317?p=emailAAFM9mtmh.xBo&d=/10.1093/law:epil/9780199231690/law -9780199231690 -e1317

Athanasiou, P., Van Dongeren, A., Pronk, M., Giardino, A., Vousdoukas, M., & Ranasinghe, R. (2023). Global database of Coastal Characteristics (GCC) [Dataset]. In Zenodo (CERN European Organization for Nuclear Research). https://doi.org/10.5281/zenodo.11072020Ban on exports of sea sand, that destroyed dozens of Indonesian islands, is being lifted – The Conversation – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/2025/01/ban -on-exports-of-sea-sand-that-destroyed -dozens- of-indonesian-islands-is-being-lifted-the-conversation/

BEDOK RECLAMATION WORK. (n.d.). Retrieved 10 December 2025, from https://www.nas.gov.sg/archivesonline/photographs/record -details/885ee62f -1162- 11e3-83d5-0050568939ad

Beyer, H., Venter, O., Grantham, H., & Watson, J. (2019). Global assessment of ecoregion intactness. https://doi.org/10.14264/uql.2019.773

Bhatawdekar, R. M., Singh, T. N., Tonnizam Mohamad, E., Armaghani, D. J., & Binti Abang Hasbollah, D. Z. (2021). River Sand Mining Vis a Vis Manufactured Sand for Sustainability. In X. -N. Bui, C. Lee, & C. Drebenstedt (Eds), Proceedings of the Internationa l Conference on Innovations for Sustainable and Responsible Mining (pp. 143–169). Springer International Publishing. https://doi.org/10.1007/978 -3-030-60839- 2_8

Bibas, B. (2025, November 21). The rights of nature: Reason versus the industrial economy. JusticeInfo.Net. https://www.justiceinfo.net/en/152554 -the-rights-of-nature-reason-versus-the-industrial -economy.html

Biodiversity and Linear Infrastructure Map and Data Portal. (n.d. -a). Retrieved 24 November 2025, from https://dataportal -largelandscapes.hub.arcgis.com/maps/ceaf8d4aa95740eea4dd674e14be5647

Both ENDS: EU -Indonesië handelsakkoord bedreigt gemeenschappen en milieu. (n.d.). Both ENDS. Retrieved 21 November 2025, from https://www.bothends.org/nl/Actueel/Nieuws/EU -Indonesië -handelsakkoord -bedreigt- gemeenschappen -en-milieu/

Brecht, B. (n.d.). SEVEN OBJECTIONS AGAINST LANDING ON EARTH.

Brooks, D., & Agosta, S. (2024c). Surviving the Anthropocene: A Darwinian guide. Global Perspectives, 5(1). https://doi.org/10.1525/gp.2024.115331

Built on Sand: Singapore and the New State of Risk – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/2015/09/built -on-sand-singapore -and- the-new-state-of-risk/

Centre, U. W. H. (n.d.). Melaka and George Town, Historic Cities of the Straits of Malacca. UNESCO World Heritage Centre. Retrieved 15 January 2026, from https://whc.unesco.org/en/list/1223/

Chen, H., Malanotte -Rizzoli, P., Koh, T. -Y., & Song, G. (2014). The relative importance of the wind-driven and tidal circulations in Malacca Strait. Continental Shelf Research, 88, 92–102. https://doi.org/10.1016/j.csr.2014.07.012

China Global Investment Tracker. (n.d.). American Enterprise Institute - AEI. Retrieved 19 November 2025, from https://www.aei.org/china -global-investment -tracker/

Cipriani, L. (2018). Landscapes of hope. RECLAIMING MALACCA. https://www.academia.edu/37054613/Landscapes_of_hope_RECLAIMING_MALACCA

Cipriani, L. (2021). The Death and Life of a Tropical Landscape: Envisaging a New Melaka, Malaysia. In S. Azzali & K. Thirumaran (Eds), Tropical Constrained Environments and Sustainable Adaptations (pp. 187 –207). Springer Singapore. https://doi.org/10.1007 /978-981-33-4631-4_11

Cleary, M., & Chuan, G. K. (2004). Trade and environmental management in the Straits of Malacca: The Singapore experience. In Shipping and Ports in the Twenty -first Century. Routledge.

Climates of Migration. (2014, November 24). Environment & Society Portal. https://www.environmentandsociety.org/mml/climates -migration

Couling, N., & Hein, C. (Eds). (2020). The Urbanisation of the Sea: From Concepts and Analysis to Design. TU Delft OPEN Publishing. https://directory.doabooks.org/handle/20.500.12854/160154

Couling, N., & Hein, C. (Eds). (2020). The Urbanisation of the Sea: From Concepts and Analysis to Design. TU Delft OPEN Publishing. https://doi.org/10.7480/isbn.9789462085930

Crain, C., Halpern, B., Beck, M., & Kappel, C. (2009). Understanding and Managing Human Threats to the Coastal Marine Environment. Annals of the New York Academy of Sciences, 1162, 39 –62. https://doi.org/10.1111/j.1749 -6632.2009.04496.x

Creech, T. (n.d.). Asia's Linear Infrastructure safeGuarding Nature.

Data Series (Data Series). (2015). [Data Series].

Data | CIESIN Columbia University. (n.d. -a). Retrieved 10 December 2025, from https://ciesin.columbia.edu/content/data

Delivering justice in sustainability transitions. (2024, February 28). https://www.eea.europa.eu/en/analysis/publications/delivering -justice-in-sustainability -transitions

designquest.com.hk. (n.d.). The Belt and Road Initiative in ASEAN - Overview | Reports | Publications | HKUST Institute for Emerging Market Studies | Research report | Publications | HKUST Institute for Emerging Market Studies. Retrieved 14 November 2025, from https://iems.ust.hk/publications/report/research -report/uob -bri-overview

Descals, A. (2024). Global oil palm extent and planting year from 1990 to 2021 [Dataset]. In Zenodo (CERN European Organization for Nuclear Research). https://doi.org/10.5281/zenodo.13379129

Devoured. (2021, July 19). Reuters. https://www.reuters.com/graphics/GLOBAL -ENVIRONMENT/SAND -POYANG/qzjpqxxabvx/

Directory. (n.d.). Minority Rights Group. Retrieved 17 November 2025, from https://minorityrights.org/world -map/

Download HydroSHEDS Core Products. (n.d.). Retrieved 24 November 2025, from https://www.hydrosheds.org/hydrosheds -core-downloads

Ehsan, S., Begum, R. A., Nor, N. G. M., & Maulud, K. N. A. (2019). Current and potential impacts of sea level rise in the coastal areas of Malaysia. IOP Conference Series Earth and Environmental Science, 228, 012023. https://doi.org/10.1088/1755-1315/228/1/012023

Emerging Hot Spots 2023. (n.d.). Retrieved 24 November 2025, from https://data.globalforestwatch.org/datasets/e2e70a606cad41e8b7121c3dee00cdb3_0/ explore

Emissary of GAIA – A voice for Nature. (n.d.). Retrieved 12 November 2025, from https://emissaryofgaia.com/

Emissions from peat drainage. (n.d.). Retrieved 12 December 2025, from https://data.globalforestwatch.org/datasets/e129158a68434ca49d96a40d0e3109b1_2/ explore?location=1.567474,102.297532,8.43

Environmental management of the Malacca/Singapore Straits: Legal and institutional issues. (n.d.). ResearchGate. Retrieved 19 November 2025, from https://www.researchgate.net/publication/254977096_Environmental_management_of _the_MalaccaSingapore_Straits_le gal_and_institutional_issues

Erosion—Overzicht. (n.d.). Retrieved 6 January 2026, from https://www.arcgis.com/home/item.html?id=1542ee555fab419da25cd89b71d044b9

External Datasets – Appraising Risk. (n.d.). Retrieved 24 November 2025, from https://www.appraisingrisk.com/external -datasets/

Fullarton, A. & Co. (1872). British Possessions In The Indian Seas. https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~3429~390043:British - Possessions -In-The-Indian-S?sort=pub_list_no_initialsort%2Cpub_date%2Cpub_list_no%2Cseries_no&mi=25&trs=33&qvq=q:Malacca;sort:pub_list_no_initialsort%2Cpub_date%2Cpub_list_no%2Cserie s_no;lc:RUMSEY~8~1#

Gan, H. (n.d.). World-Systems | Metamorphic Zone. Metamorphic Zone. https://metamorphiczone.com/matters/world-systems

Geoeconomic Crossroads: The Strait of Malacca's Impact on Regional Trade | The National Bureau of Asian Research (NBR). (n.d.). Retrieved 19 November 2025, from https://www.nbr.org/publication/geoeconomic -crossroads -the-strait-of-malaccas - impact-on-regional-trade/

GeoServer: Startpagina. (n.d.). Retrieved 5 December 2025, from https://fast.openearth.eu/geoserver/web/?0

Gilbert, J., Soliev, I., Robertson, A., Vermeylen, S., Williams, N. W., & Grabowski, R. C. (2023). Understanding the rights of nature: working together across and beyond disciplines. Human Ecology, 51(3), 363 –377. https://doi.org/10.1007/s10745 -023- 00420-1

Global assessment of ecoregion intactness —UQ eSpace. (n.d.). Retrieved 24 November 2025, from https://espace.library.uq.edu.au/view/UQ:f51cace

Global coastal satellite derived bathymetry static. (n.d. -a). Retrieved 10 December 2025, from https://data.marine.copernicus.eu/product/BATHYMETRY_GLO_PHY_COASTAL_L4_MY _016_001/description

Global coloniality and the Asian century. (n.d.). https://doi.org/10.1177/0921374015585220

Global Forest Watch Open Data Portal. (n.d. -a). Retrieved 24 November 2025, from https://data.globalforestwatch.org/maps/f82b539b9b2f495e853670ddc3f0ce68

Global Forest Watch Open Data Portal. (n.d. -b). Retrieved 12 December 2025, from https://data.globalforestwatch.org/maps/c8920d5ccd9e4e2f91f7a537b2120a3a

Global Forest Watch Open Data Portal. (n.d.). Retrieved 24 November 2025, from https://data.globalforestwatch.org/maps/f82b539b9b2f495e853670ddc3f0ce68

Global Gateway —European Commission. (2023, March 1). https://commission.europa.eu/topics/international -partnerships/global -gateway_en

Global Human Modification. (2018). [Data set]. figshare. https://doi.org/10.6084/m9.figshare.7283087.v1

Global Lakes and Wetlands Database (GLWD) version 2.0. (2025). [Data set]. figshare. https://doi.org/10.6084/m9.figshare.28519994.v1

Global Mangrove Watch. (n.d. -a). Retrieved 8 December 2025, from https://www.globalmangrovewatch.org/?bounds=[[97.41499255643657,4.326975795650554],[98.63896048903575,4.910917732698977]]&layers=[{%22id%22:%22mangrove_net_change%22,%22opacity%22:%221%22,%22visibility%22:%22visible%22},{%22id%22:%22mangrove_habitat_extent%22,%22opacity%22:%221%22,%22visibility%22:%22none%22},{%22id%22:%22mangrove_rest_sites%22,%22opacity%22:%221%22,%22vis ibility%22:%22none%22}]&active -widgets=[%22mangrove_national_dashboard%22,%22mangrove_habitat_extent%22,%22mangrove_net_change%22,%22mangrove_habitat_change%22,%22mangrove_alerts

%22,%22mangrove_species_location%22,%22mangrove_species_distribution%22,%22 mangrove_species_threatened%22]&cate gory=%22all_datasets%22

Global Shipping Traffic Density | Data Catalog. (n.d.). Retrieved 27 November 2025, from https://datacatalog.worldbank.org/search/dataset/0037580/global -shipping-traffic- density

Gokkon, B. (2025, July 18). Indonesia moves to revise sea sand export policy after court ruling. Conservation News. https://news.mongabay.com/2025/07/indonesia -sea-sand- dredging-exports-marine-fisheries/

Google Colab. (n.d.). Retrieved 14 January 2026, from https://colab.research.google.com/drive/1SYWIzPH_2NeqvfqcVzY43y1hv1Ug -YoJ#scrollTo=2zQvNEcdhX2V

Goulding, T. C., & Dayrat, B. (2023). The Coral Triangle and Strait of Malacca are two distinct hotspots of mangrove biodiversity. Scientific Reports, 13(1), 15793. https://doi.org/10.1038/s41598 -023-42057-6

Governance. (n.d.). Plan -Bleu : Environnement et D éveloppement En M éditerranée. Retrieved 12 January 2026, from https://planbleu.org/en/governance/

Green and Blue Infrastructure (GBI) and Urban Nature -based Solutions (NbS) contribution to human and ecological wellbeing and health. (n. d.). Retrieved 24 November 2025, from https://www.researchgate.net/publication/374925698_Green_and_Blue_Infrastructure_ GBI_and_Urban_Nature -based_Solutions_NbS_contribution_to_human_and_ecological_wellbeing_and_health

Gridded Bathymetry Data | GEBCO. (n.d.). Retrieved 15 November 2025, from https://www.gebco.net/data -products/gridded -bathymetry -data

Haider, L. J., Schlüter, M., Folke, C., & Reyers, B. (2021). Rethinking resilience and development: A coevolutionary perspective. AMBIO, 50(7), 1304 –1312. https://doi.org/10.1007/s13280 -020-01485-8

Halpern, B., Frazier, M., Potapenko, J., Casey, K., Koenig, K., Longo, C., Lowndes, J., Rockwood, C., Selig, E., Selkoe, K., & Walbridge, S. (2015). Cumulative human impacts: Raw stressor data (2008 and 2013). https://doi.org/10.5063/F1S180FS

Halpern, B., Walbridge, S., Selkoe, K., Kappel, C., Micheli, F., D'Agrosa, C., Bruno, J., Casey, K., Ebert, C., Fox, H., Fujita, R., Heinemann, D., Lenihan, H., Madin, E., Perry, M., Selig, E., Spalding, M., Steneck, R., & Watson, R. (NaNa). Raw Stressor D ata: A Global Map of Human Impact on Marine Ecosystems, 2008. https://doi.org/10.5063/F1JW8C4R

Haraway, D. (20). When species meet (Nachdr.). Univ. of Minnesota Press.

Heng, D. (2009). Sino -Malay Trade and Diplomacy from the Tenth Through the Fourteenth Century. Ohio University Press. http://ebookcentral.proquest.com/lib/delft/detail.action?docID=1743719

Hidayat, T., Fitrianingrum, L., Suharto, & Sudibyo, S. (2020). Ecology and sociology analysis for mineral resources management in Indonesia. IOP Conference Series: Earth and Environmental Science, 483, 012030. https://doi.org/10.1088/1755 -1315/483/1/012030

High-resolution (1 km) Köppen -Geiger maps for 1901 –2099 based on constrained CMIP6 projections. (2022). [Data set]. figshare. https://doi.org/10.6084/m9.figshare.21789074.v1

Ho, J. H. (2009). Enhancing safety, security, and environmental protection of the Straits of Malacca and Singapore: the Cooperative Mechanism. Ocean Development & International Law, 40(2), 233 –247. https://doi.org/10.1080/00908320902864854

Home page | PEMSEA. (n.d.). Retrieved 13 November 2025, from https://www.pemsea.org/

Home | Ramsar Sites Information Service. (n.d.). Retrieved 3 December 2025, from https://rsis.ramsar.org/?__goaway_challenge=meta -refresh&__goaway_id=907aa31e2c524a02e39a9d2cfec12b3f&__goaway_referer=https %3A%2F%2Fwww.google.com%2F

HydroRIVERS. (n.d.). Retrieved 8 December 2025, from https://www.hydrosheds.org/products/hydrorivers

IISS China Connects. (n.d.). Retrieved 20 November 2025, from https://chinaconnects.iiss.org/

Index of /NOAA/G02135/north/monthly/. (n.d.). Retrieved 17 November 2025, from https://noaadata.apps.nsidc.org/NOAA/G02135/north/monthly/

Indigenous Council —GARN. (2021, November 9). https://www.garn.org/indigenous -council/

Indonesia – MSPGLOBAL2030. (2025, December 16). https://www.mspglobal2030.org/msp -roadmap/msp -around-the-world/asia/indonesia/

Indonesia: Interregional Zoning Plans – MSPGLOBAL2030. (2025, December 1). https://www.mspglobal2030.org/msp -roadmap/msp -around-the-world/asia/indonesia/interregional -zoning-plans/

Indonesia's risky gamble with sea sand exports – Dialogue Earth – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/2025/03/indonesias -risky- gamble-with-sea-sand-exports-dialogue-earth/

Indriyatno, H. (2024, October 10). Javan fisherwomen lead fight against marine dredging amid fears of damage. Conservation News. https://news.mongabay.com/2024/10/fishers -women-indonesia -pantura-java-dredging-sand-exportsogical -and-economic -damage/

Integrated River Basin Management Project | PEMSEA. (2023, January). PEMSEA. https://www.pemsea.org/what -we-do/integrated -river-basin-management -project

International Best Track Archive for Climate Stewardship (IBTrACS). (2024, July 17). National Centers for Environmental Information (NCEI). https://www.ncei.noaa.gov/products/international -best-track-archive

Isa, M. M. (2023). Coastal protection strategies in sustainable landscape design at Kelanang Beach, Selangor. https://doi.org/10.47253/JTRSS.V11I1.1088

ITU - Infrastructure Connectivity Map. (n.d.). Retrieved 3 December 2025, from https://bbmaps.itu.int/bbmaps/

Jamaludin, J., De Alban, J. D. T., Carrasco, L. R., & Webb, E. L. (2022). Spatiotemporal analysis of deforestation patterns and drivers reveals emergent threats to tropical forest landscapes. Environmental Research Letters, 17(5), 054046. https://doi.org/10.1088/1748 -9326/ac68fa

Kalimantan, Borneo, Indonesia – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/2012/07/kalimantan -borneo-indonesia/

Key Biodiversity Areas. (n.d.). Retrieved 20 November 2025, from https://www.keybiodiversityareas.org/request -gis-data

Khurram, S., Pour, A. B., Bagheri, M., Helmy Ariffin, E., Akhir, M. F., & Bahri Hamzah, S. (2025). Satellite -Based Multi -Decadal Shoreline Change Detection by Integrating Deep Learning with DSAS: Eastern and Southern Coastal Regions of Peninsular Malaysia. Remote Sensing, 17(19), 3334. https://doi.org/10.3390/rs17193334

Kidner, D. W. (2012). Exploring the Farther Reaches of Commoditization: A Systemic Perspective. Bulletin of Science, Technology & Society, 32(1), 18 –30. https://doi.org/10.1177/0270467612444580

KKP | Kementerian Kelautan dan Perikanan. (n.d.). Retrieved 9 December 2025, from https://kkp.go.id/news/news -detail/pengelolaan -hasil-sedimentasi -di-laut-untuk- melaksanakan -pembersihan -hasil-sedimentasi -di-laut65fa44180959c.html

KNB. (n.d.). Retrieved 17 November 2025, from https://knb.ecoinformatics.org/view/doi%3A10.5063%2FF1NZ85ZN

Know about Belt and Road —BELT AND ROAD PORTAL. (n.d.). Retrieved 12 November 2025, from https://eng.yidaiyilu.gov.cn/list/w/know_about

Kopnina, H. (2019). Anthropocentrism and Post -Humanism. In H. Callan (Ed.), The International Encyclopedia of Anthropology (1st edn, pp. 1 –8). Wiley. https://doi.org/10.1002/9781118924396.wbiea2387

Kuala Lumpur Malaysia Sungai -Klang-03.jpg - Wikimedia Commons. (2014, October 31). Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Kuala_Lumpur_Malaysia_Sungai -Klang-03.jpg

Lai, S., Loke, L. H. L., Hilton, M. J., Bouma, T. J., & Todd, P. A. (2015). The effects of urbanisation on coastal habitats and the potential for ecological engineering: A Singapore case study. Ocean & Coastal Management, 103, 78 –85. https://doi.org/10.101 6/j.ocecoaman.2014.11.006

Land rights. (n.d.). Retrieved 24 November 2025, from https://data.globalforestwatch.org/datasets/e22b22b3525c46f3b35548daf628990 3_1/e xplore?location=2.529225,98.703959,10.59

Lane, G. (2025, March 4). Navigating the 'Malacca Dilemma' in 2025. Atlas Institute for International Affairs. https://atlasinstitute.org/navigating -the-malacca -dilemma -in- 2025/

Latour, B. (2020). Critical Zones. The science and politics of landing on Earth | Bruno-latour.fr. http://www.bruno-latour.fr/node/838.html

Lawrence, J., Blackett, P., & Cradock-Henry, N. A. (2020). Cascading climate change impacts and implications. Climate Risk Management, 29, 100234. https://doi.org/10.1016/j.crm.2020.100234

Liu, J., Wang, J., Xu, C., & Jiang, J. (2024). Spatial and temporal change assessment of marine ecological security in regions along the Maritime Silk Road. Ecological Indicators, 166, 112576. https://doi.org/10.1016/j.ecolind.2024.112576

Lower Fish Haul Due To Sand Mining, Malaysia – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/2014/07/lower -fish-haul-due-to-sand- mining-malaysia/

Luijendijk, A., Hagenaars, G., Ranasinghe, R., Baart, F., Donchyts, G., & Aarninkhof, S. (2018). The State of the World's Beaches. Scientific Reports, 8(1), 6641. https://doi.org/10.1038/s41598 -018-24630-6

MacDonald Gill, L. (n.d.). Mail steamship routes. MacDonald Gill, 1937. P.R.D. 182. https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~268344~9004 2625:M ail-steamship -routes--MacDonald -Gi#

Makarov, D., Makarova, O., Mayurov, N., Mayurov, P., & Turova, V. (2022). Development prospects and importance of the Northern Sea Route. Transportation Research Procedia, 63, 1114 –1120. https://doi.org/10.1016/j.trpro.2022.06.114

Makarov, D., Makarova, O., Mayurov, N., Mayurov, P., & Turova, V. (2022). Development prospects and importance of the Northern Sea Route. Transportation Research Procedia, X International Scientific Siberian Transport Forum — TransSiberia 2022, 63, 1114–1120. https://doi.org/10.1016/j.trpro.2022.06.114

Malacca Straits Environmental Profile | PEMSEA. (n.d.). Retrieved 13 November 2025, from https://www.pemsea.org/publications/reports/malacca -straits-environmental -profile

Malacca, Straits of. (n.d.). Oxford Public International Law. Retrieved 23 January 2026, from https://opil.ouplaw.com/display/10.1093/law:epil/9780199231690/law -9780199231690 -e1317?d=%2F10.1093%2Flaw%3Aepil%2F9780199231690%2Flaw -9780199231690 -e1317&p=email AUDJXhttImyug

Malaysia. (2023). https://minorityrights.org/country/malaysia/

Man, C. Y., & Palmer, D. A. (2022). Geo -mapping databases of the Belt and Road Initiative. figshare. https://doi.org/10.6084/M9.FIGSHARE.C.6076193

MapBiomas. (n.d.). Retrieved 4 December 2025, from https://platform.indonesia.mapbiomas.org/coverage/coverage_lclu_transitions?t[regio nKey]=indonesia&t[ids][]=4 -1-1&t[divisionCategoryId]=2&tl[id]=11&tl[themeKey]=coverage&tl[subthemeKey]=coverag e_lclu_transitions&tl[pixelValues][]=1&tl[pixelValues][]=2&tl[pixelValues][]=3&tl[pixelValues][]=4&tl[pixelValues][]=5&tl[year][]=1990&tl[year][]=2024&tl[legendKey]=coverage_lc lu_transitions

Mapping the Belt and Road initiative: This is where we stand | Merics. (2018, June 7). https://merics.org/en/tracker/mapping -belt-and-road-initiative -where-we-stand

Marine Regions · Malacca Strait (IHO Sea Area). (n.d.). Retrieved 1 December 2025, from https://marineregions.org/gazetteer.php?p=details&id=4275

Marine Regions. (n.d. -a). Retrieved 16 November 2025, from https://www.marineregions.org/downloads.php

MarineTraffic: Global Ship Tracking Intelligence | AIS Marine Traffic. (n.d. -a). Retrieved 19 November 2025, from https://www.marinetraffic.com/en/ais/home/centerx:101.1/centery:1.5/zoom:5

MarineTraffic: Global Ship Tracking Intelligence | AIS Marine Traffic. (n.d. -b). Retrieved 24 November 2025, from https://www.marinetraffic.com/en/ais/home/centerx:105.1/centery:3.8/zoom:6

MarineTraffic: Global Ship Tracking Intelligence | AIS Marine Traffic. (n.d.). Retrieved 19 November 2025, from https://www.marinetraffic.com/en/ais/home/centerx:101.1/centery:1.5/zoom:5

Maritime Transportation Security: “Malacca Dilemma” and “Strings of Pearls”. (n.d.). https://doi.org/10.1016/B978 -0-12-815152-5.00009-9

Maximum ships sizes for the Panama and Suez Canals, strait of Malacca. (2014, September 17). EIA. https://www.eia.gov/todayinenergy/detail.php?id=18011

McNair, J. F. A. (with Robarts - University of Toronto). (1878). Perak and the Malays: ‘Sarong’ and ‘kris.’ London, Tinsley brothers. http://archive.org/details/perakmalayssaron00mcnauoft

Melaka | Atlas of mutual heritage. (n.d.). Retrieved 18 November 2025, from https://www.atlasofmutualheritage.nl/page/3852/melaka

MicoLeao. (n.d.). Download GIS data on biodiversity for the globe, the ocean, and the USA. BiodiversityMapping.Org. Retrieved 20 November 2025, from https://biodiversitymapping.org/index.php/download/

Motamedi, S., Hashim, R., Zakaria, R., Song, K. -I., & Sofawi, B. (2014). Long -Term Assessment of an Innovative Mangrove Rehabilitation Project: Case Study on Carey Island, Malaysia. The Scientific World Journal, 2014, 953830. https://doi.org/10.1155/2014/9 53830

Movebank. (n.d.). Retrieved 20 November 2025, from https://www.movebank.org/cms/webapp?gwt_fragment=page=search_map

Muddy Coasts. (n.d.). EcoShape - EN. Retrieved 5 December 2025, from https://www.ecoshape.org/en/landscapes/muddycoasts/

Mustafa, M., & Ariffin, M. (2011). Protection of Marine Biodiversity from Pollution: Legal Strategies in Malaysia. International Journal of Bioscience, Biochemistry and Bioinformatics, 276 –281. https://doi.org/10.7763/IJBBB.2011.V1.52

Nanang Sujana (Director). (2019, May 7). Indigenous Peoples: The Guardian of Indonesian Forest [Video recording]. https://www.youtube.com/watch?v=8X1m9Qwy3YQ

NatureScot Spatial Data Hub. (n.d.). Retrieved 29 December 2025, from https://opendata.nature.scot/search?groupIds=68d8be95242a4cebb9aacfec9075fa80

Nedopil, C. (2025). China's Belt and Road Initiative (BRI) Investment Report 2024. Griffith University. https://doi.org/10.25904/1912/5784

Nedopil, C. (with University, G.). (2025). China's Belt and Road Initiative (BRI) Investment Report 2024. Griffith University. https://doi.org/10.25904/1912/5784

Negura, L., Plante, N., & Masse, Y. (n.d.). Representational Naturalization as a Process: How Do Representational Objects Become Social Reality?

Ng, L. S., Campos -Arceiz, A., Sloan, S., Hughes, A. C., Tiang, D. C. F., Li, B. V., & Lechner, A. M. (2020). The scale of biodiversity impacts of the Belt and Road Initiative in Southeast Asia. Biological Conservation, 248, 108691. https://doi.org/10.1016/j.biocon.2020.108691

Nusantara Atlas | Indonesia's Mining Crossroads: New Map Unveils Opportunities for Environmental Monitoring. (2024, July 3). Nusantara Atlas. https://nusantara -atlas.org/indonesias -mining-crossroads -new-map-unveils-opportunities -for-environmental -monitoring/

Nusantara Atlas | The vanishing forests of Tesso Nilo National Park. (2022, October 27). Nusantara Atlas. https://nusantara -atlas.org/the -vanishing -forests-of-tesso-nilo-national-park/

Nusantara Atlas. (n.d.). Nusantara Atlas. Retrieved 27 November 2025, from https://map.nusantara -atlas.org/

Ocean+ Habitats. (n.d.). Ocean+ Habitats. Retrieved 20 November 2025, from https://habitats.oceanplus.org

Oil Spill Preparedness. (n.d.). RFC. Retrieved 24 November 2025, from https://rfcsoms.org/oil -spill-preparedness/

Olivadese, M. (2025). Rethinking Nature -Based Solutions: Unintended Consequences, Ancient Wisdom, and the Limits of Nature. Land, 14(6), 1272. https://doi.org/10.3390/land14061272

Omara, M., Gautam, R., O'Brien, M. A., Himmelberger, A., Franco, A., Meisenhelder, K., Hauser, G., Lyon, D. R., Chulakadabba, A., Miller, C. C., Franklin, J., Wofsy, S. C., & Hamburg, S. P. (2023). Developing a spatially explicit global oil and gas infrast ructure database for characterizing methane emission sources at high resolution. Earth System Science Data, 15(8), 3761 –3790. https://doi.org/10.5194/essd -15-3761-2023

Online resources | IIAS. (n.d.). Retrieved 24 November 2025, from https://www.iias.asia/resources?tid_1=2277&tid_2=1875&field_tags_target_id=All

Open Geospatial Solutions. (2025). Opengeos/qgis -timelapse -plugin [Python]. https://github.com/opengeos/qgis -timelapse -plugin (Original work published 2025)

Opengeos/qgis -timelapse -plugin. (2025). [Python]. Open Geospatial Solutions. https://github.com/opengeos/qgis -timelapse -plugin (Original work published 2025)

Osland, M. J., Enwright, N. M., Day, R. H., Gabler, C. A., Stagg, C. L., & Grace, J. B. (2016). Beyond just sea -level rise: Considering macroclimatic drivers within coastal wetland vulnerability assessments to climate change. Global Change Biology, 22(1), 1–11. https://doi.org/10.1111/gcb.13084

Overview —Convention & Related Agreements. (n.d.). Retrieved 1 December 2025, from https://www.un.org/depts/los/convention_agreements/convention_overview_conventio n.htm

O'Brien, M., Omara, M., Himmelberger, A., & Gautam, R. (2025b). Oil and Gas Infrastructure Mapping (OGIM) database [Data set]. Zenodo. https://doi.org/10.5281/zenodo.15103476

Pekel, J.-F., Cottam, A., Gorelick, N., & Belward, A. S. (2016). High -resolution mapping of global surface water and its long -term changes. Nature, 540(7633), 418 –422. https://doi.org/10.1038/nature20584

Perry, R. I., Ommer, R. E., Barange, M., Jentoft, S., Neis, B., & Sumaila, U. R. (2011). Marine social –ecological responses to environmental change and the impacts of globalization. Fish and Fisheries, 12(4), 427 –450. https://doi.org/10.1111/j.1467 -2979.2010.00402.x

Planetary boundaries. (2012, September 19). [Text]. https://www.stockholmresilience.org/research/planetary -boundaries.html

Pond Aquaculture. (n.d. -a). Retrieved 12 December 2025, from https://www.aquaculture.earth/coastal/index.html

Ports & Cities environment. (n.d.). EcoShape - EN. Retrieved 5 December 2025, from https://www.ecoshape.org/en/landscapes/cities/ports -cities-environment/

Powell, M. A. (2021). Singapore's Lost Coast: Land Reclamation, National Development and the Erasure of Human and Ecological Communities, 1822 -Present. Environment and History, 27(4), 635 –663. https://doi.org/10.3197/096734019X15631846928710

Protected Areas (WDPA). (n.d.). Protected Planet. https://www.protectedplanet.net/en/thematic -areas/wdpa?tab=WDPA

Protected Planet | Asia & Pacific. (n.d.). Protected Planet. Retrieved 20 November 2025, from https://www.protectedplanet.net/region/AS

Protecting vital sea lines of communication: A study of the proposed designation of the Straits of Malacca and Singapore as a particularly sensitive sea area. (2012). Ocean & Coastal Management, 57, 79 –94. https://doi.org/10.1016/j.ocecoaman.2011.12.003

Rae, G. (2014). Anthropocentrism. In H. Ten Have (Ed.), Encyclopedia of Global Bioethics (pp. 1 –12). Springer International Publishing. https://doi.org/10.1007/978 -3-319-05544-2_24-1

Rahman, M. F., Lewis, D., Kuhl, L., Baldwin, A., Ruszczyk, H., Nadiruzzaman, M., & Mahid, Y. (2023). Managed urban retreat: the trouble with crisis narratives. Urban Geography, 45(1), 23–32. https://doi.org/10.1080/02723638.2023.2228094

Reef risk due to coastal development in Southeast Asia | Data Basin. (n.d.). Retrieved 24 November 2025, from https://databasin.org/datasets/0719a21bf801435d9e7097ae1e2c21f2/

Reef risk due to marine -based pollution in Southeast Asia | Data Basin. (n.d.). Retrieved 24 November 2025, from https://databasin.org/datasets/e752447c153440fba39d8361ae72f305/

Regime building in the Malacca and Singapore straits: Two steps forward, one step back. (n.d.). Retrieved 18 November 2025, from https://ocean -archive.org/view/1420

Regional Transport Infrastructure: Mapping Projects to Bridge South Asia and Southeast Asia. (n.d.). (43).

Rehabilitating mangrove belts. (n.d.). EcoShape - EN. Retrieved 5 December 2025, from https://www.ecoshape.org/en/concepts/rehabilitating -mangrove -belts/

Reichhardt, T. (2013, November 16). The first photo from space. Smithsonian Magazine. https://www.smithsonianmag.com/air -space-magazine/the -first-photo-from-space- 13721411/

Research, P. I. for C. I. (n.d.). Planetary Boundaries framework gains traction in sustainability science. Retrieved 14 January 2026, from https://phys.org/news/2024 -11- planetary -boundaries -framework -gains-traction.html

Risk and Vulnerability Data. (n.d.). Geospatial Analytics. Retrieved 29 December 2025, from https://www.clarku.edu/centers/geospatial -analytics/risk -and-vulnerability -data/

Sanchis, I. R., & Meulen, G. J. M. van der. (2021). Challenges and Opportunities in Upscaling Room for the River. A conversation about large -scale change through small - scale interventions. International Forum of Urbanism. https://doi.org/10.24404/6151D869B3DD970008EAF672

Sand Mining – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/sand -mining/

Sand Storm: $750 Million Worth of The Material is Unaccounted For in Cambodia – Coastal Care. (n.d.). Retrieved 23 December 2025, from https://coastalcare.org/2016/11/sand -storm-750-million-worth-of-the-material-is- unaccounted -for-in-cambodia/

Schinas, O., & von Westarp, A. G. (2017). Assessing the impact of the maritime silk road. Journal of Ocean Engineering and Science, 2(3), 186 –195. https://doi.org/10.1016/j.joes.2017.08.002

Sheaves, M. (2009). Consequences of ecological connectivity: the coastal ecosystem mosaic. Marine Ecology Progress Series, 391, 107 –115. https://doi.org/10.3354/meps08121

Shoreline Typology Map of Singapore 2018 | NPARKS. (n.d.). Retrieved 20 November 2025, from https://data.gov.sg/datasets/d_1c8da29731b8d11a29ec5dfaff88c0f7/view

Shoreman -Ouimet, E., & Kopnina, H. (2016). Culture and Conservation: Beyond Anthropocentrism.

Sidiq, T. P., Gumilar, I., Abidin, H. Z., Meilano, I., Purwarianti, A., & Lestari, R. (2025). Spatial distribution and monitoring of land subsidence using Sentinel -1 SAR data in Java, Indonesia. Applied Sciences, 15(7), 3732. https://doi.org/10.3390/app15073732

Spaliviero, M., Boerboom, L., Gibert, M., Spaliviero, G., & Bajaj, M. (2019). The Spatial Development Framework to facilitate urban management in countries with weak planning systems. International Planning Studies, 24(3 –4), 235–254. https://doi.org/10.1080/13563475.2019.1658571

Statistisk havisfrekvens for Arktis for de siste 30 år (1995 —2024)—Kartkatalogen. (n.d.). Retrieved 17 November 2025, from https://kartkatalog.geonorge.no/metadata/statistisk -havisfrekvens -for-arktis-for-de- siste-30-aar-1995-2024/1823714a -3f0d-4d0e-b9a4-05c0c2dfeb52

Straits of Malacca | Smithsonian American Art Museum. (n.d.). Retrieved 18 November 2025, from https://americanart.si.edu/artwork/straits -malacca -32079

Studio, N. S. V. (2014, November 5). NASA Scientific Visualization Studio | Tesso Nilo National Park. NASA Scientific Visualization Studio. https://svs.gsfc.nasa.gov/30545/

Submarine Cable Map. (n.d.). Retrieved 26 November 2025, from https://www.submarinecablemap.com/submarine -cable/2africa

Tahir, A., Zamari, Z., Mohd Aripin, N., Desa, N., Bakar, S., Wahab, F., & Mohd Noor, A. (2020). Contribution of Artists Through Printing as Visual Communication Medium Among Colonies During the British Era in Malaya. https://doi.org/10.2991/assehr.k.201202 .078

Team, G. R. (n.d.). Global Lakes and Wetlands Database (GLWD) v2.0. Global Lakes and Wetlands Database. Retrieved 2 December 2025, from https://glwd -app.confluv.io

Team, T. A. P. (2016, December 29). China's BRI Negatively Impacting The Environment. The ASEAN Post. https://theaseanpost.com/article/chinas -bri-negatively - impacting - environment

The Belt and Road Initiative Progress, Contributions and Prospects —BELT AND ROAD PORTAL. (n.d.). Retrieved 19 November 2025, from https://eng.yidaiyilu.gov.cn/p/86739.html

The IUCN Red List of Threatened Species. (n.d.). IUCN Red List of Threatened Species. Retrieved 27 November 2025, from https://www.iucnredlist.org/en

The Ocean Legacy of Malaka and Sustainability of the Straits of Malacca. (n.d.). Retrieved 18 November 2025, from https://ocean -archive.org/view/1419

The rights of nature and the human right to nature: An overview of the European legal system and challenges for the ecological transition. (n.d.). Retrieved 21 November 2025, from https://www.researchgate.net/publication/372138793_The_rights_of_nature_and_the_h uman_right_to_nature_an_overview_of_the_European_legal_system_and_challenges_f o r_the_ecological_transition

The Sea Level Explorer. (n.d.). Retrieved 19 November 2025, from https://ccar.colorado.edu/altimetry/

The Strait of Malacca – a historical shipping metropolis. (n.d.). World Ocean Review. Retrieved 18 November 2025, from https://worldoceanreview.com/en/wor - 5/living-with- the-coasts/coastal -functions/the -strait-of-malacca -a-historical - shipping-metropolis/

The Strait of Malacca. (n.d.). Retrieved 18 November 2025, from https://ocean - archive.org/collection/138

The Strait of Malacca: An Inland Sea | Gis Asie. (n.d.). Retrieved 23 December 2025, from https://www.gis -reseau-asie.org/en/article/strait -malacca -inland-sea-0

The Suma oriental of Tomé Pires : an account of the East, from the Red Sea to Japan, written in Malacca and India in 1512 -1515 ; and, the book of Francisco Rodrigues, rutter of a voyage in the Red Sea, nautical rules, almanack and maps, written and drawn in the East before 1515 : Pires, Tomé, approximately 1468 -approximately 1540 : Free Download, Borrow, and Streaming : Internet Archive. (1944). Internet Archive. https://archive.org/details/McGillLibrary -136385-182

Thia-Eng, C., Gorre, I. R. L., Adrian Ross, S., Bernad, S. R., Gervacio, B., & Corazon Ebarvia, M. (2000). The Malacca Straits. Marine Pollution Bulletin, 41(1), 160 –178. https://doi.org/10.1016/S0025 -326X(00)00108 -9

Thia-Eng, C., Gorre, I. R. L., Adrian Ross, S., Bernad, S. R., Gervacio, B., & Corazon Ebarvia, M. (2000). The Malacca Straits. Marine Pollution Bulletin, Seas at the Millennium: An Environmental Evaluation, 41(1), 160 –178. https://doi.org/10.1016/S0025 - 326X(00)00108 -9

Tropical Pond Aquaculture and Coastal Wetlands. (n.d. -a). Retrieved 24 November 2025, from https://data.globalforestwatch.org/datasets/c8920d5ccd9e4e2f91f7a537b2120a3a _0/e xplore

Tropical Pond Aquaculture and Coastal Wetlands. (n.d.). Retrieved 12 December 2025, from https://data.globalforestwatch.org/datasets/gfw::tropical -pond-aquaculture -and-coastal-wetlands/about

Troubled waters. (2019, August 22). Kontinentalist. https://kontinentalist.com/stories/troubled -waters-piracy-and-maritime - security-in- southeast -asia

UNESCO World Heritage Convention. (n.d.). Melaka and George Town, Historic Cities of the Straits of Malacca. In unesco.org. https://whc.unesco.org/en/list/1223/maps/#map

View of land reclamation works in progress at Jurong Island …. (n.d.). Retrieved 10 December 2025, from https://www.nas.gov.sg/archivesonline/photographs/record - details/6abb42f8 -1162-11e3-83d5-0050568939ad

Viner, D., Ekstrom, M., Hulbert, M., Warner, N. K., Wreford, A., & Zommers, Z. (2020). Understanding the dynamic nature of risk in climate change assessments —A new starting point for discussion. Atmospheric Science Letters, 21(4), e958. https://doi.org/10. 1002/asl.958

Ward, K., & Observatory, N. E. (2025, December 12). Earth at Night/Black Marble: Flat maps - NASA Science. NASA Science. https://science.nasa.gov/earth/earth - observatory/earth -at-night/maps/

Watersheds of Southest Asia with erosion estimates | Data Basin. (n.d.). Retrieved 24 November 2025, from https://databasin.org/datasets/1efa9f4da8cd45a3be861df62fb3015e/

Welcome to Cerulean. (n.d.). Retrieved 14 January 2026, from https://cerulean.skytruth.org/?area=0_Infinity&classes=2_3_4_5_6_7_8&date_range=20 25-01-01_2025-12-31&hitl_classes=2_3_4_5_6_7_8_9&hitl_review=0_1&min_confidence=0.7&source_limit =3&source_score=0_Infinity&lat=1.471432&lon=101.938044&zoom=4.620946&mpa=tru e&sources=1_2_3

Winterwerp, J. C., Albers, T., Anthony, E. J., Friess, D. A., Mancheño, A. G., Moseley, K., Muhari, A., Naipal, S., Noordermeer, J., Oost, A., Saengsupavanich, C., Tas, S. A. J., Tonneijck, F. H., Wilms, T., Van Bijsterveldt, C., Van Eijk, P., Van Lavieren , E., & Van Wesenbeeck, B. K. (2020). Managing erosion of mangrove -mud coasts with permeable dams – lessons learned. Ecological Engineering, 158, 106078. https://doi.org/10.1016/j.ecoleng.2020.106078

Wisha, U. J., Wijaya, Y. J., & Hisaki, Y. (2025). Tidal regime deformation due to sea level rise in the Malacca Strait: Its impact on tidal bore generation in macro -tidal estuaries. Marine Geodesy, 48(4), 498 –532. https://doi.org/10.1080/01490419.2025.2482099

World Bank. (2026). A catalogue of Nature-Based solutions for coastal resilience. In Washington, DC: World Bank eBooks. https://doi.org/10.1596/44618

Yan, J., Su, F., & Wang, M. (2017). The development processes and regional differentiation of both banks of the Strait of Malacca during 1980 –2010. Ocean & Coastal Management, 139, 141 –152. https://doi.org/10.1016/j.ocecoaman.2017.02.012

Yang, F., Yang, X., Wang, Z., Liu, Y., & Liu, B. (2020). Changes and Regional Differences in Urban Land Areas on Both Banks of the Strait of Malacca Based on Remote Sensing. Sustainability, 12(22), 9714. https://doi.org/10.3390/su12229714

Yang, F., Zhang, L., Chen, B., Li, K., Liao, J., Mahmood, R., Hasan, M. E., Mamun, M. M. A. A., Raza, S. A., & Sutrisno, D. (2023). Long -Term Change of Coastline Length along Selected Coastal Countries of Eurasia and African Continents. Remote Sensing, 15(9), 2344. https://doi.org/10.3390/rs15092344

Zulkifli, N., & Yasid, A. F. M. (2020). Maritime Cooperation in the Straits of Malacca (2016-2020): Challenges and Recommend For a New Framework. Asian Journal of Research in Education and Social Sciences. https://www.academia.edu/43259521/Maritime_Cooperation_in_the_Straits_of_Malacc a_2016_2020_Challenges_and_Recommend_For_a_New_Framework

DATA MANAGEMENT CHECKLIST

Instruction

This checklist is relevant for all graduation projects of the Master AUBS. The form is intended to highlight common aspects of graduation projects that require particular attention with regard to planning the research and data management. Relevant information and supplementary sources regarding each question are provided below each question.

With this checklist, the faculty wants to avoid that students unexpectedly find themselves in complex and stressful situations, in which ethical or privacy matters and/or other laws and regulations become an issue. In projects involving humans, certain types of data processing increase the risks to the human participants: planning such projects requires additional evaluations and advice from university staff before ethical approval can be received and the project can begin. In the case of a graduation project, obtaining additional advice or permits may delay the project with an extra education period or semester. To avoid this, it is recommended that students set up a graduation project with a low level of risk. Therefore, all students have to check their risk, by completing this checklist before their A1.

The first section of the checklist (A) should be completed by all students, together with their supervisor, during the planning of the graduation project, before the A1. It does not need to be submitted to anyone for review or approval. Please consider questions 1 to 3 carefully in relation to the intended graduation project, and answer with 'yes' or 'no'.

The second section of the checklist (B) should only be completed if the graduation project involves working with data from human participants. In that case, the student and their supervisor must apply for and receive ethical approval from the Human Research Ethics Committee (HREC) before the project can begin (see the paragraph 'Explanation and follow-up' after the questions). The student can submit the application to the HREC, but the supervisor is responsible for making sure that the project is compliant with relevant privacy regulations and ethical policies.

Section A. General considerations	yes	no
1. Is the graduation project conducted as part of an internship (at a company), or as part of a research project at TU Delft? If a student's graduation project is conducted at a company or as part of a research project at the university, questions of data ownership and intellectual property rights need to be addressed in a written graduation or internship agreement before the project begins. Students and their supervisor should consult the Intellectual Property Rights of Students webpage. Additional information can also be found in the Extended Personal Research Data Workflow.		X
2. Does the project involve conducting (part of) the research outside the Netherlands? Students who intend to travel abroad (even to other EU countries) for study, exchange, research, internship, or graduation project purposes need to follow the Travel Safety Protocol. This includes attending a mandatory Travel Safety Training Session: see the Disclaimer.		X
3. Will the research involve processing data from humans, such as running a survey, conducting interviews or workshops, collecting data through social media or internet forums, or re-using existing datasets about humans provided by a third party? (If 'yes', see follow-up questions 4 to 13 in Checklist B.) Students who work with data from human participants must complete the next section and apply for and receive ethical approval from the Human Research Ethics Committee (HREC) before conducting the research.		X

Fieldwork route



