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Delta Challenges under Nature-Based Solutions Perspectives

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Delta Challenges under Nature-Based Solutions Perspectives

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Deltaic areas and coasts tend to be extremely vulnerable as a result of the fusion of high-density urban agglomerations, overexploitation, and degradation of natural resources and the increase of climate events. The complexity of the combination of natural coastal and deltaic processes and human-made activities requires an integral perspective regarding planning, design, and governance (Meyer, 2009; Zagare, 2018).

This issue examines Nature-based solutions approaches to reach integral perspectives for achieving societal challenges in deltas and coasts, including climate adaptation, socio-economic development, and disaster risk reduction. By identifying major challenges worldwide on three socio-economic, biophysical, and governance perspectives, this issue explores the potentialities and possible constrains of these new perspectives to address societal challenges as well as dealing with the high level of complexity and uncertainty that characterizes these areas.

Nature-based Solutions (NbS) comprise “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (Cohen-Shacham et al., 2016). It is an umbrella concept that covers a whole range of ecosystem-related approaches, which can be implemented alone combined with more “traditional” solutions, basically related to grey infrastructure.

The design and implementation of NbS in deltas implies the recognition of four main challenges. The first challenge is related to the comprehension of Urban Deltas as complex adaptive systems which are subjected to internal and external drivers of change, in a context of high uncertainty. This means that these systems are constituted by components at different scales (element, subsystem, system, etc.), which interact as a result of constant adaptation processes. Working with NbS requires the understanding of the interrelationships that take place within the system and between the system and its environment, which are in a dynamic equilibrium (Manson, 2001).

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The second challenge is related to the change of paradigm associated with water management and risk reduction, from "grey" solutions to "green and blue" solutions, or a combination between them. The notion of controlling nature usually associated with the development of infrastructure has become obsolete in the face of present and future challenges. Nature based Solutions require integral approaches that acknowledge natural dynamics and a high level of uncertainty as part of the problem, but also the solution. Water management and risk reduction can be achieved through ecosystem-based actions without dismissing socio-economic development, and nature, within its own dynamics, can also enhance the efficiency of grey infrastructure when implemented combined as part of the same integrated strategy.

The third challenge is integration. The recognition of the complexity that lies behind sustainable transitions demands cross-sector and cross-scale alignment, and the development of integral plans that include all the dimensions and the stakeholders involved (Loorbach & Rotmans, 2006). In order to increase resilience, and adaptive capacity, it is necessary to build robust structures linking "soft" actions (capacity building, knowledge transfer, Integral Water Management Plans, etc.) and "hard" actions (infrastructure development, flood protection, Sustainable Urban Drainage Systems, etc.). This demands a change of paradigm in the existing planning framework, from adaptative planning towards planned adaptation. The systemic interdependencies are complex and dynamic; they can result in positive interactions but also present trade-offs which need to be assessed, projected, and acknowledged within a clear spatial adaptive planning system.

Finally, integration leads to the fourth challenge: participation. Social involvement and appropriate governance processes are critical for the success of NbS towards triggering transformative change. Governance of NbS must include opportunities for people to participate in the decision-making process, addressing inequities between the different groups, especially empowering the most vulnerable ones (IUCN, 2020). Integration in the delta management perspective can be enhanced by the consolidation and expansion of NbS approaches, going beyond the supportive perspectives that can be created through time via a robust and evolving system of care.

This issue presents collaborations of different authors in the fields of theory, project, and practice. All the articles pay special attention to the design and implementation of NbS in deltas, riverine, and coastal areas, addressing the challenges previously mentioned following different pathways and methods.

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JDU's' "Delta challenges under NbS perspectives" issue starts with the "Paper" section, bringing two contributions related to complexity approaches to deltas. Han Meyer presents a reflection on different perspectives to address the complex relations between natural and urban processes within delta areas. He emphasizes the need for a "second game change" to reactivate the dynamics and resilience of deltas giving priority to Nature-based Solutions and energy transition. The second Paper is a contribution by Veronica Zagare, who delves into the concept of Nature-based Solutions in relation to delta and coastal areas, focusing on complexity approaches to generate pathways for sustainable transition.

The "Dialogue" section of this issue presents and interesting contribution that discuss the challenges of deltas and a change of paradigm on delta management related to the concept of sustainable transitions and Nature-based Solutions, from the perspective of three experts on the field, Kim van Nieuwaal, Niki Frantzeskaki, and Emmanuelle Cohen Shacham.

The section "Practice" starts with a case of wetland restoration through a participatory process using autochthonous techniques in Argentina, presented by Heber Sosa and Nidia Amaya. It follows with the case of Water as Leverage – Cascading Semarang project (Indonesia), presented by Begoña Jaimerena, which focuses on closing the gap between Nature-based Solutions plans and implementation through strategies based on the theory of change. The section closes with the contribution of Michael van Buuren, who presents a method for research (through) landscape design to operationalize within the interface between science and practice.

The “Project” section includes the contribution of Johnathan Subendran, M. Van Nieuwehove, A. Menge, and K. Vanackere. They present experiences of Nature-based Solutions as productive interfaces enabling socio-ecological transformation along the Flemish coast, particularly in Blankebberge, Ostend, and Middelkerke. The section continues with an article by Hugo Lopez, who proposes a conceptual methodology for the landscapes within the Rhine Basin in the context of rapid energy transition.

The Dictionary section will delve into the concepts of Delta (by Cornelia Redeker) and Urbanism (by Giambattista Zaccariotto).

We expect that this special edition will contribute to the knowledge on Nature-based Solutions in relation to Delta territories, riverine, and coastal areas, and encourage new stakeholders from academia and practice, to get involved in the subject.

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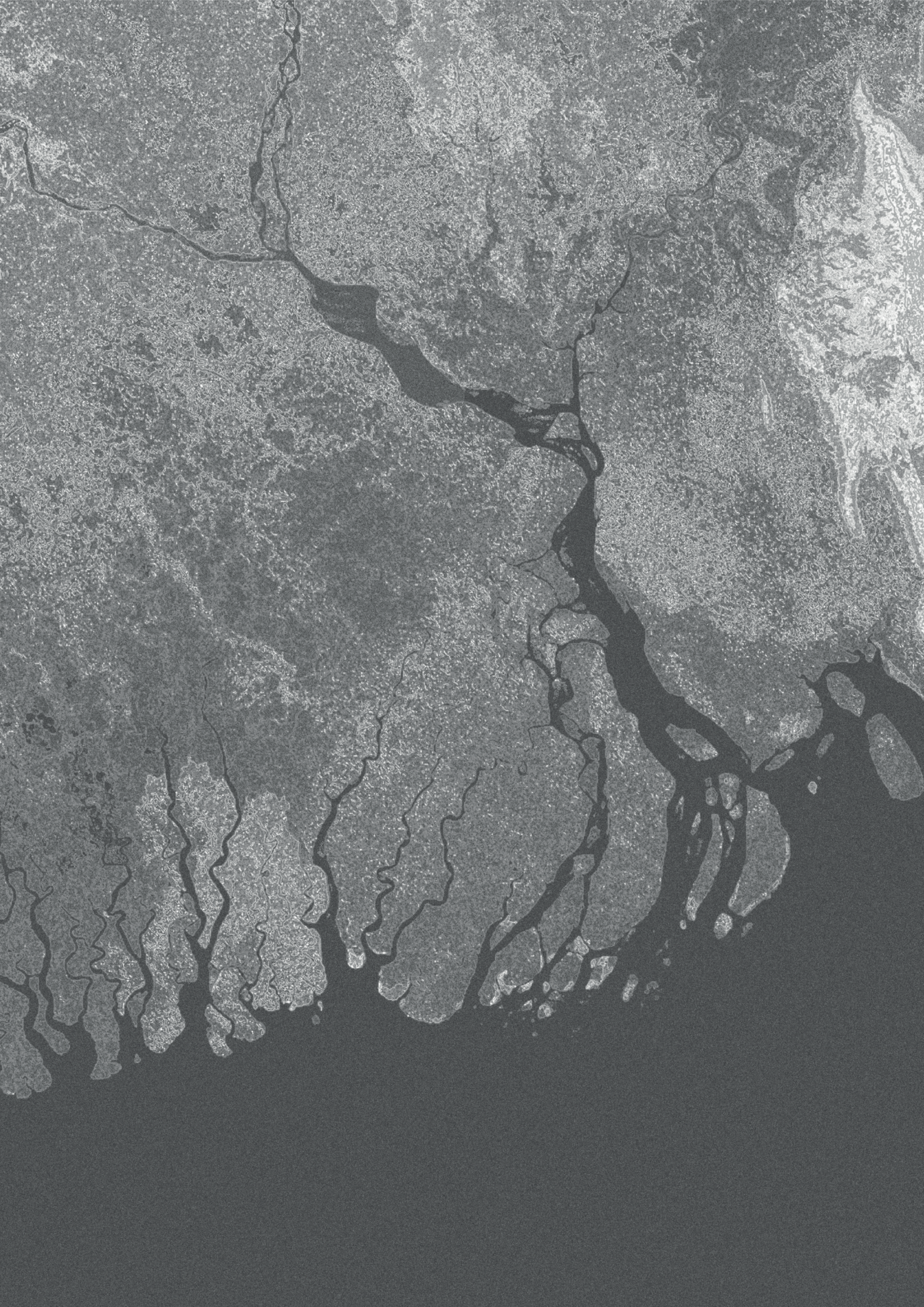

Papers

River basins and deltas need a second game-change

Han Meyer

River basins and deltas can be considered as complex systems with dynamics resulting from natural processes. These dynamics have generated many ecosystem services, but they are also erratic in nature.

Since the industrial revolution, the belief has emerged that these systems can be controlled, thereby suppressing the erratic nature of rivers and deltas and maximizing economic benefits. This has led to a game change in the development of rivers and deltas: until the mid-19th century, the natural system was dominant and economic and urban development followed; after the mid-19th century, economic and urban development became dominant and the river and delta systems were increasingly adapted to the new economic and urban realities. The result of this first game change was the disappearance of sufficient room for the natural dynamics of river and delta systems. This has led to major problems in the current times of climate change, which can only be tackled with a second game change, which takes more into account the natural dynamics of the river and delta systems and offers more space for these dynamics.

An example of what this second game change could look like is a proposal for the reorganization of the main discharge of the Rhine and Maas rivers in the Dutch Rhine-Meuse delta. This reorganization has major consequences, but also offers new opportunities for the water system, as well as for the natural environment and for port development, urban development, and the necessary energy transition. For this new game change, design explorations are necessary to investigate how a new synergy can be achieved by combining all these aspects.[1]

INTRODUCTION: NOT JUST CLIMATE CHANGE

The 21st-century world is facing the enormous challenge of a complex combination of adaptation to climate change, of preventing an acceleration of climate change through energy transition, and of restoring biodiversity and the resilience of natural systems.

This complex combination of tasks occurs to an extreme extent in the catchment areas of the major river basins and in particular in the delta areas, where the rivers flow into the sea and where the greatest economic and urban growth has taken place worldwide over the past 150 years and continues to occur. The major rivers, and especially their deltas, are at the heart of the logistic processes of production, transport, and consumption of modern industrial societies. Adaptation to climate change in these delta regions seems to be extremely difficult but also extremely urgent.

However, it would be a mistake to look for the causes of these problems in climate change alone. In the search for effective long-term strategies, the changes in the physical conditions of river basins and delta areas, especially caused by human hands during the last century and a half, must also be considered. Although there were good reasons for these changes (economic development, urban growth, and prosperity), the downside is that the resilience and dynamism of the natural system in these areas has declined sharply. The effects of climate change, such as rising sea levels and increasing peak discharges of rivers, can have a greater impact on river basins and delta areas due to this reduced resilience.

In this paper I will argue that the transformation of river basins and delta areas during the 19th and 20th centuries can be considered a 'game-changer': the game changed from a dominating role of the dynamics of natural systems to a dominating role of man-made patterns of land use, manipulating natural systems with excessive engineering. The central hypothesis of this paper is that we need a second game-change, leading to a reactivation of the dynamics and resilience of natural systems in river basins and delta areas. For all urbanized delta regions in the world, it is necessary to discuss and determine whether such an approach is possible and effective. An important question is what consequences such an approach has/could have for economic and urban development, and how this approach can be combined with strategies for energy transition and making our economies, cities, and landscapes more sustainable.

This paper will start with a description of the character of the natural system of the delta (section 1), which is necessary to understand the essence of the first 'game change' (section 2). The section on this first game change will clarify why a second game change is necessary (section 3). The argument will be illustrated with examples from the deltas of the Rhine and Meuse (the Netherlands), the Yangtze (PR China) and the Mississippi River (USA).

THE DYNAMICS AND FORMATIVE POWER OF THE DELTA'S NATURAL SYSTEM

Deltas are the result of dynamic processes of rivers and sea, with regular and irregular changes in currents, tides, wave action, sediment transport and sedimentation, vegetation, wind, precipitation. Most deltas owe their present shape largely to the way in which these processes took place in the last 12,000 years, after the last Glacial Period. The large amounts of sediment that were brought in by rivers and the sea and subsequently became overgrown with vegetation led to dynamic processes of land formation (Kleinhans 2010; Teresa et al. 2021).

The dynamic nature of the natural system of deltas gave rise to three main characteristics of deltas: first, extraordinarily rich ecosystems. According to some, deltas and estuaries contain the richest ecosystems, with the most 'ecosystem services' of any ecosystem in the world (Costanza et al. 1997). Deltas include important intersections of migratory fish and migratory birds, which use deltas for foraging, spawning, and breeding.

Secondly, the dynamics of the delta led to the continuous formation of new (wet)land, which increasingly served as a protective buffer in the coastal landscape. It is true that these processes were erratic and in various places they also led to erosion and flooding of land. But the net result over the centuries was that the land in the delta grew with or even grew faster than the rise in the sea level (Seybold et al. 2007).

Thirdly, the dynamics of water and sedimentation also lead, with some regularity, to structural changes in the course of the main river outflow, and thus in the shape of the delta. The development of the Mississippi Delta shows a number of 'delta lobes', which are the result of changes in the course of the main river outflow since the last Glacial Period (Campanella 2006; Blum, Roberts 2012; Giosan, Freeman, 2014). These changes occur once every few hundred or thousand years and are the result of the silting up of the estuary by sediment supply and deposits by the river itself and the sea. At the moment that the riverbed of the main discharge starts to silt up, it starts to act as a blockage, and the water tries to find another, easier route to the sea, especially in the case of huge peak discharges. The development of the Rhine/Meuse delta shows a similar process. The main discharge of the Rhine has moved south in several steps over the course of 12,000 years (Vos 2011).

These processes continued in most deltas until around the mid-nineteenth century, when a series of major interventions began that radically changed the hydrological system and the spatial structure of the deltas.

THE FIRST GAME CHANGE: FROM DYNAMIC SYSTEM TO CONTROLLED MECHANISM

Two important developments during the nineteenth century are responsible for a fundamental ‘game change’ in the systems of river basins and delta: technology and the rise of nation-states. These two developments created the conditions for the era called ‘the Anthropocene’ (www.britannica.com ; Sijmons 2014).

The technological revolution of the nineteenth century includes the invention of the steam engine and later the electric and gasoline engine, and the discovery and use of coal and later oil and gas as energy sources. The new energy sources and technical equipment created the necessity as well as the possibility of making major adjustments to the water systems of deltas and rivers. The steam engine allowed for larger ship sizes; the larger ships required deeper waterways, which were made possible by

1 This paper is a rework of a start document for a working conference of the PBL (Netherlands Environmental Assessment Agency) and CCICED (Chinese Council for International Cooperation on the Environment and Development), written by the author. The working conference took place in October 2022.

steam and diesel-powered dredgers. Riverbed narrowing also took place on a large scale, resulting in deep waterways on the one hand and more available land for agriculture and urbanization on the other. The waters that mainly served as a transport corridor were separated from the land by high dikes, where urban, agricultural and industrial development could take place. Due to intensive drainage of the swampy lowland, subsidence occurred behind the dykes, increasing the vulnerability to possible flooding.

The new nation-states of the late 18th and 19th century created the institutional conditions for the large-scale, cross-regional interventions in the river basins, such as the Rijkswaterstaat (National Water Management Agency) in the Netherlands, and the US Army Corps of Engineers in the USA (O'Neill 2006; Lonnquest et al., 2014; Meyer 2017).

The deltas of the Rhine, Yangtze and Mississippi all experienced this development. It is true that there are many differences between the characteristics of these three deltas, but essentially the development process of each of these three deltas has the same characteristics. If we compare the maps of the three deltas from ca. 1850 with those of 2022, we can not only see a spectacular increase in urban and industrial land use, but also the consequences of large-scale river rectifications and normalisations, of new land reclamations, of countless waterworks such as new canals, dykes, dams, locks, of roads, railways, and pipelines. We also see what has disappeared: many dozens of square kilometres of intertidal areas: wetlands, mud flats, salt marshes, sandbanks, beaches, and dunes.

What took place during this period, which began with the deployment of the first steam-powered ships, dredgers and drainage pumps, and has in fact still not ended, can be called a first fundamental game-change. With the rise of the fossil fuel-based industrial society, compared to the previous centuries, a fundamental change of the game has taken place, with new players, new rules, and new outcomes.

The net result is that, during the last century and a half, delta areas have been drivers of explosive economic growth and prosperity. Not only have the delta areas themselves become centres of economic growth and wealth, but this development has also been crucial for the hinterland. The Mississippi has become the main transportation corridor of the United States since the mid-19th century; 90% of what is shipped across the Mississippi and its tributaries goes to or comes from ports in the Mississippi Delta (O'Neill 2006). The Rhine basin is the economic artery of Europe, or the 'Blue banana' according to the French geographer Roger Brunet (Brunet 1989). The transformation of the Rhine delta into an efficient transhipment and distribution centre played a key role in developing the Rhine into the 'Blue banana' (Klemann, Wubs 2013).

In China, the Yangtze Delta and the Pearl River delta are the two most densely-urbanized regions of the country; together they are responsible for 40% of China's GDP (www.thinkchina.sg)

However, the flipside of this development is that the delta has changed from a natural system to something resembling a mechanical system. The entire water system of the river and delta has taken the form of an industrial machine. This also creates the illusion that rivers and their deltas can be controlled and monitored like an industrial machine. The toll that must now be paid for this illusion is threefold.

Firstly, we must note that the 'mechanisation' of the delta has led to a large decline in biodiversity. In some deltas, the specific features of the delta ecosystem have largely or even almost entirely disappeared. Not only has this led to a considerable impoverishment of fauna and flora in the delta landscape itself; this also has major implications for life on Earth in a much wider context. With the disappearance of large parts of the delta environment, an essential link in the food chains of countless birds, fish, shellfish and plants in our rivers, seas and oceans has been lost (https://www.worldwildlife.org/habitats/wetlands).

Directly linked to this is the second major problem: the disappearance of a large part of the formative capacity and thus of the resilience of the natural system of the delta. Instead of processes of siltation, land accretion and soil raising, other processes have come to the fore: erosion, subsidence, ever higher water levels in the river mouths, and a saltwater tongue penetrating deeper and deeper into the land. And although there is still a supply of sediment, as the most important building block for land formation, it is dredged away to ensure the rivers have the right depth for shipping (Ericson et al. 2006; Tessler et al. 2015; Hoitink et al. 2020).

Thirdly, the attempt of optimal control and fixation of the river and delta has led to the natural process of displacement of the estuaries appears to have come to an end. We emphatically state that this process 'appears to have come to an end', as we see that water management authorities over the past hundred years have been forced to build more and more engineering works in the river system in order to maintain the existing main drainage riverbed. In the Mississippi Delta, a series of dams, spillways and flood ways have been created around the connection between the Mississippi and Atchafalya Rivers to counteract the natural system's tendency to divert the main drainage to the Atchafalaya River. Nevertheless, it is feared that the time will come when this tendency will no longer be countered, with disastrous consequences for the city of New Orleans and the surrounding area (Barnett 2017; Day et al.2014). In the complex network of river courses of the Rhine/Meuse delta, a series of projects have also been carried out that counteract the tendency of the Rhine and Maas rivers to discharge more and more water via the Haringvliet and force this discharge out to sea increasingly via the Nieuwe Waterweg [New Waterway] near Rotterdam (Vellinga et al. 2014).

More than fifty years ago it became clear that maintaining this approach to the river system is harmful and unsustainable. The first large-scale protests against the loss of river and delta nature date back to the 1960s, and led to the first major adjustments in the Netherlands, such as the cancellation of the complete closure of the Oosterschelde [East Scheldt] and the construction of the Markerwaard [Marker polder]. Not coincidentally, the report of the Club of Rome, The Limits of Growth (1972), was published during this period. Although the main aim of these protests and changes was to prevent the disappearance of the delta nature, the need for a fundamental change in economic growth was already hinted at as a guiding principle in the development of natural landscapes (Buelens 2022). The American landscape architect Ian McHarg introduced an analysis and design method for wetland landscapes in the 1960s, in which he addressed the need to make a distinction between slow (climatic, geological, geomorphological, hydromorphological) change processes and faster, often human-initiated, change processes such as infrastructure development and urbanization (McHarg 1969). His position was that it is important to take good account of the slow processes, to offer sufficient space for this, and to adapt infrastructure and urbanization accordingly. In practice, he saw exactly the opposite happening, with disastrous results. This method was later elaborated in the Netherlands and became known as the 'layer approach', which was advocated in various government memorandums of the 1990s and 2000s (Meyer 2017).

The relevance of this layer approach became apparent from the 1990s, when the first signs of climate change emerged, and it became clear that the channelled river courses did not have enough capacity to discharge the increasing amounts of melt and rainwater caused by climate change. The Dutch Room for the River program (2005-2015) was the first important implementation of the layer approach. Restoration of the river ecosystem was combined with the task of increasing the discharge capacity of the rivers and restoring and strengthening the resilience of the natural system (Sijmons et al. 2017).

Also, in and around the Mississippi Delta, the first ideas for major modification of the river drainage system date back to the 1990s and gained momentum after the 2005 Hurricane Katrina disaster. The wetlands of the delta have been subject to severe erosion since the 1930s. As a result of the channelling of the Mississippi river, all of the tributaries that fed sediment- and nutrient-rich freshwater into the wetlands were dammed. The wetlands form a buffer that reduces the force of hurricanes. Erosion of these wetlands is catastrophic to the survival of the city of New Orleans (Campanella 2006; Barnett 2017).

However, with the latest insights and predictions regarding climate change and sea level rise (Deltares 2018; IPCC 2022), the question is whether the aforementioned changes in the Rhine/Meuse delta, Mississippi delta and Yangtze delta are sufficient. The restoration of nature and especially the restoration of the dynamics and the formative power of the deltas requires a significantly more radical 'game change'.

TOWARDS A SECOND GAME CHANGE: REACTIVATING THE DYNAMICS AND RESILIENCE OF THE NATURAL DELTA SYSTEM IN COMBINATION WITH ENERGY TRANSITION

The need for a new ‘game change’, giving priority to nature-based solutions in delta areas, has already been addressed (Costanza 1997; Temmerman, Kirwan, 2015; Day et al. 2014). However, the major task in delta areas is twofold: (1) to restore the resilience of the natural system and provide room for its dynamics, and (2) to stimulate the transition from fossil to non-fossil energy sources. This means a combination of maximum mitigation as well as adaptation.

One of the main driving forces behind these changes in deltas is the port and shipping industry. In many cases, and certainly also in the deltas of Mississippi, Rhine and Meuse and Yangtze, the transshipment, storage and processing of fossil fuels plays a central role. Port development and shipping were the basis for the radical spatial and hydrological transformation of the delta, but also for the fact that the deltas have become central hubs in an economic system based on fossil energy sources. Due to the large amount of space required and the many infrastructural systems, the port and shipping system also appears to be the most difficult to change. Because of this strategic role of ports and shipping in the delta areas, and in order to make the discussion more concrete, the consequences for ports and shipping will have to be explicitly addressed when discussing possible future prospects for these delta areas.

Discussions are ongoing in both the Netherlands and the Mississippi Delta about the most effective and desirable strategies for making the delta resilient to sea level rise. In the Netherlands, three approaches seem to emerge in the Sea Level Rise Knowledge Programme: (1) continue the development of the past century, with even larger-scale civil engineering projects, (2) a 'retreat' of cities and economic activity to higher ground, and (3) more room for restoration and reinforcement of the natural system, in the expectation that this will also lead to processes that make the delta less vulnerable to sea level rise and higher peak discharges (Haasnoot et al. 2019).

Also, in the Mississippi Delta, there seems to be a balancing of comparable alternatives, as reflected in the design competition 'Changing Course' (http://changingcourse.us/) .

The first option (reinforcement of the existing system) only seems to cause more problems in both deltas in the longer term. Maintaining increasingly large-scale 'armour' to protect low-lying territory will encounter increasing technical, managerial and financial problems. It seems much too early for the second option ('retreat'); hopefully it doesn't have to come to that. To prevent this option, ‘something’ will have to be done in the delta areas. This ‘something’ should be a first step in the second game change, based on a new priority for space for the natural system.

AN EXAMPLE FROM THE NETHERLANDS: SHALLOWING THE NEW WATERWAY

The proposal for ‘The Rhine mouth as an estuary’ can function as an example of a possible starting point of the second game change (Deltastad, ARK, WWF, 2020; Deltastad, ARK, WWF,H+N+S, 2022). This proposal is based on an analysis of the dynamics of the Rhine and Meuse delta up to the mid-19th century. During this period, the main discharge of the Rhine and Maas rivers was increasingly shifting from the Nieuwe Maas (on which Rotterdam is located) to the Haringvliet river arm, further to the south.

The silting-up of the Nieuwe Maas created the problem of making the port of Rotterdam inaccessible for increasingly larger seagoing vessels. As a solution, a new river mouth was dug to provide the port of Rotterdam with direct access to the sea: the Nieuwe Waterweg [New Waterway] .

figure 01 — page 24

The result was an enormous growth of the port and city of Rotterdam. During the 20th and early 21st century, the port was expanded in a number of steps and the Nieuwe Waterweg was deepened further and further, while the main discharge was again artificially guided via Nieuwe Maas and Nieuwe Waterweg.

figure 02— page 24

figure 03— page 25

The downside of this development is that the influence of the sea on the river mouth region has increased. High water levels and salt intrusion have increased significantly. Moreover, more than 90% of the flora and fauna of the delta has disappeared, which has led to a dramatic reduction in biodiversity in the region.

Similarly, the salt water wedge occurs during the low water stage of the Mississippi River, threatening the water supply intakes of the area around and south of the city of New Orleans.

'The Rhine mouth as an estuary' is a proposal to investigate to what extent it is possible to have the main discharge run again via the Haringvliet and to make the Nieuwe Waterweg shallower. *figure 03— page 25*

This intervention is expected to be an important condition for the restoration of the flora and fauna of the delta, and to reduce salt-water intrusion and high water levels in the Rotterdam region. Research results by students from TU Delft and Rotterdam University of Applied Sciences have so far shown that the effects of shoaling on saltwater intrusion and high water levels are substantial (Hensen, 2021; Iglesias, 2022).

A shallowing and widening of the estuary can go hand in hand with a spatial reorganization of the port area, so that the estuary area becomes a central hub in a major landscape. and a significant ecological structure instead of a blockage. New ways of 'living on the water' will make the region more attractive as a place to live and work.

A strategy based on shoaling will also help to galvanise the necessary transition and transformation of the port area, whose land use is still largely (60%) determined by the storage, transshipment and processing of fossil fuels. When it becomes more shallow, the Nieuwe Waterweg can still remain navigable for inland vessels and smaller seagoing vessels, but no longer for the largest carriers. For the time being, the ports of Maasvlakte 1 and 2 and Europoort can remain accessible to the largest seagoing vessels via the parallel waterway, the Caland Canal.

CONCLUSIONS

This analysis of delta areas and the proposal for an approach for the Rhine and Meuse estuaries indicate that the current game change must entail a change of priorities: while in the past 150 years, as a result of the first game change, economic and urban development have taken centre stage and the water system has been adapted accordingly, this will now have to be completely reversed: attention must now be focused on a strategy for a sustainable water system, characterized by the reactivation of natural dynamics and natural processes of land formation, meaning that economic and urban development will have to adapt accordingly. The proposal for 'The Rhine mouth as an estuary' shows the results that can be achieved with a reversal of this kind.

This reversal is perfectly feasible at this current moment in time, because of the needs of the energy transition, which will have huge impacts on industrial land use.

However, this reversal of priorities will not take place by itself. In most delta regions, port authorities and port- and shipping-related companies play a major role in the area of water management and spatial planning. However, in all these delta regions an analysis and public discussion is necessary if the economic values of ports and shipping are still in balance with the increasing problems for humans and the other flora and fauna in the delta. In other words: are the profits for private companies still in balance with the public expenses for flood defence systems and related engineering systems, and for nature conservancy? Finally, strong political leadership at national and cross-national level will be necessary as a condition for implementation of the second game change.

But as a first step, exploring the possibilities and new potentials of a new game change will be necessary to start the debate. Design explorations, and the collaboration of designers with engineers and with ecological and hydrological scientists will be crucial in providing us with a vision of what the second game change can look like, how it can be implemented, and what kind of new conditions for economic and urban development can be derived from it.

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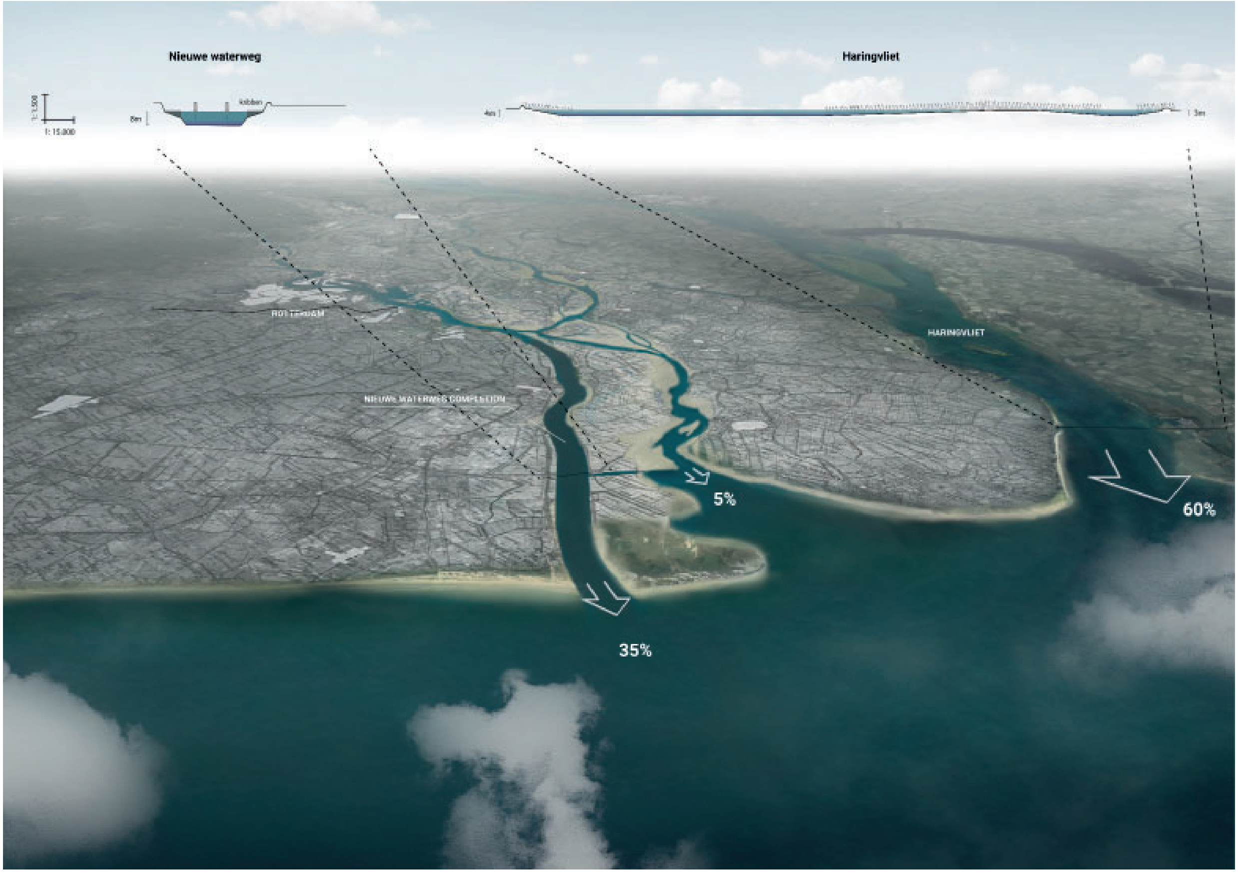

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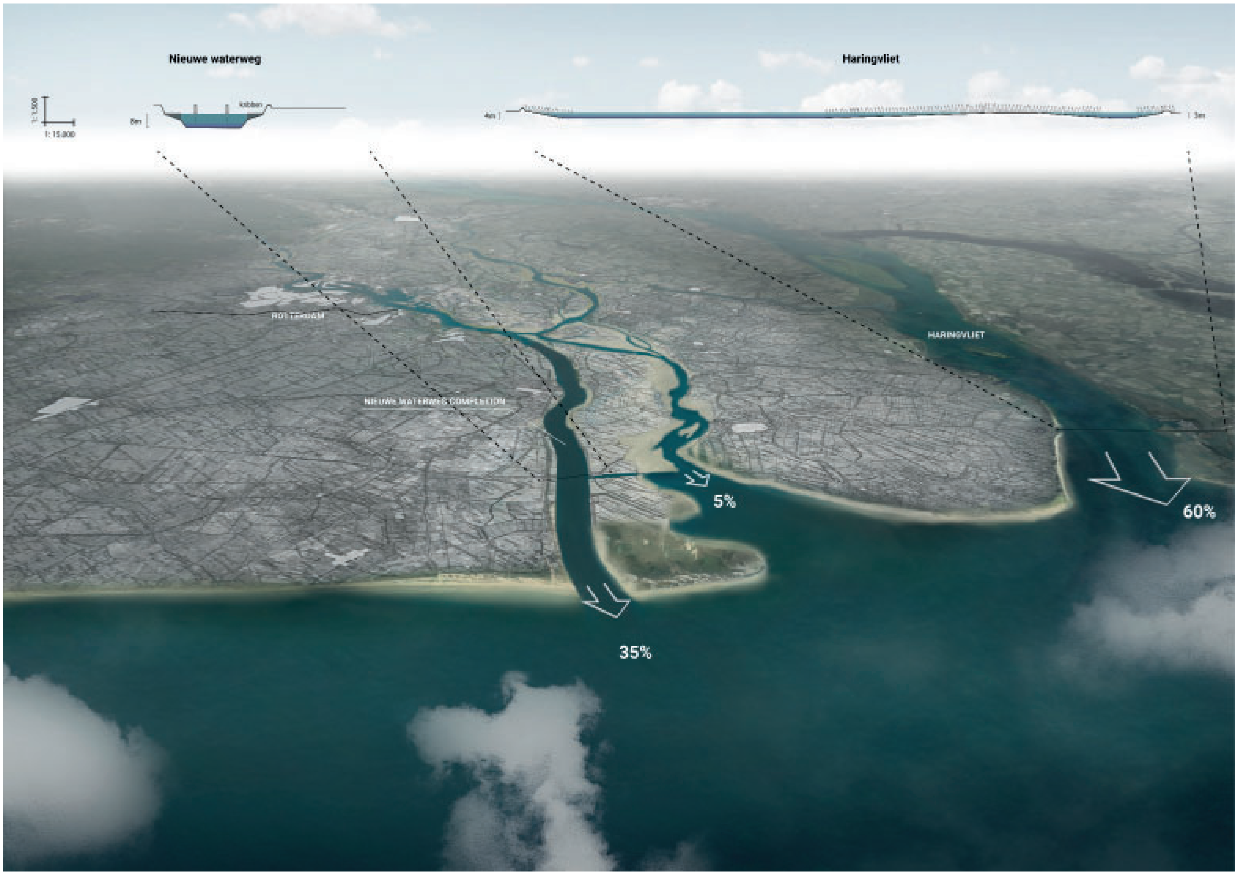

02

01 Birds eye view of Rhine-Meuse delta in 1900, seen from the west, and sections of the waterways.
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02 Birds eye view of Rhine-Meuse delta in 1980, seen from the west, and sections of the waterways.
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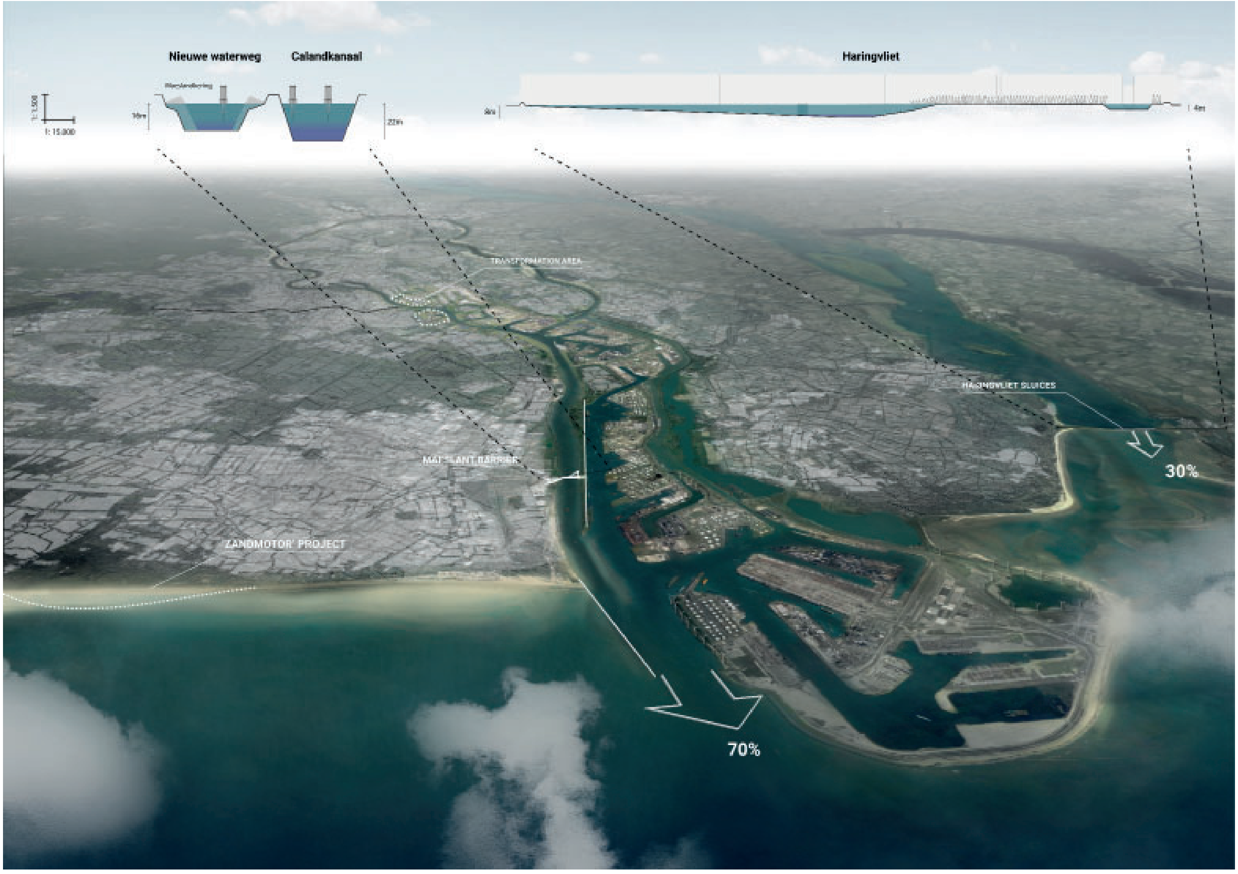

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03 Birds eye view of Rhine-Meuse delta in 2020, seen from the west, and sections of the waterways. © H+N+S Figure Landscape architects.

04 Birds eye view of a possible future of the Rhine-Meuse delta, seen from the west, and sections of the waterways. © H+N+S Figure Landscape architects.

Nature-based Solutions for climate adaptation and mitigation in Deltas and coastal areas.

Verónica M.E. Zagare

Coastal areas, especially deltas, are some of the most urbanized territories in the world. Historically, the natural richness and strategic location of these areas resulted attractive for human settlements worldwide. However, these areas are also highly vulnerable due to rapid and unplanned urbanization, land use changes, and extreme climate events. There is an international consensus on the need for new strategies for sustainable development to help cities to mitigate the effects of climate change, as well as adapt to new changing conditions in a context of increasing uncertainty. This paper will explore the specific aspects of urban deltas and coastal areas, from a complexity-based approach, and analyse Nature-based Solutions as alternatives towards sustainable development in these areas.

INTRODUCTION

Coastal areas, especially deltas, are some of the most urbanized territories in the world. It is estimated that half of the world's population has settled within a radius of 200 km from the coasts (Reker et al., 2006). The natural richness and strategic location of these areas have resulted attractive for human settlements for centuries. However, these areas are also highly vulnerable due to rapid and unplanned urbanization, land use changes and extreme climate events. There is international consensus on the need for new strategies for sustainable development to help cities mitigate the effects of climate change, as well as to adapt to new changing conditions in a context of increasing uncertainty. In this sense, Nature-based Solutions are innovative alternatives that are capable of meeting these goals, while changing the existing paradigm of development and flood protection. Historically, coastal protection and water management were seen as a matter of civil engineering, developed in a top-down and centralised way to get control and guarantee rapid and tangible results. Over the last few decades, ecosystem-based initiatives, encouraged by complex-system approaches, have arisen in order to address the same problems from a different perspective, intending to address societal challenges, ensuring long-term benefits for communities, and at the same time, increasing biodiversity and reducing ecosystem loss. This paper will explore the specific aspects of urban deltas and coastal areas, from a complexity-based approach. Then, the concept of Nature-based Solutions (NbS) will be analysed to explore new possibilities of planning, design and governance, without dismissing the risks and obstacles that any novelty concept like this can entail. Furthermore, cases from different parts of the world will be presented to reflect on the potential that NbS can have in terms of the planning, design and management of future coastal cities, with the involvement of civil society in the decision-making process.

DELTAS AS COMPLEX ADAPTIVE SYSTEMS

Deltas can be considered complex adaptive systems, where ecological, social, environmental and many other factors coexist in constant transformation within a context of great uncertainty, exacerbated by climate change (Zagare, 2018). This conception of urban deltas as complex adaptive systems comes from Complexity Theories, and it is related to different aspects. First, urban deltas are open systems in constant interaction with their external environment. Within the system, many subsystems (formed by physical components, social actors and the relationships between them) interact with each other (Zagare, 2018). The interactions are a result of constant adaptation processes between the components and between the system and the environment, which leads to changes in the structure and organization of the system. This process is referred to as co-evolution and takes place in a context of self-organization and path dependence. Self-organization refers to the spontaneous emergence of order without control, that arises from mutual adaptation, while path dependence entails that the direction of each particular change is determined by previous events (Pols et al., 2015). This means that even the smallest component of a system is capable of triggering a qualitative change that can affect the entire system, due to cross-scale interlinkages. As a result of this complex process of constant interactions, the system reaches a dynamic equilibrium where each component is in constant adaptation, but is subjected to possible sudden changes that may lead to a critical transition that will force the system to reach a new dynamic equilibrium (Gladwell, 2000).

Contrary to a reductionist approach, this systemic vision of urban deltas addresses the complexity of interrelationships that takes place in these areas, while identifying drivers of change and possible pathways for planning and design. One of the main drivers is related to increased urbanization, land use changes, and the pressure exerted on the land for economic development purposes (Meyer, 2014). The increase in density in coastal areas and the incorporation of other uses, such as industries, port facilities, and new dwellings entails a higher demand for urban services and implies an increase in pollution and greenhouse gas emissions. Undoubtedly, climate change is the other main driver that increases the vulnerability of these areas. Extreme events are occurring with increasing frequency and intensity than ever before, and the delta´s capacity to cope with them is being affected, due to variability in run-off and sediment transport (Bates et al., 2008). Sea level rise, hurricanes, tsunamis, storm surges, floods, erosion, and other events affect coastal settlements, generating not only economic losses but also casualties. For this reason, it is increasingly necessary to design strategies for climate adaptation as well as for mitigating its effects, guaranteeing sustainable development for communities, as well as contributing to international environmental commitments.

In this paper, the concept of sustainable development is understood as the fulfilment of the aspirations for a better life, “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1988). According to Loorbach (2007), sustainable development is a complex, multi-level and multi-actor process, so a complex systems approach is central to the management of transitions towards sustainability (D. Loorbach & Rotmans, 2006). Knowledge of the dynamics and long-term changes of natural systems, combined with knowledge of the dynamics of external environment and internal interrelationships is fundamental for understanding the properties of the systems, to operate in the fields of planning, design and management in an integral way, instead of carrying out independent actions to address occasional needs dismissing future situations and the nature of uncertainty that may arise.

While the concept of complex adaptive system has taken shape over the last few decades as a logical way to understand environmental-related issues, conversely, during the last century, responses to increased urbanization and climate change effects were based on the development of large-scale infrastructure projects: highways, dikes, pumping and storage facilities, culverts, and drainage networks, among other actions (Chiu et al., 2022; EPA, 2016). Industrialization led to the growth of our cities and with it the demand for infrastructure to meet the needs of operational and economic development. As a result, it was necessary to build communication routes, provide services, and develop urban drainage networks. Many infrastructure projects were carried out without taking environmental characteristics into account. By the beginning and middle of the 20th century, there was no perception of uncertainty related to climate change, and the interrelationship between the different subsystems. Contrary to expectations, infrastructure projects would later have negative and in many cases irreversible effects. This is the case of many urban rivers, which turned into open sewers, and were then culverted, channelled, rectified, and diverted, making them disappear from the surface of the cities.

The need for flood protection also stimulated the construction of dams and barriers, the closure of rivers, and the installation of water pumping and storage facilities, among other works. During the last century, the vision of hard engineering solutions (referred to as "grey infrastructure") as the most legitimate response to urbanization and climate effects was the prevailing paradigm.

Hard infrastructure seemed to be the ultimate response. It was practical, provided short-term benefits, and allowed standardization and thus, replication. However, it also had negative effects. In some cases, it increased water and soil pollution, as well as run-off volumes, given the lack of absorbent surfaces (EPA, 2016). They also required high maintenance and continual renovations to meet increasing demands.

Over the last few decades, scientific evidence has shown that the challenges are increasing. Climate change will worsen, and cities will continue their expansion and densification. Within this context, it has been necessary to find other paths for sustainable development and climate adaptation/mitigation through innovative alternatives that will not become obsolete in the long term, and which are embedded into a sustainable development strategy for coastal areas. These new strategies could bring long-term benefits for communities while increasing biodiversity and reducing ecosystem loss in an integral way. In this sense, a complex system approach seems to be pivotal for planning future coastal cities, being able to operate at different subsystem levels, and generating path-dependent positive externalities at different scales.

A CHANGE OF PERSPECTIVE

The ecosystem approach was first adopted in 1995 in Jakarta, before the second Conference of the Parties (COP 2) of the Convention on Biological Diversity (CBD). It emerged as the main framework for action for the integral management of land and natural resources, which was later published in 2004 (Secretariat of the Convention on Biological Diversity, 2004). Afterwards, the World Bank Report "Biodiversity, Climate Change and Adaptation" (MacKinnon et al., 2008) recognized the role of biodiversity in Climate Change mitigation, adaptation, and water and food security. Since then, new strategies emerged broadening the scope, not only focusing on environmental resources but also on their interaction with society, "recognizing the two-way, dynamic relationships between people and nature" (Mace, 2014). Among these approaches, the concept of Nature-based Solutions emerged in the International Union for Conservation of Nature (IUCN) Position Paper presented at the COP 15 and was then followed by the Report "Natural Solutions" elaborated by the IUCN, The World Bank and other renowned organizations (Dudley et al., 2010; IUCN, 2009). In the latter document, protected areas were suggested to be integrated into broader conservation strategies and mitigation and adaptation plans, including nature as part of a solution itself. In 2012 the term Nature-based Solutions was formally adopted by the IUCN and was a key part of the 2013-2016 Programme of the organization. Later, it was also included at the core of the research and innovation programme Horizon 2020 of the European Commission (IUCN, 2012). In 2016, a definition of NbS was developed by the IUCN (Cohen-Shacham et al., 2016), and then a Global Standard was defined to have a common agreement on the compliance of 8 Criteria (IUCN, 2020a). At present, adaptation through NbS is recognised in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Dodman et al., 2021) as a key pathway within the subject "Cities, settlements and key infrastructure". In addition, NbS are aligned with the Sustainable Development Goals (SDGs) adopted by the United Nations Development Programme (UNDP) within the 2030 Agenda (Gerstetter et al., 2020).

NATURE-BASED SOLUTIONS FOR CLIMATE ADAPTATION AND MITIGATION

Nature-based Solutions (NbS) are defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016). Among societal challenges, it is possible to identify water and food security, human health, disaster risk reduction, climate change mitigation and adaptation, economic and social development and environmental degradation and biodiversity loss (IUCN, 2020b). NbS is considered an umbrella concept since it includes different types of actions, approaches, and interventions, which are capable of responding to one (or more) social challenges. According to Walters (2016), the ecosystem-related approaches associated with the concept of Nature-based Solutions are ecosystem restoration, ecosystem protection, ecosystem management, issue-specific approaches, and infrastructure. Within these approaches, NbS comprise a wide range of interventions that include not only soft actions (regulations, plans, capacity building, etc.) but also hard actions (development of green-blue infrastructures, Sustainable Urban Drainage Systems -SUDS-, etc). *figure 01 — page 42*

Ecosystem-based Adaptation (EbA) and Ecosystem-based Disaster Risk Reduction (EbDRR) are two of the Issue-specific -related approaches that can be included within the global concept of NbS (Cohen-Shacham et al., 2016). They particularly address two of the societal challenges that are related to climate. Nevertheless, these challenges are interrelated with the others, and NbS must be designed integrally, considering the system properties, and interrelationships that are generated within the system and between the system and its environment. This is a very difficult task since it requires scientific knowledge of the system and a high level of governance that includes the participation of the different sectors (academia, government, practitioners, citizen organizations, etc.) throughout the entire process of design and implementation.

In that sense, the Global Standard aims to set criteria to ensure that NbS are developed under common parameters, without overlooking any challenge or stakeholder. Within the Standard's eight criteria, it is possible to discern a complexity-based approach, given the importance that the cross-scale interrelation between different actors and components plays in the design and implementation of NbS, and the role that participation plays within the process. Furthermore, NbS must relate to the national policy on the reduction of greenhouse gas (GHG) emissions, to meet the goals of the Nationally Determined Contribution (NDC) within the scope of the Paris Agreement.

EXAMPLES OF NBS IN DELTAS AND COASTAL AREAS

There is a wide range of NbS cases for climate adaptation in delta areas, at different scales, depending on the type of combined challenges to address. A complexity-based approach to NbS must address integration, inclusiveness, and adaptation as criteria to be followed. Integration refers to the cross-scale, cross-sector, and cross-level interrelationships to integrate systems, subsystems, agents, and networks. Inclusiveness concerns participatory-based approaches enabling joint decision-making and including stakeholders. Finally, adaptation alludes to the generation of planning, design and governance strategies that combined with the existing framework, can allow for the development and implementation of different actions in a flexible way, considering the high degree of uncertainty that characterises these systems (IUCN, 2020b; D. Loorbach & Rotmans, 2006).

The NbS cases presented in this paper were selected taking into consideration the presence of the previously-mentioned criteria: integration, inclusiveness, and adaptation, which implies the acknowledgement of a complexity-based perspective to cities, deltas and coasts. It is important to clarify that some of the cases were carried out prior to the development of the Global Standard to Nature-based Solutions (IUCN, 2020b). For this reason, an ex-post evaluation of the cases with respect to the Standard has not been carried out in this paper but may be the subject of future research.

One of the most renowned NbS cases is the program "Room for the River", developed in The Netherlands between 2006 and 2015 (Rijkwaterstraat, 2017). It implied a radical change of perspective from the previous policy on flood defences, which was mainly based on grey infrastructure. The program "Room for the River" emerged as an innovative alternative to restore delta conditions and natural floodplains while protecting the most vulnerable areas of the Rhine-Meuse-Scheldt delta. The program, developed at a national scale, consisted of 34 projects that created more space for the major rivers to flow through the country, thanks to a series of actions that included the lowering of dams, removal of obstacles, and extension of floodplains, among others (Sijmons et al., 2017).

figure 02 — page 42

The result was a reconfiguration of the space, including green and blue zones for recreation that improved the quality of the area and changed the concept of "flood safety". It also enhanced habitat restoration and multifunctionality in many areas, which now offer different opportunities when the water level is high or low. Some projects, such as the Millingerwaard floodplain excavation, the Lent dike relocation (Nijmegen), and the Munnikenland Buitenpolder dike relocation, also represent a new concept of urban river parks, providing areas for recreational activities and urban services.

figure 03 — page 43

figure 04 — page 43

This program was characterised by cross-scale interventions, and included uncertainty in the process, and expected results, as key variables to consider. Furthermore, according to (Rijke et al., 2012), this program adopted a new multi-level governance approach integrating agencies in different disciplines, at national, regional and local levels, as well as used a mix of centralised (national) and decentralised (regional) decision-making processes. It challenged the traditional vision of water management, which was seen as a matter of civil engineering, as a way of “control”. On the contrary, it turned it into an integrated concept, which manages transitions operating as long-term non-linear processes that result from a co-evolution of different values on various scale levels, through a robust strategy of public participation (Rijke et al., 2012; Sijmons et al., 2017). In fact, the case of Nijmegen was awarded internationally in 2011 for its innovative design approach and stakeholder process, and communication strategy (Red-dot, 2011; The Waterfront Center, 2011).

At other scales, NbS can also be applied for coastal protection, focusing on existing natural components, and using “ancient ecosystem engineering” (Meulen & Zetten, 2022). Mangroves historically protected coasts from storm surges, high waves, and winds, and their roots also retained sediments, preventing erosion. Productive activities such as aquaculture and the development of coastal infrastructure led to the removal of mangroves from many coastlines, causing soil and biodiversity loss, floods, and an increase in the vulnerability of the communities. This is the case of the North Coast of Central Java in Indonesia, one of the most populated coastal areas in Asia (Thiele et al., 2020). After losing hundreds of hectares of coasts, mangrove replanting efforts failed to succeed due to the existing sediment disturbance, so it was necessary to find a different solution to the problem. The project developed in Java followed the Building with Nature approach, which “integrates Nature-based Solutions into marine engineering practice, (…) considering both engineering and ecological principles in the design process” (Wilms, van der Goot, et al., 2020).

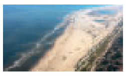
The strategy consisted of the placement of semi-permeable dams built by the community, using local natural materials within an inclusive process of participation (Meulen & Zetten, 2022; Spalding et al., 2014).

figure 05 — page 44

The dams allowed the retention of sediments and the formation of land suitable for mangrove recolonization. Also, a new scheme of Associated Mangrove Aquaculture (AMA) was designed to guarantee the sustainable economic development of the community. This project enhanced bottom-up decision-making and considered multi-dimensional causes and benefits. The analysis of the results shows that within the AMA system, the ponds can be managed more intensively due to an increase in water quality, resulting in 15 times more benefits than the old system (Bosma et al., 2020; Tonneijck et al., 2022). *figure 06 — page 44*

Sand and mud are also used to improve the ecology and water quality as well as protect the coasts from erosion and floods. Several cases in Malaysia and Kerala (India) include sand nourishment to contribute to risk reduction, ecosystem conservation and community livelihood improvement (Van Wesenbeeck et al., 2019). In the Netherlands, sand nourishment has been part of policies for the last 30 years. Before the 1990s, it consisted of coastal stabilization through foredunes which needed to be restored after each storm season (autumn and winter). After 1995, coastal management policy took a more natural direction, aiming at preserving coastal functions and their natural dynamics (Lodder & Wang, 2019). One example is the Zandmotor, a mega project developed on the coast of the Hague (2010) that added 20 million m3 to the coast, covering around 2.5 km2.

figure 07 — page 44



The innovation behind this project was based on the development of a large nourishment located in a specific area, which would slowly change its contour through the action of currents and waves. The natural dynamics would transport the sediments along the coastline, and the process was estimated to have a lifetime of more than 20 years. This implied economic benefits due to the lack of periodic refills, environmental benefits since plants and animal species settled on the Zandmotor, and social benefits because it became a place for recreational activities (Meulen & Zetten, 2022). Sandscaping in Norfolk is another example of sand nourishment, located in the north of the village of Bacton, in one of the main gas terminals of the United Kingdom (UK), which manages one-third of the UK's gas supply. This terminal is close to cliffs and has pipelines buried beneath the beach, which are at risk from coastal erosion (Vikolainen et al., 2017). After evaluating different alternatives, sandscaping proved to be the most cost-effective and has also brought benefits to the community from to tourism and recreation, business support, dwelling protection, and safeguarding of the country's gas supply.

figure 08 — page 44

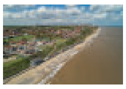


figure 09 — page 45

THE ROLE OF DESIGN

Nature-based Solutions offer new opportunities for the design and management of urban public spaces in urban deltas and coastal areas. Given the great diversity of elements involved in these solutions, the possibilities are endless. Green and blue infrastructure, Sustainable Urban Drainage Systems (SUDS), Water Sensitive Urban Design (WSUD), Integrated Urban Water Management (IUWM), and Stormwater Control Measures (SWCM), among other approaches, whether combined with traditional "grey infrastructure" or not, allow landscape and urban design to get a prominent role. They also encourage the involvement of stakeholders, operating at different levels, system-subsystems-components. Nevertheless, the design should not be restricted to the landscape field. On the contrary, it can play an important role to explore how NbS can be developed and implemented, and how it can connect and integrate other agendas such as infrastructure planning, urban development, production, and transportation, and even be part of the long-term development strategies of the cities (and the countries).

This is the case of Sponge Cities, which start out from the city scale to generate an aggregated impact at the regional or national scale. These cities are a good illustration of a way to increase the resilience of the systems, operate at subsystem levels, contribute to climate mitigation/adaptation, and at the same time improve spatial quality by addressing other societal needs. According to Shannon (2009), the concept of the "City as a sponge" was first adopted in a project for the city of Vinh in Vietnam, to reduce the impacts of seasonal floods through a strategy of low-land/high-land interconnected reconfiguration. Later, the idea of "Sponge City" was adopted in China, where in 2014 the homonymous program was launched to manage water-related risks in their cities that are exposed to frequent flooding (Zevenbergen et al., 2018). Sponge Cities (SC) "are able to adapt, flexible, like sponges, to changes in the environment, such as they absorb, store, permeate and purify rainwater, and (…) make use of the stored water when needed" (Li et al., 2018). Sponge cities regulate the water cycle through the incorporation of big sponge infrastructures including natural elements as a key to restoring the capacity of the cities to cope with rainwater. According to Zevenbergen et al. (2018), the SC concept is closely linked with Water Sensitive Urban Design (WSUD) and can be part of an Integrated Urban Water Management (IUWM) strategy. Within this scope, Green Infrastructure (GI) and SUDS are specific technologies to foster high spatial quality design. Between 2014 and 2016, China's Ministry of Housing and Urban-Rural Development (MOHURD) selected 30 pilot projects including the cities of Beijing, Shanghai, and Shenzen (Zevenbergen et al., 2018). These approaches have the potential to reduce the risk and have been recognized by the Intergovernmental Panel on Climate Change, which also highlights other cases in Melbourne (Australia) and Semarang (Indonesia) (Dodman et al., 2021).

An example of SC is Sanya Mangrove Park, located on the Linchun River, near the intersection with the Sanya River, close to its mouth in Sanya Bay (China).

figure 10 — page 45

The site is strategic for the environmental interrelation between the inland areas and the sea since it is at the limit the ocean tides can reach, where saltwater meets fresh water. There, the former natural mangroves had been destroyed by urban developments, the land was filled, and grey infrastructure for flood protection was built instead. The site was also degraded due to the presence of debris and rubbish, and the waterways were polluted. Public access to water was hindered due to a lack of pedestrian spatial connections. One of the main objectives of the park was to restore the mangroves and rehabilitate the area in terms of ecological diversity. For this reason, it was necessary to protect the area from the winds and floods of the annual tropical monsoon storms that could harm the mangrove plantation. It was also necessary to guarantee the protection of the plantation from the pollution related to the urban runoffs. As a result, the design consisted of a series of ecotones of interlocked strips with diverse aquatic settings that can manage low and high tides coming from the ocean. It also includes bioswales to filtrate polluted urban runoffs, organized in terraces, creating public places at different levels, and offering a variety of landscapes (Turenscape, 2019b). Similar examples can be found in many Chinese cities, such as the Haikou Meishe River Greenway and Fengxiang Park (Hainan), or the Taizhou Jiangbei Park (Zhejian).

figure 11 — page 45  *figure 12 — page 45* 

Both parks work with the concept of terraces, integrating sewage treatment processes into an ecological system and replacing concrete defences and landfills with wetlands (Turenscape, 2019a, 2019c).

OBSTACLES AND POTENTIAL OPPORTUNITIES FOR THE IMPLEMENTATION OF NBS IN DELTAS AND COASTAL AREAS

The design and implementation of NbS is not an easy task. It requires the integration of actions at different scales within the system and subsystems levels, with the intervention of a multiplicity of social actors, depending on financing mechanisms to make them feasible too. It is possible to identify three groups of barriers. The first group is related to the lack of knowledge about the NbS concept, and awareness of the benefits it can bring to society. There are currently no protocols at the local or national level for the design, implementation and evaluation of these solutions. Scientific evidence on the results of these interventions is being developed but is still in formats that may not be accessible to all stakeholders, hindering knowledge transfer between science, policy and planning (Egusquiza et al., 2019). To overcome this obstacle, it is necessary to implement innovative communication strategies and generate scientific documents accessible to all sectors, including good practice manuals, guidelines, and educational documents for schools, to raise awareness in the community. Governmental officials also need to be trained regarding processes, techniques, and concepts.

The second group of obstacles is related to governance. Governance is complex in itself, especially in deltas and coastal areas, where environmental conservation and the need for socio-economic development collide. NbS require coherence between short-term needs and long-term goals. Local authorities often need to show results within short action cycles and make decisions without considering long-term sustainable plans (sometimes those plans do not even exist). Furthermore, the complexity of governance structures undermines coordination between levels of decision-making and departments, generating “sectorial silos” which are not compatible with the multilevel, multiscale and multidisciplinary approaches that NbS require in order to be fully implemented (Egusquiza et al., 2019; Kabisch et al., 2016). Lack of public participation and top-down processes are also obstacles, as well as an unsupportive and rigid legal framework. Knowledge transfer (previously mentioned), capacity building and collaborative governance include a wide range of instruments and methods which can generate spaces for social mobilization that can be anchored within the planning and institutional existing framework (Zagare, 2018).

The third group concerns economic barriers and how they are interrelated to knowledge and governance. The source of funding for NbS varies depending on the environmental domain, the technology required, and the scale of the project. Small-scale NbS such as urban agriculture or community gardens may have a high percentage of community funding, in some cases through crowd-funding instruments (McQuaid, 2019). Green roofs, vertical gardens, rain gardens, and other small interventions can also be funded by the private sector (owners), indirectly, through legal instruments (subsidies, incentives, or exemptions). Other infrastructure projects related to larger private developments can be financed by the developers if the respective legislation has instruments that demand them for environmental compensation. With regards to large-scale NbS projects, such as SUDS, IUWM, SC or other interventions, according to Mulder et al. (2021), around USD 133 billion is invested in these projects worldwide each year. In these cases, the public sector (mainly domestic governments) is responsible for more than 90 per cent of the investment, while the private sector (NGOs, biodiversity offsets, sustainable supply chains, etc.) contributes the rest. One of the reasons for this imbalance is that NbS is a new concept that includes environmental benefits, in which revenues and risks are not well estimated nor communicated (Egusquiza et al., 2019). Another reason is that NbS have long-term benefits, which in many cases discourage private participation. Given the restricted budget that characterises local governments, investment in NbS is not always a priority. To counteract this situation, it is necessary to explore innovative business models that include both sectors to attract investors and which allow the projects to scale up (Egusquiza et al., 2019). It is also a key factor to align the long-term vision of the investment with the general goal of the project and to produce a cost-benefit analysis. Another option for local authorities is to access funding through international and regional adaptation and mitigation multilateral funds, considering that NbS are an opportunity to contribute to National Adaptation Plans (NAP) and Nationally Determined Contribution (NDC) for reducing greenhouse gas (GHG) emissions, to meet the Paris Agreement and the Sustainable Development Goals (SDGs) adopted by the United Nation Development Programme (UNDP). The United Nations Framework Convention on Climate Change (UNFCCC), and the European Commission, among other multilateral agencies, include instruments for financing adaptation and mitigation (Instituto para la promoción de la diplomacia parlamentaria en el sistema interamericano, 2021).

Alongside the benefits of NbS, negative externalities can emerge. Recent evidence suggests enhancing greenspace and investing in infrastructure improvements to regenerate degraded urban areas may lead to a rise in property values. This phenomenon can lead to a subsequent displacement of low-income local communities followed by the arrival of high-income groups (Frantzeskaki, 2019; Scott et al., 2016). This process is called “eco-gentrification” and implies a high risk given that, according to the core principles of NbS and the IUCN Global Standard (Cohen-Shacham et al., 2019; IUCN, 2020b), these actions must address social challenges, within a process of inclusive governance. New approaches for regeneration programmes must include stakeholders from the beginning of the process and allow them to actively participate in the co-design of the areas, to legitimate the process through citizen engagement. It is therefore important to regulate social programmes for the area and legal instruments to avoid gentrification, especially when the communities are indigenous people, minorities and vulnerable populations (IUCN, 2020b). Another risk is associated with the concept of “greenwashing”. Many of the biggest enterprises and developers that contribute to greenhouse gas (GHG) emissions invest in natural solutions to counteract the negative externalities they cause, instead of investing in net-zero carbon plans. These enterprises (and the nations that subsidise them) do not carry on a systemic change, but they continue their operations, as usual, considering NbS as carbon "offsets" (Seddon, 2022). As previously noted, NbS must be considered within a general plan for the reduction of greenhouse gas (GHG) emissions, avoiding a limited perspective of impacts and compensations. It becomes crucial to rely on scientific, practical and technical knowledge developed by organizations and institutions, such as the IUCN Global Standard (among other documents), in order to guarantee that the risks are minimised. NbS must be embedded within a national policy on greenhouse gas (GHG) emissions reduction, to meet the goals of the Nationally Determined Contribution (NDC) set by each nation.

CONCLUSIONS

Nature-based Solutions for climate adaptation and mitigation in deltas and coastal areas offer a limitless range of possibilities for planning and design. There is therefore a definite need for a change in the paradigm of urban development towards a more sustainable approach. Deltas and coastal areas must be understood as complex adaptive systems, where all the components and subsystems are interrelated within a context of high uncertainty. This concept must be present in planning, design and governance processes in order to address societal challenges of the present and ensure possibilities for the future. Consequently, NbS, like any other urban strategy, must be undertaken in an integral, flexible way, with the active participation of stakeholders to legitimate the process. Participation is a central factor from the theoretical perspective since it is related to the self-organization that characterises complex systems. Furthermore, it is also important from the practical realm, to generate real changes that can be maintained in the future and achieve a paradigm shift in urban growth in coastal areas from a bottom-up perspective. Finally, it is necessary to consider that NbS are broad actions to address societal challenges including climate change adaptation and mitigation. These interventions must be included in broader strategies for the reduction of greenhouse gas (GHG) emissions, and no social challenge should be dismissed since they are all part of the problem, but also the solution.

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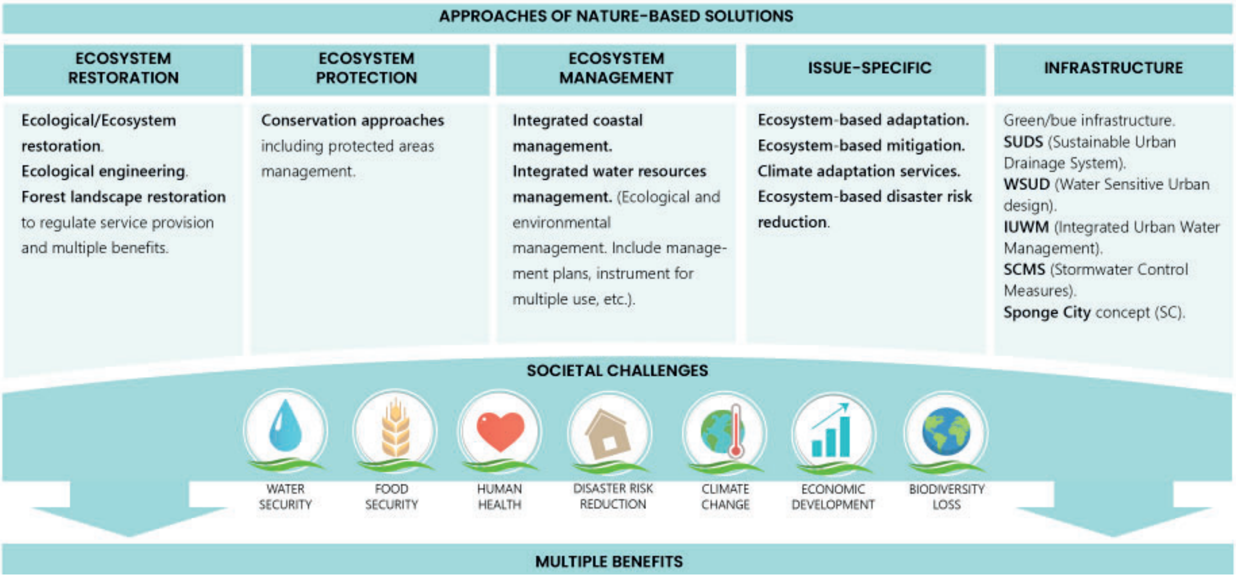

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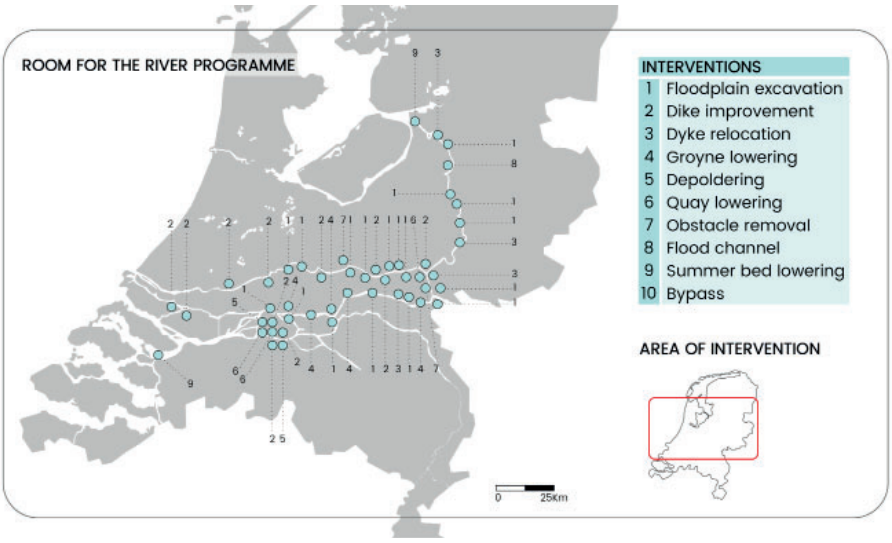

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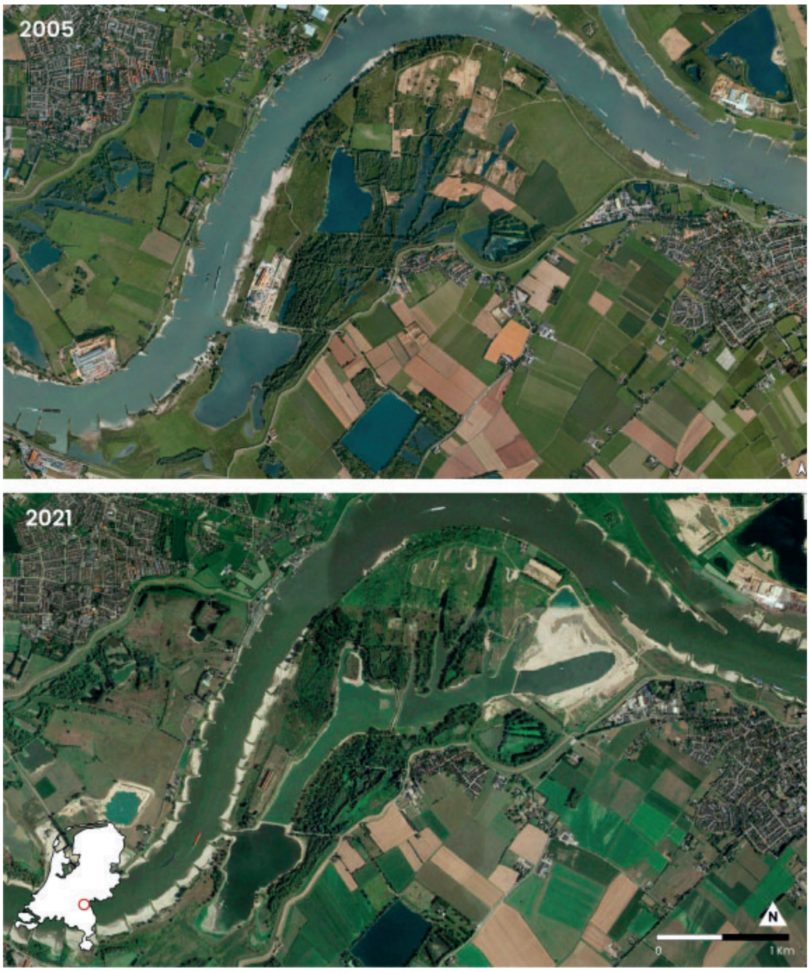

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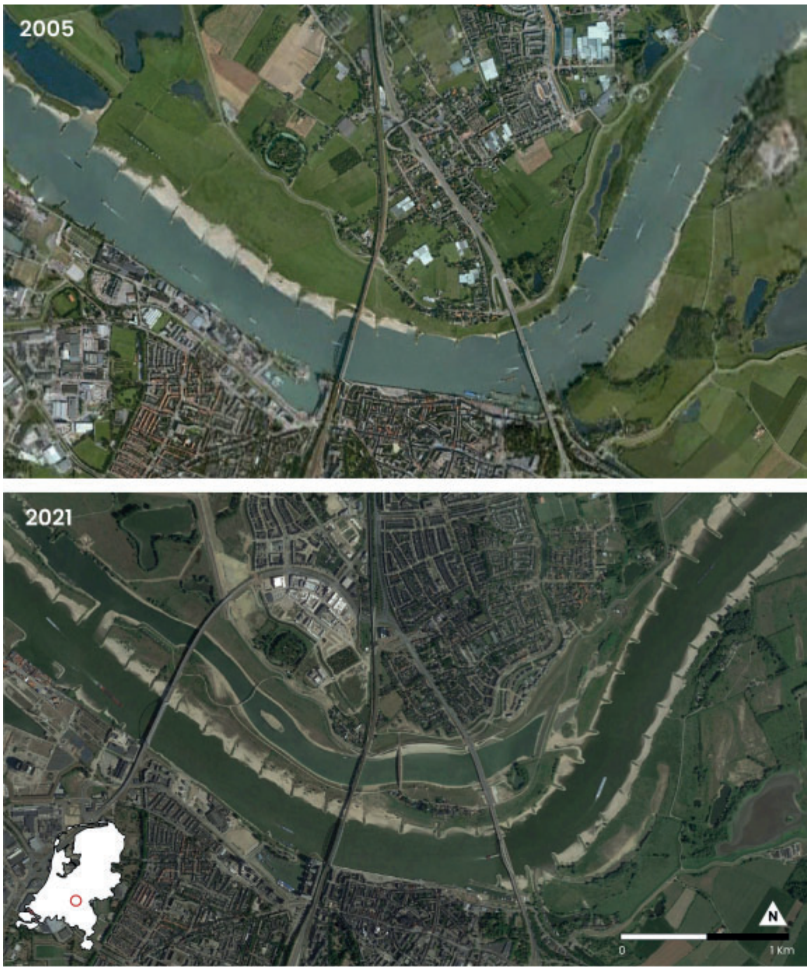

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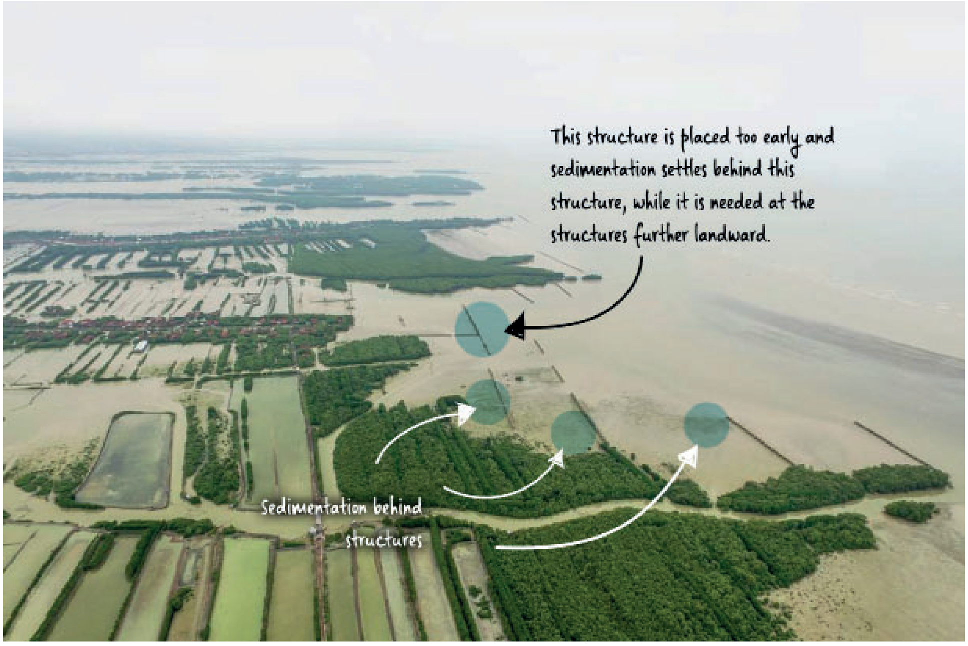

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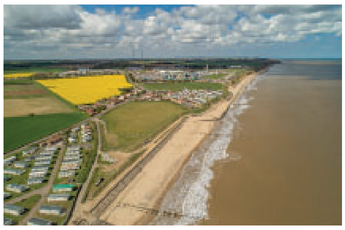

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05 Permeable structures in Timbulsloko (Demak, Indonesia) ©Tom Wilms, Witteveen+Bos. Retrieved from Wilms, van Wesenbeek, et al. (2020).

06 Example of spatial design in Timbulsloko (Demak, Indonesia) ©Pro57. Retrieved from Wilms, van Wesenbeek, et al. (2020).

07 Zandmotor, the Netherlands ©Rijkswaterstaat. Retrieved from Wilms, van der Goot, et al., (2020)

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09 Sandcaping Norfolk, UK. @ christaylorphoto.co.uk

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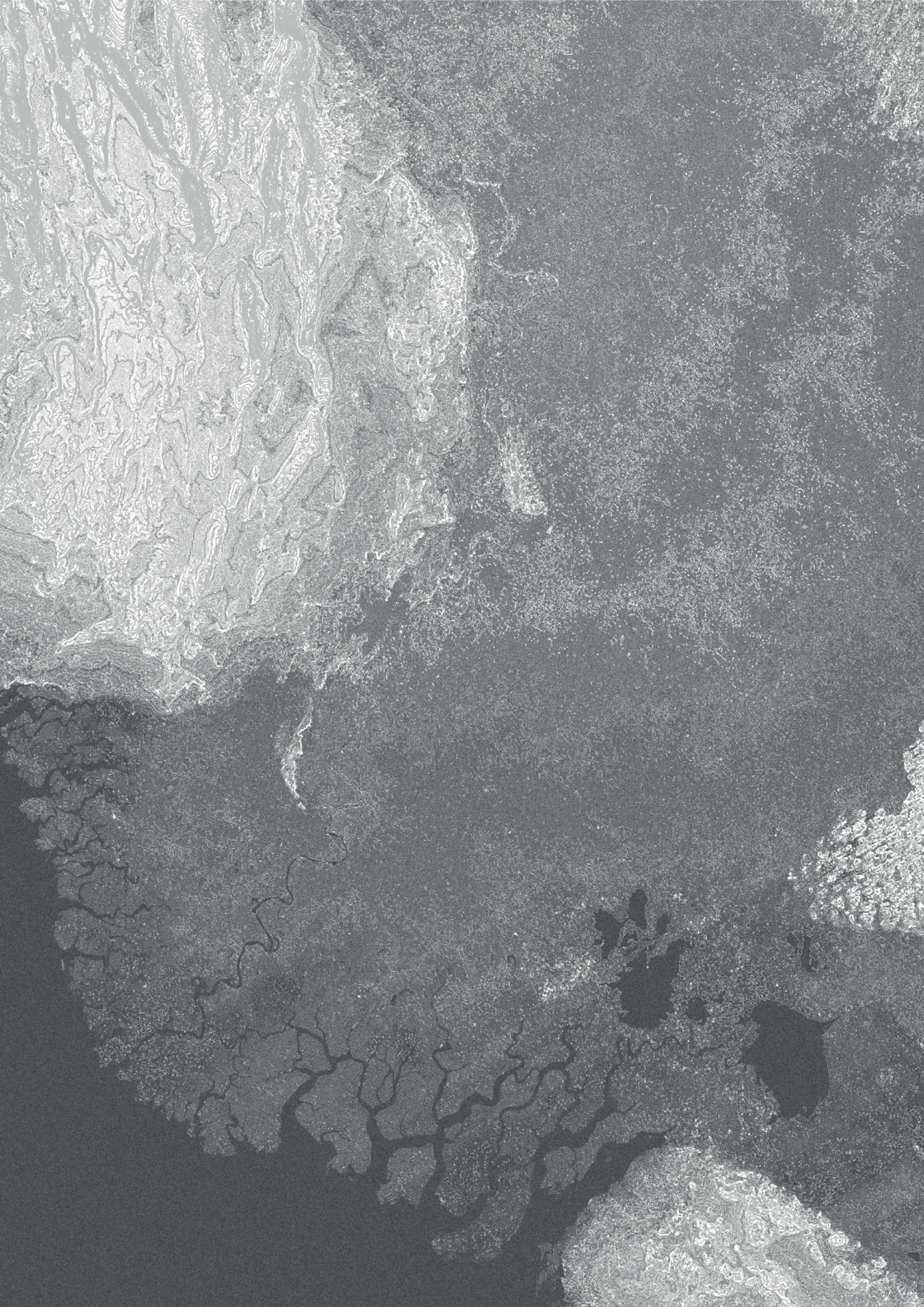
10 Sanya Mangrove Park. ©Kongjian Yu, Turenscape.

11 Haikou Meishe River Greenway and Fengxiang Park. ©Kongjian Yu, Turenscape.

12 Taizhou Jiangbei Park. ©Kongjian Yu, Turenscape.



Dialogues

Delta Challenges and Nature-based Solutions in Dialogue

Kim van Nieuwaal
Niki Frantzeskaki
Emmanuelle Cohen-Shacham

The delta areas had been significant for human development.The environmental degradation and the climate change are one of the multiple pressures experienced by urban deltas such as groundwater extractions, land subsidence affecting the provision of ecosystem services that pose extra risk in the livelihoods of the local as well on the global populations living in these areas. Nature-based solutions have proved their potential to counteract some of these pressures. The following talk brings to the fore an interdisciplinary take on the potential, the value as well as the challenges encompassed in designing, planning and governing nature-based solutions for urban deltas.

This dialogue is the transcription of a series of interviews from the guest editors, Veronica Zagare and Diego Sepulveda with the authors, held during October/November 2022.

KIM VAN NIEUWAAL

Kim van Nieuwaal is a specialist in science-policy interactions, particularly in the field of adaptation to climate change. Currently, Kim is strategic advisor at Climate Adaptation Services foundation. He is director of Delta Alliance International. Kim is also chairman of the board at the Dutch Wadden Sea Society. Kim was one of the lead authors of the National Adaptation Strategy of the Netherlands which was published in 2016. Also, Kim has been involved in climate adaptation strategies for Rotterdam, The Hague, Mainport Schiphol Airport, the South-west Delta, the Wadden Sea and the major rivers in the Netherlands.

NIKI FRANTZESKAKI

Niki Frantzeskaki is a Chair Professor in Regional and Metropolitan Governance and Planning at Utrecht University, the Netherlands. Niki has published more than 100 peer-reviewed articles and she has released five books on urban sustainability transitions. She is involved and has led research on environmental governance, and urban sustainability transitions in a portfolio of research projects with research institutes across Europe, Canada, Brazil and Australia.

EMMANUELLE COHEN-SHACHAM

Emmanuelle Cohen-Shacham is a consultant, researcher and group lead, working on various nature conservation, environmental sciences and policy projects, with academic institutes, governmental and non-profit organisations. She leads the Thematic Group on Nature-based Solutions (NbS), at the IUCN Commission on Ecosystem Management. She has co-led the development of the IUCN work on NbS since 2014. She is the lead author of the IUCN publication Nature-based Solutions to address global societal challenges, and co-author of the Global Standard for NbS, and the guiding principles for ecosystem restoration.She holds a BSc and MSc in Environmental Sciences from Tel-Hai College, Israel and from Wageningen University, the Netherlands. She did her PhD at Tel-Aviv University, Israel, focusing on the link between the provision of ecosystem services and ecosystem management in Mediterranean wetlands.

PART I — KIM VAN NIEUWAAL

Editor: *Considering your overall and broad vision of different deltas around the world, which are the challenges and opportunities you identify concerning climate adaptation in deltas?*

Kim van Nieuwaal: Let me start with the opportunities. This is actually the 'fun part' for me, as I find this the appealing aspect of climate adaptation. Climate change and the need to adapt to that urges us to reconsider our delta from an integrative perspective. It is a trigger to critically rethink the complex system that our delta has become. We now know and acknowledge that climate change is happening. It is here and we should do something about the causes, which is the mitigation aspect. But we now also know that climate adaptation is unavoidable, regardless of our mitigation efforts.

I see it in the Netherlands, but also other deltas are realising this. The changing climate puts pressure on your system and urges you to look for solutions amidst other major societal challenges that also put pressure on the deltaic system, such as the transition of energy and food supply. The bigger picture needs to be taken into account and only integrated approaches will suffice. And that is what I find a real fascinating puzzle, in the light of what we all want to achieve in the end: a healthy and attractive environment to work and live in. Eventually, our world will be greener in the future, as I really believe that this is the only way forward for us as human species. It will be an adaptive world, particularly in the deltas of the world, which I consider the pressure cookers of our time and the time to come. People have always been attracted to deltas because of their ecological dynamics. Deltas are like magnets in that sense. This entails certain threats, like that of effects of climate change that hit harder and earlier than anywhere else, but it also entails certain opportunities, which is the potential of the beauty of living in a delta as a green-blue environment. That is something we need to invest in. And that is what I like about climate adaptation: it is essentially an investment issue of how to make the world a better environment to live in.

And then you ask for challenges. There are plenty of them of course. The first thing that comes to mind is the integrative approach that I just touched upon. I mean, sometimes I wonder what is more challenging than solving problems in the Delta, because it has so many aspects, involving so many disciplines, under such big pressure. Another challenge I think is capacity: to have the right people in the right place to work on that giant complex puzzle, as a whole, but also in all its details. And then there is of course the issue of funding. We are talking big money when it comes to the challenges in the delta. But to unlock those funds bankable proposals are needed. Well, and then the mentioned complexity and capacity comes in. Another challenge is the science policy interface. Things are moving at a rapid pace in the deltaic pressure cookers and it is very difficult to keep up with all the knowledge that is being produced and all the policy frameworks, rules and regulations that are at stake. So, the science policy interface, which translates the knowledge to policy makers is, I think, crucial, but also very difficult because you would expect that policy is always underpinned by science, but that is not always the case, unfortunately. Another challenge that I could think of is the one that we are currently also working on very hard - and one that I think will be one of the 'next big chapters' in adaptation - is the monitoring aspect. I think we have acquired a lot of knowledge and expertise. We do have plans. We are implementing things. But soon you will have to question: taking all of this into account, are we on track? Also, in terms of the money: we are investing a lot in this, in the capacity, the science, the policy and the plans and implementation, and somebody eventually will ask: are we doing the right thing? For mitigation it is relatively easy to measure your progress by using Co2 as an indicator. Climate adaptation does not have such an indicator, yet. I personally think that the climate risks could be an indicator. We are working on a system now in the Netherlands for a national monitor based on that notion. Can you 'freeze' our current climate risks in the future by taking the right measures, and perhaps even diminishing those risks, but at least not see them increasing in the future. And here also the financing comes in. Investors will be very interested to see their properties safeguarded from increasing climate risks.

Editor: *Could you identify, in general terms, some responses and trends being developed in deltas towards climate adaptation?*

Kim van Nieuwaal: In general terms, we recognize two dominant ways of reacting to climate change. One is risk avoidance and the other is going for the opportunities. The avoidance approach is reductionist. It's very much technical and engineering-driven, bringing the issue back to its bare essentials as a problem. It is very much about quantification of risks and uncertainties, in answer to questions such as: are the measures cost effective? So, what you actually want to do with the risk avoidance approach is to minimise risks. We've done that in the Netherlands actually after the 1953 flood, when we decided that we don't want this to happen again, so we are going to minimise the risk of another flood. Notwithstanding those efforts we had some recent floods in 1993 and 1995, which cannot be compared to the one of 1953, but they were a wake-up call to a certain extent. It was the time when climate change got on our radar. We started to realise that the forces of nature are not something only to be fought against, as we had primarily done with the Delta Works. A next chapter would become the Room for the River approach, which literally does what it says. We have learnt that measures as part of that approach also improve the quality of the spatial environment. So you could say we have gone through a paradigm shift, from the avoidance approach to minimising risks towards a more opportunity-based framework. And when you think in terms of opportunities, you look at things in a more integrative and holistic way. What you would want to do is create support for that, for instance by using design and visualisation. You want to actually seduce people, rather than scaring them or forcing them in certain directions. So, in contrast to risk avoidance, where you want to minimise the risks, when you think in terms of opportunities, you actually want to maximise the opportunities and value creation. I see this in the Netherlands but also elsewhere. And I think this is the way to go. Nature-based solutions are a logical component of the opportunities approach I think.

Editor: *Which is the role that nature-based solutions may have towards a sustainable transition in deltas?*

Kim van Nieuwaal: The relevance of nature-based solutions goes beyond that of the specific measures and projects I believe. As I argued earlier, our built environment will have to be more and more green in the future. So, we will need to know more about ecosystems and how to live with them. Putting nature-based solutions into practice will teach us and inspire us in that respect. What I really believe in is that when you get to know and understand something, you will start to appreciate it, or even love it, and when that is the case you will make an effort to take care of it. And this applies I hope to our future deltas. We want to know more about the financial world or about travelling to other planets. But I think one of the real resources in the future is our knowledge of ecosystems and our role in relation to them. And the people who have the knowledge and capacity to do so. But also, I think, we have a competitive advantage in creating a world which is more attractive to live in, also for investors. This is something we all want to see happening in the future.

Allow me to refrain from details on nature-based solutions, as I am not an expert myself. But, I just came back from Indonesia and walked through the mangrove forests again, thinking to myself: this is the future for deltas, coastal areas and small islands. You find the local community being involved in those joint endeavours, taking care of their shared environment. I honestly hope that future generations push the boundaries in that respect, coming from a time and place of urban jungles and worrying about materialistic things and returning to situation in which we better understand that our natural environment is something that we should treasure as a necessary condition for our existence. The recent pandemic was and is overall a tragedy of course, but I think we have also witnessed an increased appreciation of our living environment as we were restricted in our travelling. So, they started to look for places where there is water and trees, like lakes and parks. So, eventually, nature-based solutions are perhaps more part of our human nature than we often realise.
This is why I remain positive about the future.

PART II — NIKI FRANTZESKAKI

Editor: *Which is the role that nature-based solutions may have towards a sustainable transition in deltas?*

Nikki Frantzeskaki: What I can offer in this dialogue on the potential of nature-based solutions for urban deltas is taking a sustainability transitions perspective on what needs to be done for climate adaptation in cities and in delta cities, but also for the governance of and with nature-based solutions. Let me start by saying it is really recognized across many of the global reports that in order to deal with the combined crises of climate change and biodiversity loss, we need to make systemic transformations at pace and at scale. In this case, we have seen that cities, especially well-equipped cities in terms of staff, capacity, in terms of planning, in terms of climate adaptation knowledge, are taking very daring steps. However, we need to think about what happens with all the other cities that do not have these capacities. Would a way forward be to invite them or actively engage them into the discussion on transformative change into the issues and accelerate their capacities to take up action?

Have people tried and acquired knowledge of the systemic solutions that are economically, ecologically, socially, and technically ready for dealing with climate adaptation and climate mitigation in cities? So, when we talk about capacity, we need to think beyond financial capacity. We need to think beyond ‘the right people’ because ‘the right people’ does not often refer to experts. And what we see from looking at effective initiatives in cities from a transition’s perspective, is that it is about multiple actors that synergize, that work in a coordinated way, that device or find innovative ways to change existing ways of organisation. Such activation of collective agency we see to progress climate adaptation. So, we need to think about multiple expertise, multiple knowledge coming into play.

In my view, when I talk about systemic solutions like nature-based solutions, we have stressed the need to be underpinned and guided by a systems approach for the design, implementation, management and the stewardship of these solutions. And this is not about being reductionistic. This is about having an organising framework of taking complexity seriously, analysing and understanding complexity - taking it to heart. It is about recognizing the feedback loops, the interconnectedness between the social, ecological, and technological components that need to be well-designed and prepared in nature-based solutions.

At the same time, we need to, and again, I say we, in terms of everybody who is involved in adaptation efforts, we need to take the context seriously. A solution is not effective if it is not tailored to the context nor if it does not connect and is embedded in the context. We have seen a lot of examples, and from my earlier work in Jakarta, for example, with the flood protection works there and all the challenges (including the failures faced), it was because a lot of these large infrastructure projects were not well connected to the socio-cultural context drivers. You might make a rain garden, you might even make drainage canals, but if people litter or block them, that will result in their destruction and malfunction.

I think we have a lot of examples, including the ones in the Netherlands, that we saw this shift from an approach that was more about engineering, managing, and confining nature, versus living with nature. This big shift in the Netherlands was pioneered with the Living with Water program, the sand machine, and the sand dunes, the deculvering of riverbank areas as well. I think these are all measures that show how we can implement nature-based solutions without compromising the urban lifestyle. Finding space for and giving it back to nature in urban deltas, comes with a lot of conflict for space, and for how public space will be designed and used. Hence, we need to really take into account that this is a spatial planning aspect.

We need to start to think of nature-based solutions in urban deltas as part of the puzzle of urban infrastructure; how they can connect and be integrated and hybridised better. So, for me, the most important future step for the science and practice of nature-based solutions is to think about how they can connect, how they can interface with other urban infrastructures. There are some examples to consider such as using rain gardens for passive irrigation of urban trees, and linear parks with trees creating canopy cover (and shading) to bicycle lanes and pedestrian pathways.

The last statement is about how to ensure that nature-based solutions when employed for urban regeneration create equal distribution of benefits and are not employed as means of displacement/gentrification. This connects with the point on the values and challenges of Green Infrastructure posed by Kim. I want to stress the aspect of the context in which N.B.S are being introduced or thought of being introduced, needs to be taken very seriously into consideration, not as a barrier. When designing and planning nature-based solutions, we need to take this kind of understanding of the social cultural practices that are in place and engage with citizens in a way that fits their socio-cultural practice. Such co-creation processes require different skills and capacities from planners and researchers alike. It is often the case that we cannot do it with a technical language of illustrating benefits or efficacy of nature-based solutions, different approaches for co-creation and engagement are needed. I'm not saying technical analysis isn't important; it's very important, and expert knowledge is very important. At the same time, we need to recognize that we also need some other types of knowledge and expertise in order to engage with citizens. And this expertise exists. To summarise it is really important to take inter- and trans-disciplinarity as a principle, for designing, implementing, and managing nature-based solutions for climate adaptation in urban deltas.

PART III — EMMANUELLE COHEN SHACHAM

Editor: *What is the role that the Global Standard for NbS play towards the implementation of NbS for climate adaptation in deltas, and what are some reflections on the two previous opinions regarding Deltas, Sustainable transitions and NbS?*

Emmanuelle Cohen Shacham: The perspective I can provide to this dialogue is based on the work on Nature-based Solutions (NbS) I have been part of, within IUCN's Commission on Ecosystem Management. One first point to mention is that the IUCN work on NbS - both the conceptual and operational frameworks - should be relevant and was intentionally done to be used and adaptable to a diversity of contexts: whether the geographic context, for a use in all the regions around the globe, the ecological context (for the various types of ecosystems), or aiming at addressing a whole range of societal challenges (like climate change adaptation and mitigation, addressing biodiversity loss and ecosystem degradation, ensuring food security and water security, disaster risk reduction, ensuring human health, and social and economic development), with different NbS interventions. In other words, the NbS framework is not designed to be used in just one particular context, like deltas. In addition, NbS shouldn't only be implemented for or looked into just for one particular challenge (such as addressing climate change through ecosystem-based adaptation). Indeed, although it may be challenging, and as mentioned above, NbS are about addressing several types of societal challenges in an integrative manner, through collaboration and the coordination of multiple stakeholders, and through synergies across sectors, while benefiting nature and society.

The NbS conceptual framework consisted of a definition and a set of 8 principles for NbS, to set a common basis of understanding of what NbS are and aren't. Based on it, the Global Standard for NbS was developed, with a set of eight criteria and 28 indicators, to firstly ensure that anyone that is talking about NbS, planning to develop or implement one, is actually doing so. In addition, the Global Standard has a self-assessment tool to provide different types of users with a robust operational framework to help them design, implement, assess, improve and scale their interventions. It is aimed at being used by a variety of stakeholders, whether they are project managers, planners, donors, the finance sector, citizens, practitioners on the ground, policymakers, or researchers that are actually using this as a research framework. The eight criteria and 28 indicators, helps to underline specific aspects or activities that need to be considered or taken into account at different phases of an NbS intervention - during the planning, implementation or ongoing management phase. And then, the more all these aspects are considered, the more the intervention is adapted to meet all of these criteria and indicators, the more adapted and improved NbS these interventions become, and the better the targeted societal challenges are addressed.

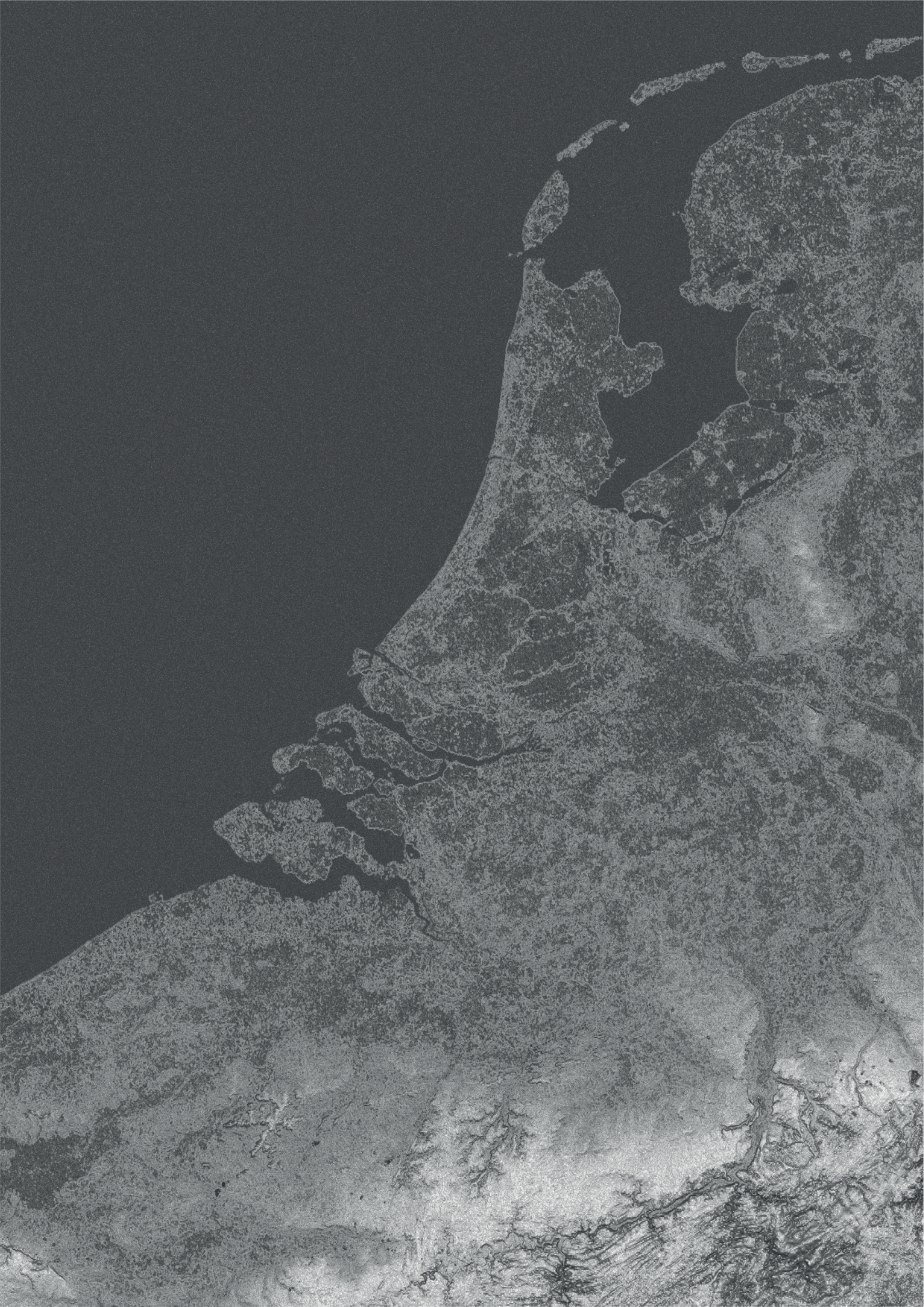
The NbS Global Standard's eight criteria focus on NbS addressing societal challenges; NbS designed at scale; NbS resulting in a net gain to biodiversity and ecosystem integrity; NbS as economically viable; NbS being based on inclusive, transparent and empowering governance processes; on equitably balancing trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits; NbS being managed adaptively; and NbS being sustainable and mainstreamed within an appropriate jurisdictional context.

As it was mentioned above, the monitoring aspect is important and can help follow the intervention's progress, and verifying if the targets that were set during the planning phase are being reached. Such results may be used for different purposes, among them convincing policymakers or planners to choose NbS over more conventional type of intervention, and donors to fund similar initiatives. And of course, monitoring is important to keep track of the progress and identify good practice to be replicated.

I agree with what was mentioned on the importance and need for a system approach to help guide the design, implementation, and management of the of NbS interventions. The NbS Global Standard can help organising and listing all the most important aspects that need to be taken into account during the planning, implementation or the ongoing management phase of the NbS intervention.
Also regarding the importance of tailoring NbS to the context, I agree and as I mentioned above, NbS interventions are being planned and implemented in very different contexts, and they are context dependent. In certain regions, certain norms are in place and are already being implemented and used. Relevant legislation and policy at the local, regional, national or even international context can help to support the success of the intervention. NbS may also very much vary, depending on other, more physical types of contexts, such as the place, the ecological context (which vary from instance, from dry land, coastal wetlands, mountain, urban area, a lake, a delta, or a marine type of ecosystem) the climate and regional contexts and what kind of stakeholders are involved in the intervention's development. How many people are aware of their initiative and involved from the start? How many people know about what is at stake and care about what is being done? How many organisations would be willing to develop NbS in the short run, accurately and take into account, the different criteria and indicators, of the Global Standard?

I also agree that it is very important to involve the local community, indigenous people's community if present, local stakeholders, because of their knowledge of the place, the different tools that could be used, and the different types of knowledge that they could bring to the table. Ensuring that all relevant stakeholders, including the local community, are present and involved in the full NbS process, is the focus of Criterion 5 (on inclusive, transparent and empowering governance processes), of the NbS Global Standard. In addition, according to Criterion 2 (on NbS design informed by scale and synergies) of the Global Standard, it is important to look for complementary interventions that can help support the success of the NbS. One relevant example was in our 2016 publication, focusing on Green Infrastructure in Barcelona. Education and awareness raising to the local community was an essential source of success for that intervention. First, on the importance of nature and the ecosystem services that are being provided thanks to the intervention. Second, on the role of nature as a source; as a basis for the solutions, and on how important it is to make sure that the ecosystem are kept healthy in order for the NbS to continue to be sustainable in the long run.

It is important not to isolate NbS only for climate adaptation, but to use this framework and the tools available to address a variety of societal challenges, in an integrated way. There are examples of NbS for climate adaptation, while implementing ecosystem based management and adaptation, and also addressing food security, water security, and economic development, in dryland ecosystems in Jordan. Another one is NbS for adaptation while also implementing ecosystem restoration, ecosystem-based management, integrated natural resources management, and agroecological approaches, to address water and food security, biodiversity loss and ecosystem degradation, and socio-economic development, in the highlands of Ecuador. Although some examples can be framed as adaptation, the intervention can also increase carbon storage in parallel, and increase climate mitigation, while addressing other societal challenges. So, I wouldn't single out adaptation when planning or referring to an NbS intervention, and try to look more in a more integrative way, on how to contribute to other issues, such as biodiversity loss or ecosystem degradation, food or water security, or other societal challenges.



Projects

Between The Sea And Giants:

The Case on Nature-Based Solutions along the Flemish Coast

J. Subendran
M. Van Nieuwehove
A. Mengé
K. Vanackere

The Belgian coastline is 65 kilometres, has 15 coastal towns and, like many of its North-Sea neighbours, experiences the volatile dynamics of sea level rise and raised demand for effective coastal safety measures. Today, we are seeing the consequences of hard and grey infrastructural solutions which solely address the concerns of coastal safety in a majority technical way. Along the Belgian coast, exists an array of sea walls, dikes, and beaches along a traditional sweeping concrete surface delineating the edge between land and sea. Through the perspective of Nature Based Solutions (NBS) this paper will unpack how NBS has been planned and implemented across three of the Belgian coastal towns Bankenberge, Middelkerke and Ostend. These three Flemish pilots are representative for the typical coastal conditions of a dense urban frontage along concrete boulevards, substantiating the edge condition to the sand and sea. The pilots are a showcase of how NBS can acts as a performative buffer, or interface, between the urban edge and the sea, between the sea and giants.

Placement of Eco-blocks along the breakwater at the Newlyn project site. Source: SARCC Project, 2022

INTRODUCTION

The Sustainable and Resilient Coastal Cities (SARCC) project, one of the projects within the 2 Seas program of INTERREG, is focused on streamlining NBS solutions through seven pilots across four countries, The United Kingdom, The Netherlands, Belgium, and France. The core of the project is the idea of working with nature, rather than against it through balancing the benefits of socio-ecological systems (Sowińska-Świerkosz, 2022). The type of NBS however differs per case while they all address societal challenges, restore ecosystems or help mitigate risks of climate change. It is also essential that innovative solutions respond to the conditions of the context and its Longue Durée.

The innovative nature of NBS leads to reluctance to implement because it is not yet proven in its performance and the financial and managerial costs are not clear (European Commission, 2022). However, research suggests that NBS are cost-effective with awareness of the different financial models that may require a larger upfront investment for long-term impact (Van der Biest, K et al, 2017). Programs such as the INTERREG program, a research and impact funding scheme under the European Commission, develop topic-focused programs such as the 2 Seas Program that aims to create more experience and evidence, and mainstream Nature-Based Solutions into coastal management and policy-making across coast cities within the INTERREG ecosystem.

The Belgian coastline is 65 kilometres, has 15 coastal towns and, like many of its North-Sea neighbours, experiences the volatile dynamics of sea level rise and raised the demand for effective coastal safety measures. Today, we are seeing the consequences of hard and grey infrastructural solutions which solely address the concerns of coastal safety in a majority technical way. Along the Belgian coast, exists an array of sea walls, dikes, and beaches along a traditional sweeping concrete surface delineating the edge between land and sea. The 15 medium size towns are scattered along the coast, where this threshold is substantiated by paved and impermeable surfaces connecting the dominant urban face, giving little space for socio-ecological dynamics, such as water infiltration, recreation, vegetation and biodiversity. In contrast, increasing demands for Nature-Based Solutions can be seen as an opportunity to transform these hard edges into a dynamic interface and strengthen coastal resilience in an integrative manner.

Through the perspective of NBS, this paper will unpack how NBS has been planned and implemented across three of the Belgian cases. The three pilots are unique

Transformation of road segment into grassy- dune scape and foot/cycle path at Blankenberge project site. Source: SARCC Project, 2022

in their coastal condition, particularly with dense urban frontage along concrete boulevards, substantiating the edge condition to the sand and sea. The space between the urban edge and sea, the interface, is the predominant domain of intervention across all three Flemish pilots. In doing so, the review of these cases will be developed through the lens of the interface and unravel how NBS acts as a performative buffer between the urban edge and the sea, between the sea and giants.

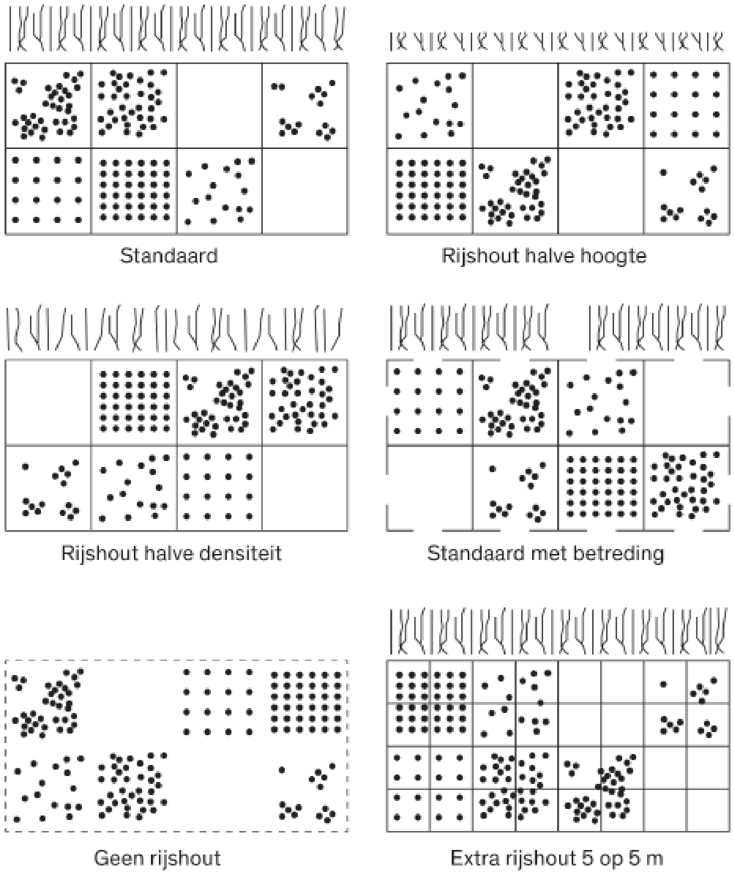
THE INTERFACE ALONG THE FLEMISH COAST

Blankenberge

The project of Blankenberge sits along the main road connection behind the dune stretching east and west, connecting itself to the N34, an arterial road spanning almost the entire country's coastline. The coast of Blankenberge is lined with a one-kilometre-long dune connecting the city's boulevard and the city's seawall. The location of the pilot is adjacent to the main road and behind the kilometre-long dune. The road is comparatively larger than the other roads in the city, which facilitates a two-direction tram line and road and is flanked by parallel parking.
The main objective of this pilot is concerned with returning close to 50% of its section (approx. 12 meters) back to nature, specifically to expand the current system and facilitate human-based mobility such as a new foot and bicycle path. This effort also reflects an increasing demand to 'bring back' nature over the last decade (Hooimeijer and Bortolotti, 2022). In principle, the aims are to double the dune and prioritize native and endangered species by transitioning the largely concrete road surface to a natural corridor. By naturalizing the space between the coast and the first line of urban frontage, an interface is realized, enabling socio-ecological benefits such as ecosystem enrichment, and activation of human-centred mobility while strengthening the coastal resilience capacity.

Ostend

Together with the Municipality of Ostend as well as the Maritime and Coastal Agency, the project in Ostend focuses on how the sea wall, in the context of high flood risk and consequential impact, can be combined with the nourishment of the beach (Hooimeijer and Bortolotti, 2022). The pilot project is concerned with the capacity between the beach and the urban edge. Given the large span of open-air sand, the beach and consequentially the larger urban coastal conditions face challenges of erosion and the uplift of sand during high winds.
To address this intersection of challenges and diversify the current plans for extending the sea wall, the project aims



Planting scheme on dune at the project site in Ostend.
Source: SARCC Project, 2022

to embellish the current seawall along the tram line with a dune. The design of the dune includes the planting of local vegetation to tame the sand in windy conditions (see Figure 3). Additionally, the design creates recreational and leisure functions to increase the attractiveness of the area. In doing so, a bike lane is combined along the dune and on top of the dike. The catching of the sand by the dune with its planting allows the cycle path to stay free of sand and be used without obstruction.
Introducing a combination of recreation, and leisure through an ecological landscape such as a dune along the existing hard infrastructural solution enables conditions for an active interface that is multi-functional as well as non-intrusive. Although the intervention can be deemed 'minimal' in the grand scheme of NBS around Europe, it has been slowly adopted by the community and is increasingly considered a vital armature of socio-ecological benefits. The naturalization of the hard edge between urban and coastal conditions serves as a viable solution for a cost-effective, high-impact, easily acceptable interface for the local community and ecosystem to thrive (Gussé, Stijn., et al., 2022).

Middelkerke

Similar to the partnership between Municipality and Agency for Maritime and Coastal Services, the Middelkerke project aims to reinforce the existing seawall through the realization of an 85-hectare vegetated dune activating the adjacent residential fabric. The proclaimed, dune for a dike project, contains three aspects to the design, increased protection, green and sun, making for a multi-functional operation (Gussé, Stijn., et al., 2022).
Currently, the pilots serve to provide the dune as a cost-effective solution and after several months of being active, it has proven to positively compensate for the upfront maintenance and 'setting-up' process, by lessening the maintenance required over long-term operation. During a workshop on sharing progress, pilot managers from Middelkerke stated that the activation has enabled cascading socio-economic benefits such as increasing financial investment incentives for businesses and increased access to recreational activities for both local inhabitants and incoming tourists (Ibid).
After its implementation, this project can be seen as an effective pathway to implement NBS due to the project being bound by European Union law. As a project within the INTERREG program, the project can secure its realization by leapfrogging any stalling local bureaucracy and accelerating the decision-making process under the umbrella of an EU-funded project. Considering its suc-

Planting of Marram grass and construction phases at the Middelkerke project site.
Source: SARCC Project, 2022

cess, the interface, in this case, was able to materialize a range of benefits that positively impacts the well-being of both the local biodiversity as well as inhabitants, while in turn proving the positive return on investment through cost-effective maintenance and local business development (Ibid).

CONCLUSION

The interface as a Nature Based Solution

Across the three project cases, NBS serves as a simple and effective solution that can act as a productive interface enabling socio-ecological transformation, being a natural buffer to neutralize the threats of sea level rise, and erosion of the shoreline, and mitigating the uplift of large uncovered sandy areas. The implementation of dunes, which in this case is the primary medium, also establish and regenerates biodiversity, creating local flora and fauna for them to thrive. Moreover, undeniable benefits that arise can be attributed to recreational and coastal safety maintenance. This demonstrates the vegetated-dune landscape proves to have widespread values engaging with the surrounding social fabric, activating socio-economic activities such as local economies as well as providing a space for recreation. Giving the space back to nature through a human-centred experience. From concrete to sand, from weeds to tall grass and insects, from grey to green, and from degenerative to regenerative. The three Belgian cases exemplify the cost-effectiveness, high impact and versatility of simple implementation of NBS like the vegetated dunes.

It also showcases the various typologies of this landscape, from the double-dune, dune as a dike, and coupling with hard infrastructure such as a sea wall. Between the distinct urban frontage and the sea, these interventions have created a productive interface, far exceeding the values of pre-existing conditions, by introducing a naturalized buffer area serving as a value multiplier across societal, economic, operational and ecological domains.

The sea-land relationship along the Belgian coast is not unique, however, the dense urban fronts are very typical and for example, are rarely found in the Netherlands. An ideal comparison would be with Scheveningen where the solution for boulevard enforcement has been done with grey infrastructure. Thus, the implementation of these NBS interfaces can be considered a best practice or exemplar case as a real cost-benefit alternative to traditional mono-functional hard-grey infrastructures. The collective effort along the North Sea coastline, could inspire larger initiatives around the world and unite coastal resilience through a nature-based approach.

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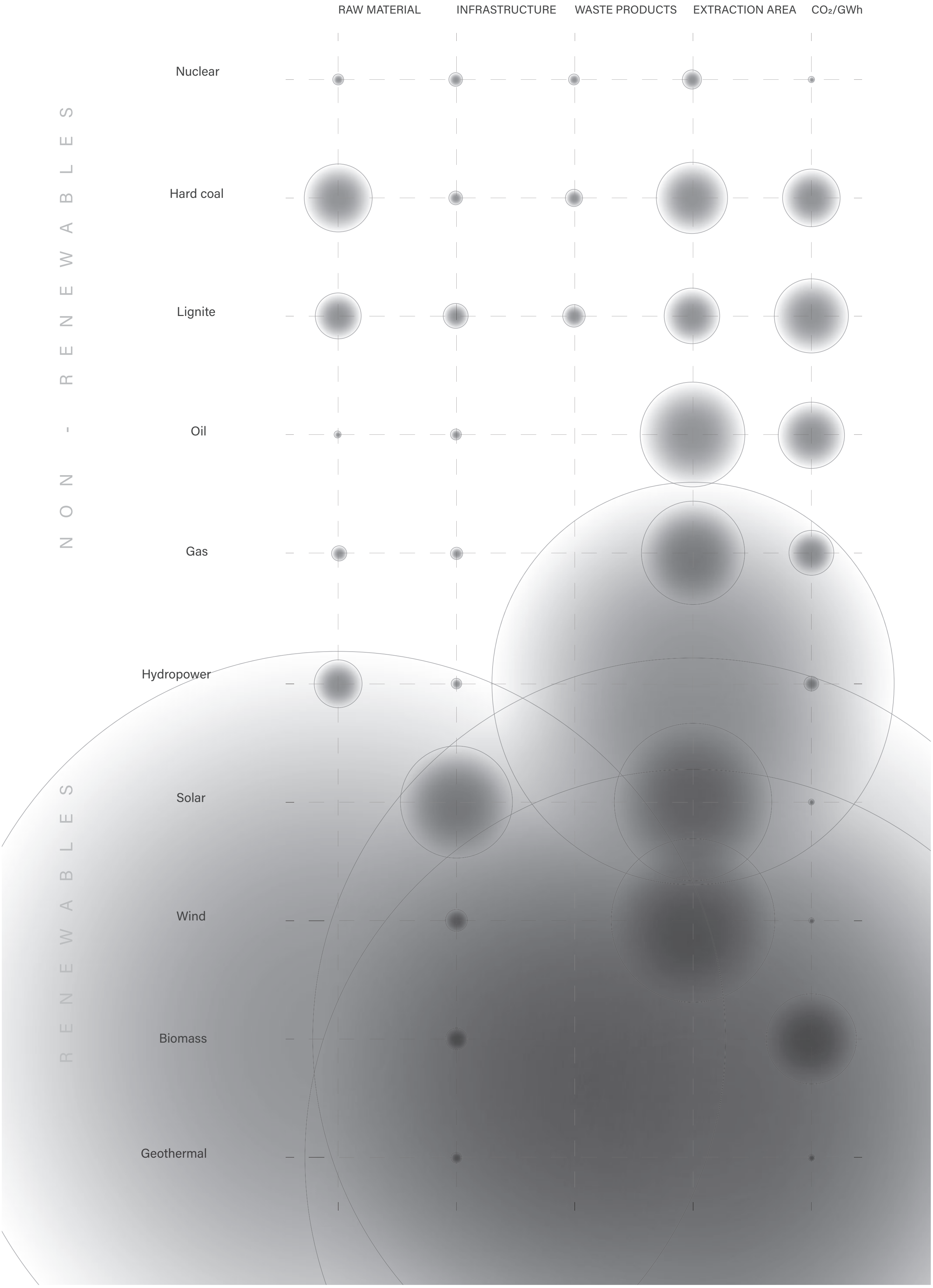
Energy as a spatio-temporal project & the Rhine Basin urbanisation

Hugo López

Looming crises demand viable territorial responses for their interdependent challenges. Approaching energy as a spatio-temporal project can reorient spatial planning and urban design to organise such responses. The current context of quickened ‘energy transition’ requires the investigation of the scaling-up of renewable energy so that the coming decades can compose socio-ecologically just alternatives in renewed urbanisation paradigms towards the 22nd century. Accordingly, the project proposes a conceptual tool and methodology for the transitional territories of operational energy landscapes in the Rhine Basin. First, it maps the evidence of non-renewable energy, then anticipates and assesses the ‘energy transition’ in its current and future landscapes, informing its territorial design. The project surpasses current dichotomies between the urban and rural, conservation and intervention, and nature and society, developing hybrid landscapes where technologies for mitigation, restoration and sustainability are grounded in the temporalities of the habitats for humans and more-than-humans. In other words, a reorganisation of the links between energy, food, and work into ecological frameworks. Moreover, it works as a platform that contributes with speculative spatial thinking to refresh the concept of sustainability, problematising the geopolitical project for the planet into a geological age of climate instability.

Figure 1: Spatial footprint in hectares for the equivalent of the electricity demand of 1 million homes, or around 3387 GWh. Data: Sijmons, 2014; IEA, 2019



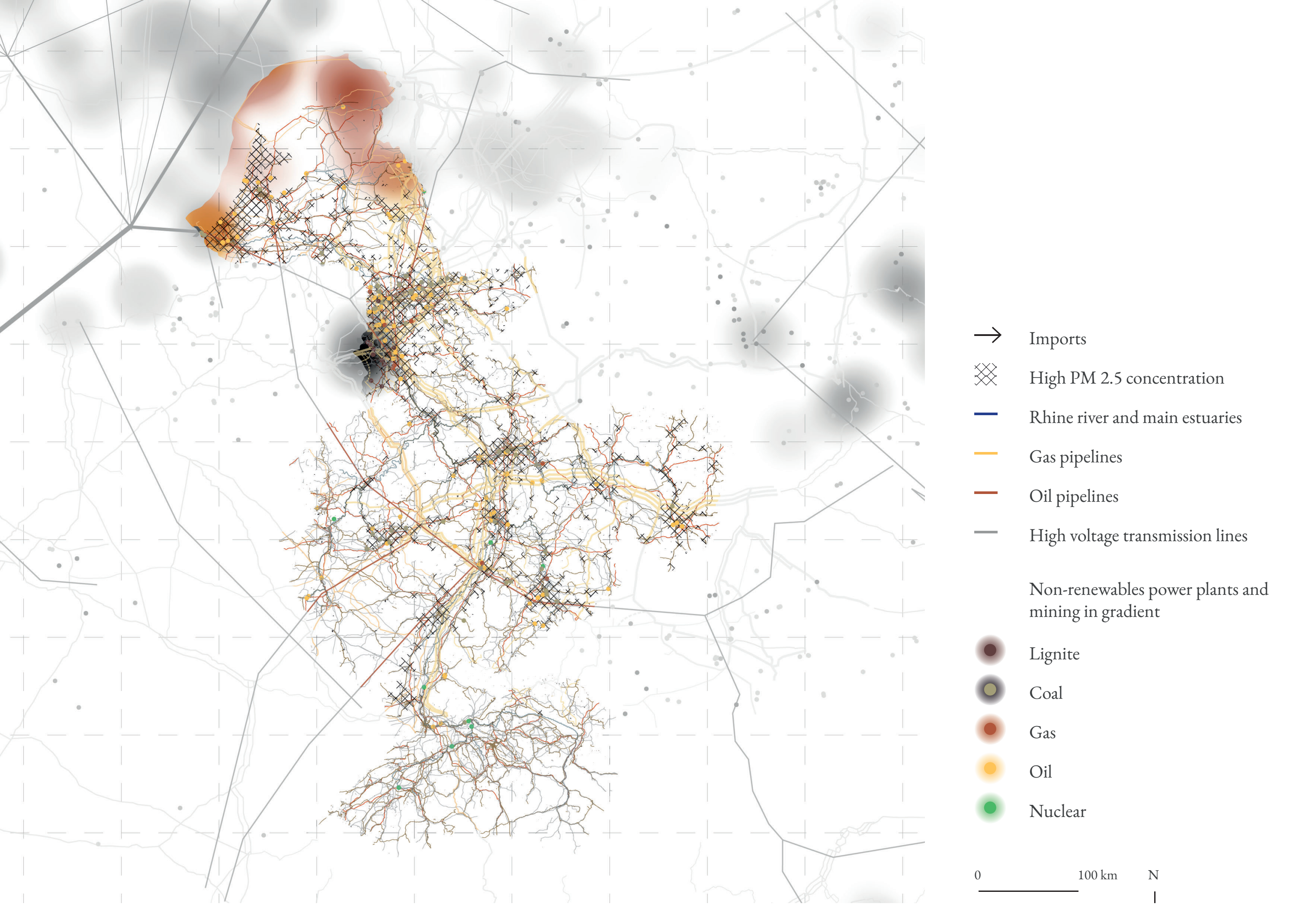


Figure 2: Rhine Basin as an operational landscape

INTRODUCTION

Context

The Great Navigations inaugurated the period known as “the long 16th century”. They kick-started Extractivism (and the capitalist world-ecology) through European powers colonising other continents' natures - mainly people’s labour and land resources. (Moore, 2015) After many waves of exploitation of natures and exhaustion of frontiers, non-renewable sources have globally become the best EROI (energy return on investment) and, subsequently, the backbone of every activity. (Illich, 1983) The Industrial Revolution of the 18th century, and especially the Great Acceleration in the middle of the 20th century, fueled the modern era to the new possibility of energy-intensive life and exponential growth. In a bit more than a century, the process that operationalised the Earth and provoked a sharp increase in production also feedbacks in the forms of climate change and biosphere degradation (Steffen et al., 2015), with burning fossil fuels for the generation of energy being one of the most significant contributors. (EEA, 2020)

The exponential growth of a globalised industrial society and the amount of exploitation led to concerns about the planet’s liveability for future generations since the 70s when the scientific community sounded the alarm, and an environmental movement began to gain momentum. The 1973 and 1979 energy crises were the first global demonstration of the link between energy landscapes, a planetary society, and the Earth’s depletion. (Mair et al., 2020)

Nowadays, the predicted supply shortage and the climatic consequences are becoming too latent and dangerous/unprofitable for the smooth functioning of (Neo) Extractivism. (Acosta, 2013) The triad of energy, economy and environmental conditions is forming a scenario where spatial planning and urban design can be relevant in composing an alternative spatial project as the energy landscapes of the renewables era require and make possible different spatial configurations. (Ghosn, 2009) Further than applying more ‘sustainable’ practices, a different plan for the role of urbanism is necessary to avoid reshaping the perpetuation of unjust geographies of power. What is the agency of territorial design and spatial planning in conceiving and composing a viable design for the Earth’s habitats, productivity, and logistics?

Energy as a spatio-temporal project

Energy has a spatial project to operationalise its processes and support consumer society. The shift from a nomadic to an agricultural society created the possibility for settlement. The second shift from agricultural to industrial gave rise to networks that are called a process of “planetary urbanisation”. (Brenner, 2013) The modern era is the reorganisation of the territory around the avail-

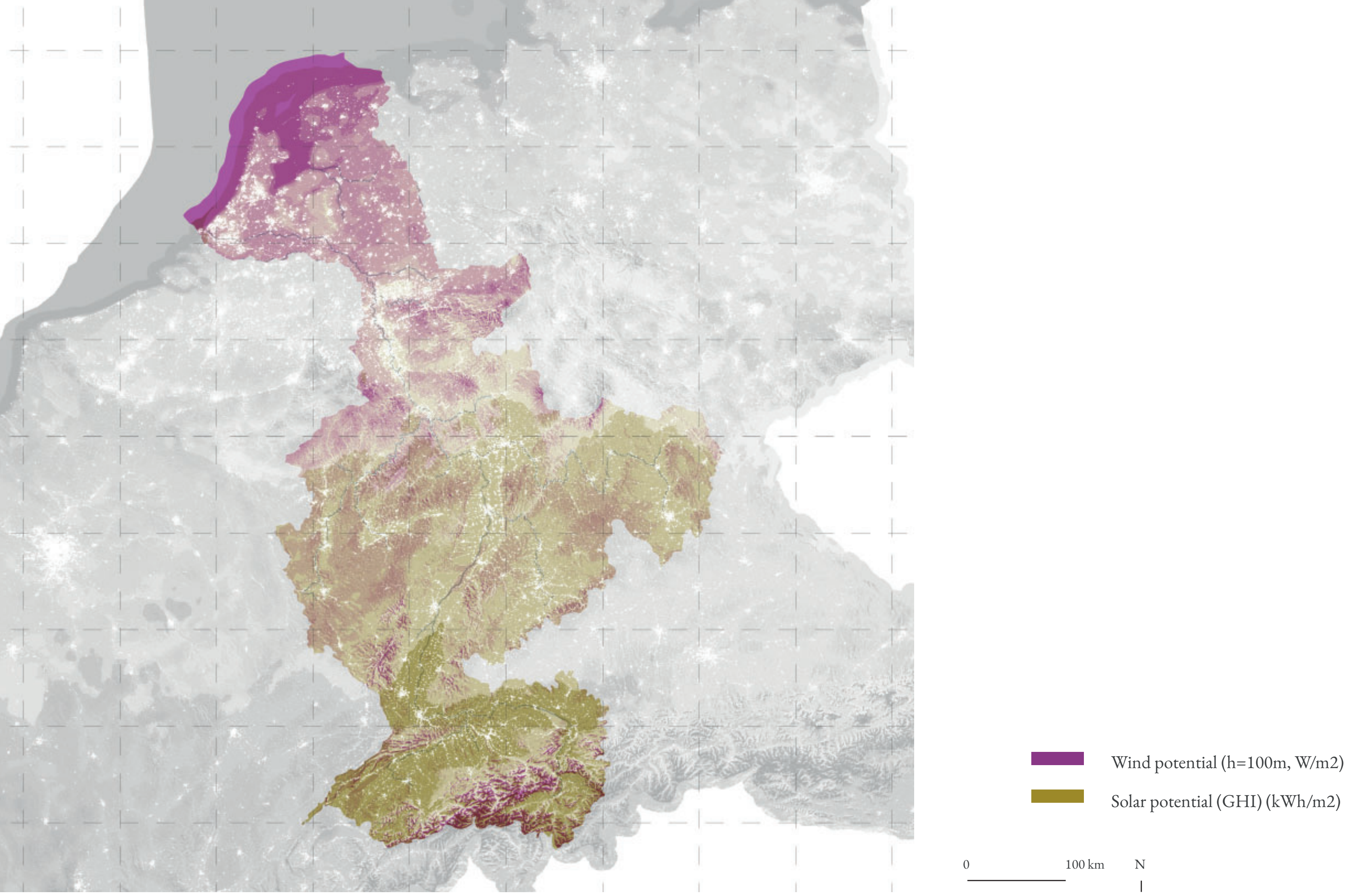


Figure 3: Wind and solar renewable energy potential

ability of abundant (non-renewable) energy established by a new horizon of possibility for production. (Iturbe, 2019)

The phasing-down (yet very active) of non-renewables is territorialised in extended urbanisation with nodes of production in a dense web of connection to mining territories. Conversely, the spatial challenge of renewable energy is that of another kind of urbanisation, highlighting different spatial challenges, especially in the energy landscapes of conversion. (Bruckner et al., 2012) The comparisons (Figure 1) make clear the spatial footprint for the processes in non-renewables and renewables.

It is possible to map energy landscapes of extraction in mining materials to build renewable technologies, mostly silicon, aluminium, and glass for the solar cells and panels and steel for the wind turbines and its column. Vast landscapes of grasslands, intensive and extensive agriculture and forestry are becoming operationalised to receive renewable energy production technologies - or serving as the primary material. This situation shapes a radically different landscape than the previous mode of energy. The overlapping and alignment of new spatial demands with existing structures will take different forms.

METHODOLOGY

Methodological framework

The project follows a methodology that identifies the evidence of energy transition and energy landscapes to inform the next steps. The unpacking of transdisciplinary literature review and research of various data sets informed the fundamental understanding of energy as a spatial project, especially in scaling renewable energy technologies - like grid adaptation, solar panels, wind turbines, batteries, CCS (Carbon Capture and Storage) plants and others.

The framework is organised into three parts: Inheritance, Anticipation and Projection. The composition of sets of cartographies on the Rhine Basin forms a spatial analysis of the non-renewable forms of energy landscapes summarised in the drawings presented in the “Inheritance” section. Following the investigation of the crises of the fossil-fuel era, the “Anticipation” section maps and points to the current state of ‘energy transition’ as one incapable of addressing the looming planetary issues of climate change and biosphere degradation when its focus is on technological transition and decarbonisation of the economy. In a state of climatic instability, exhaustion of old energy supplies and ecological depletion, the need for social and ecological just alternatives shows that energy as a spatial project must already be a concern of today’s urbanism.

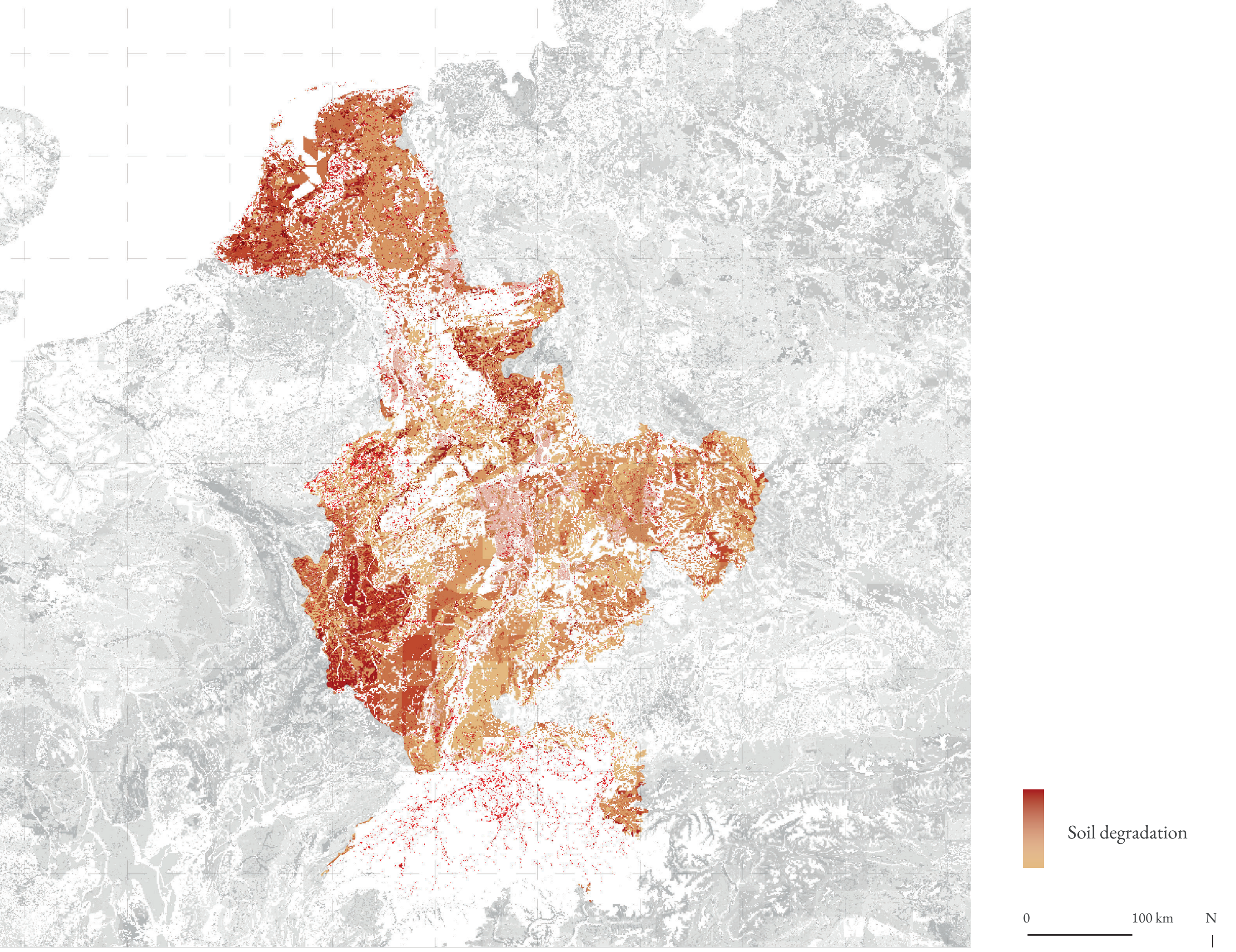


Figure 4: Subsurface: Soil degradation

Those two movements serve as the first synthesis, identifying the operational landscapes as the typological territory of the coming interventions, as these are set to be crucial for the next energy temporality. It also shows that these landscapes could host its transitional territory potential for new hybrids of energy and ecological systems, human and more-than-human production and inhabitation. In that context, how can energy landscapes mediate a socio-ecologically just urbanisation for future modes of energy production in the Rhine Basin?

The "Projection" section gathers speculative design proposals for the territory of the Rhine Basin and territorial typologies of the future operational landscapes of energy. In this section, "Cartography" overlays different kinds of infrastructures from the "Inheritance" and "Anticipation" temporalities to conceive and compose a Rhine scale "Energy-Ecology Network". This project implements the renewable energy mode, understanding its transitional essence and building new urban networks along the European continent. The elements and landscapes that form this "Energy-Ecology Network" are refined in the following chapter of "Terraforming", which uses typological transects to unpack the configurations and relations in these crucial landscapes. Moreover, it weighs into the tense debate of the international political game over energy sources. The proposal works as a platform that contributes to grounding a practico-philosophical rethinking of the planet and its urbanisation and a refreshed understanding of 'sustainability' into a geological age of climate instability.

Concomitantly, it highlights that the back and forth between the European continent, Rhine basin, regional and even local scales are part of a planetary perspective that crosses scales. The planetary is not only spatial; it also informs temporalities - highlighted and converging in the years 2030, 2050 and 2100. Apart from their specificities and scientific, ecological, societal and economic predictions that combine in them, they form a set of short, medium and long-term speculative framing needed for this terraforming - as analysis and project. It is essential to build on a new temporality that considers the long duration of the Earth and turns technological conditions into historical conditions for the fitting position of the human agency in planetary systems. This nexus makes it possible to think of energy as a spatio-temporal project. In the Rhine Basin, it becomes a project for transitioning infrastructure, a kind of infrastructural landscape design. This method and proposal suggest that this understanding can build more socio-ecologically just paradigms of urbanisation. In this case, triggered by the infrastructural character of energy landscapes.

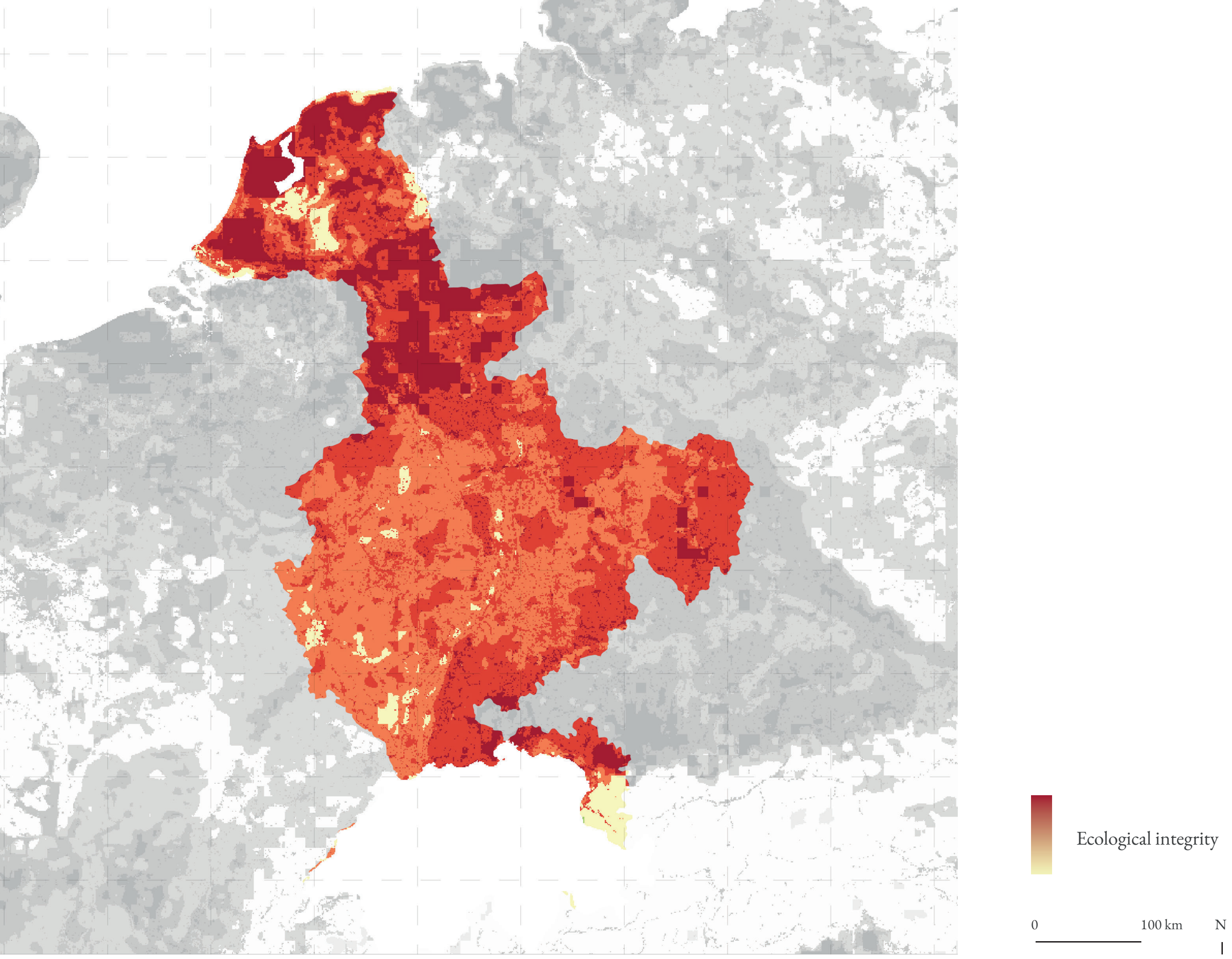


Figure 5: Surface: Land fragmentation

EXPERIMENT/RESEARCH

Inheritance: Rhine Basin as operational landscape

Focusing on the Rhine Basin's energy landscapes is to map the sociospatial and environmental transformations that unfold in the wide-range fabric of urbanisation. "Inheritance" investigates urbanisation from the perspective of the zones outside agglomeration and how those spaces are structured to support cities' material and commodity demands. The energy landscapes of non-renewables form a network of operational landscapes. (Brenner & Katsikis, 2020). The map (Figure 2) identifies energy landscapes of extraction, transport, conversion and distribution that compose and support metropolitan regions with its networks: the energy distribution grid, gas pipelines, oil traffic, road and water logistics, including the Rhine River, where not only water converges to it but many elements of the energy apparatus. It also shows nodes: fossil fuel mining, power plants and the dumping of its 'externalities', here presented mainly as atmospheric pollution.

Through the various configurations of these operational landscapes, the Rhine Basin constitutes one of the bases for Europe's material economy and commodity flows. However, as operationalisation processes intensify in the constant search for profit, the capacities of natural systems to support them are gradually exhausted. They need to be compensated through recurring investment and eventual capital intensification. While it is considered one of the best-managed basins in the world, with restoration projects successfully restoring biodiversity and improving water quality in the past years, it should broaden its perspective further than its rivers to see the whole landscape that its waters make possible.

In this scenario, the issue for energy landscapes is not only to find solutions for the energy issues, which will lead to considering the biophysical limit to energy generation, proposing decarbonisation and a European Green Deal that misses the opportunity to rethink the ways those territories are formed and inhabited. It is essential to think with the "externalities" (Ghosn, 2020) of the current energy-intensive modes of inhabitation and propose an alternative geopolitical project out of a renewed perspective on what 'sustainability' means, in this case, demonstrated through and for energy landscapes. Building in the now the new temporality of energy seizes the opportunity to deal with the transition as another possible urbanisation. In that direction, Ghosn (2009) poses a very pertinent question: what are the social, political and spatial implications of future modes of energy, and how can design practices partake in shaping a more just urbanisation?

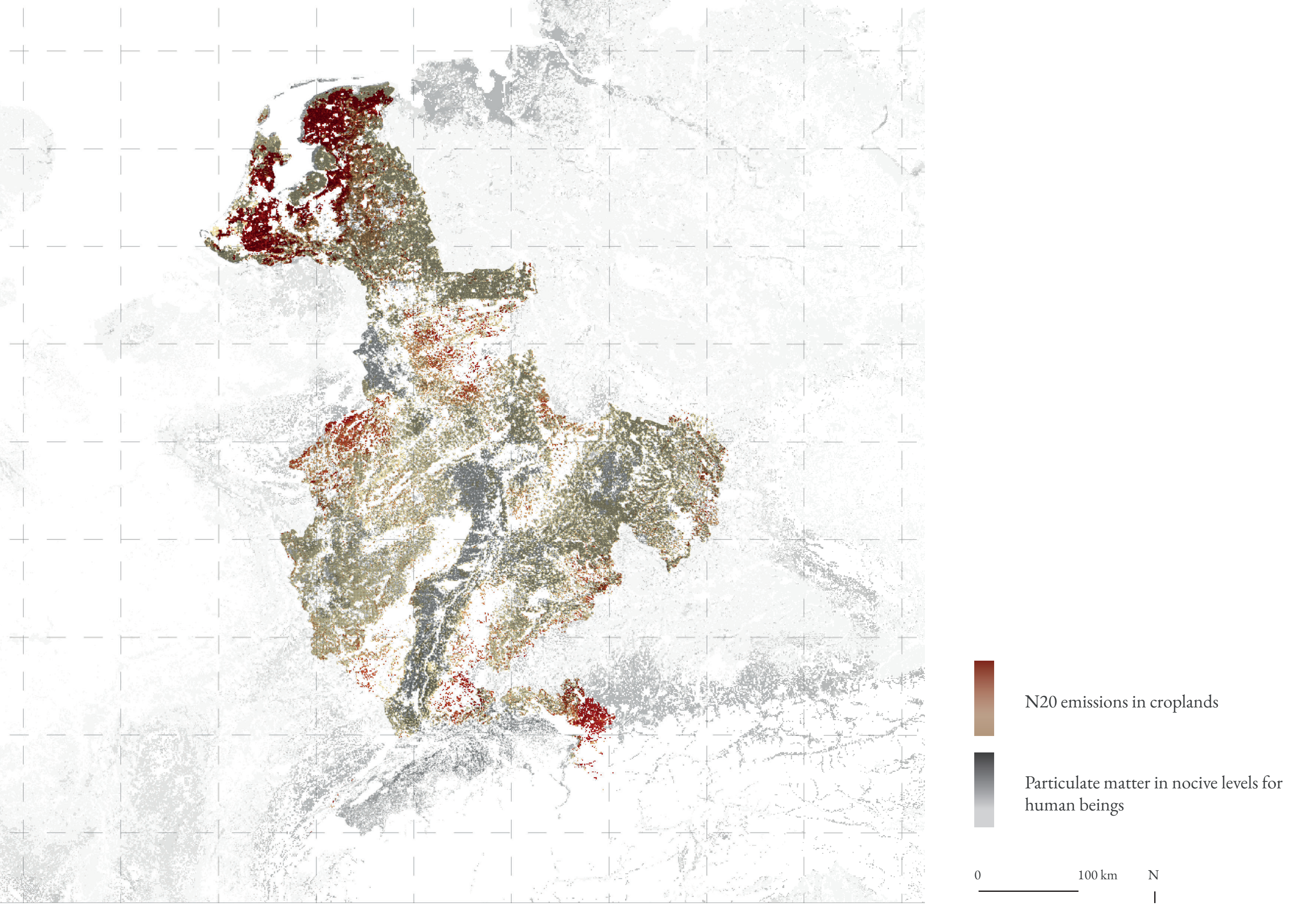


Figure 6: Atmosphere: “Externalities” dump

Anticipation: Future operational landscapes of energy in the Rhine basin

“Anticipation” foresees conditions of the ‘energy transition’ under the brief organised by the last decades of the thinking and geopolitics on “sustainable development”. It focuses on the energy mode of renewables and its contribution to mitigating the climatic inheritances of the previous mode of energy, backing up a pace of development for some centuries.

The methodology follows the same pattern as the previous section. With the European Green Deal as policy and the IPCC and EC (European Commission) reports as technical limits, it is possible to anticipate the spatial effects of the decarbonisation of many industries and the scaling-up of renewable energy landscapes. As the energy sector is set to “cannibalise” other landscapes, it must receive a comprehensive analysis of its territorial consequences in its search for “cheap natures” to exploit. In the current geopolitical trend, by 2050, the ‘energy transition’ will demand a reevaluation of its spatial project.

Given the inheritance and the anticipation of the “energy transition”, a consistent move towards renewables will see more and more land being taken for energy production. In metropolitan regions, adapting the built-up area is essential: photovoltaic on roofs, wind turbines, and geothermal installation where possible will assist local energy needs. However, the greater network that sustains all the other activities and keeps the provision of energy for the agglomeration zones through renewable energy is still to become mature. It is expected that the contemporary ‘energy transition’ will operate precisely this change and awaken the new temporality of energy, heavily based on solar and wind sources of energy production. That movement will tilt the balance towards other uses of the available land, changing the dynamics of operational landscapes in the Rhine basin.

The map (Figure 3) shows the renewables' potential outside agglomeration zones, focusing on wind and solar energy. These technologies are being invested in large-scale energy production, competing with fossil fuel energy. According to the European Commission, in 2020, renewables overtook fossil fuels as the number one power source in the EU for the first time, generating 38% of electricity, compared to 37% for fossil fuels. It aligns with the goal behind the European Green Deal, which is to become a climate-neutral continent by 2050.

However, the scale-up of the renewable era of energy production does not come alone. The looming climate and biosphere collapses will bring together many other complex consequences - that will be felt socially and economically. For the moment, there is a significant concern about the rapid loss of biodiversity, in which the population abundance of wildlife (including mammals, birds, reptiles, amphibians and fish) has been decreasing by more than half in less than 50 years. This scenario is

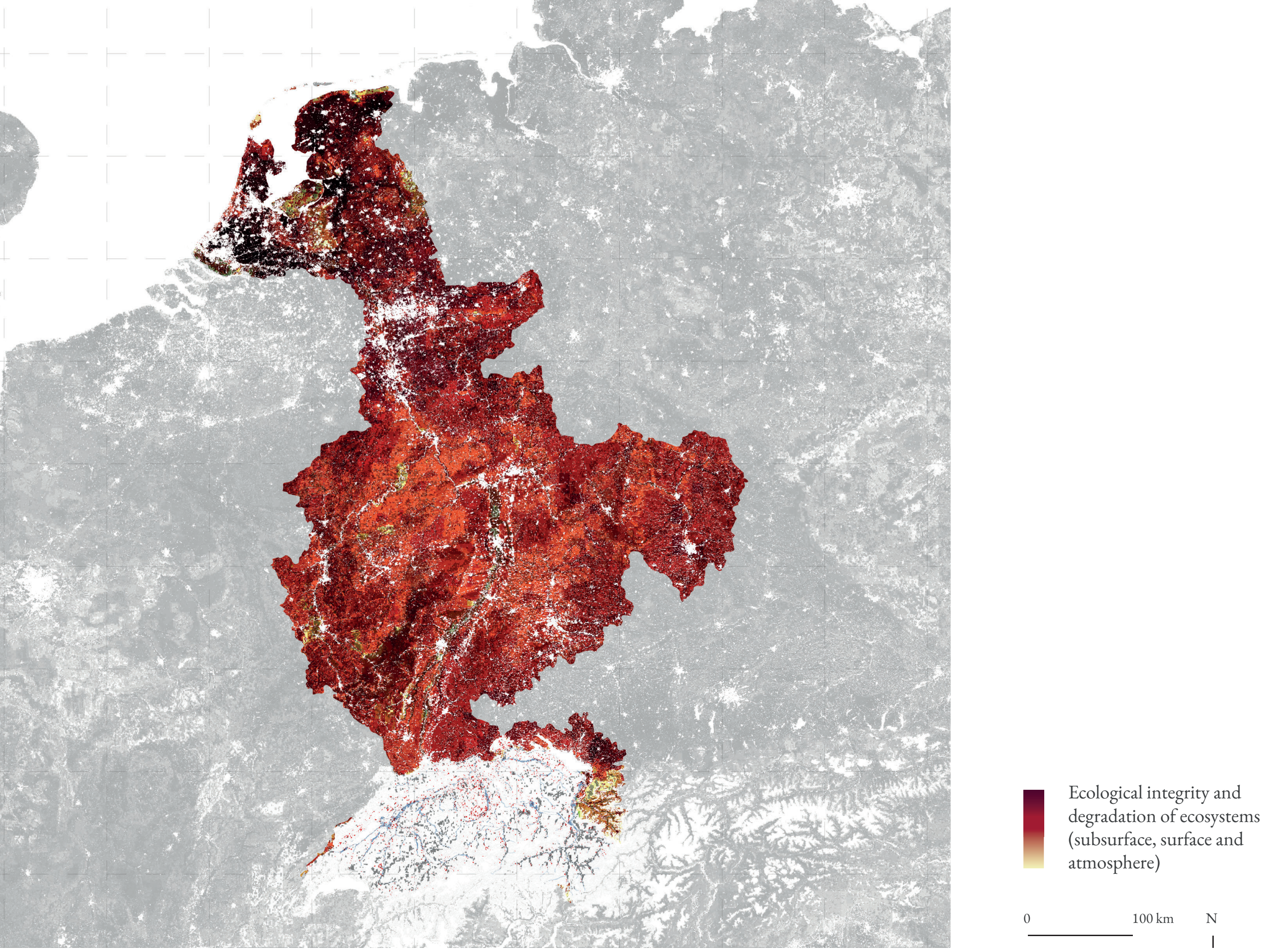


Figure 7: Low ecological integrity and high degradation of ecosystems (subsurface, surface and atmosphere)

well-known for the Rhine Basin and spreads over the landscapes that the next mode of energy is set to operationalise. A vertical mapping of the subsurface, surface and atmospheric conditions was composed to understand the current situation of the landscapes these energy production technologies will encounter.

For the subsurface, the case is of overall soil degradation. Intensive practices and the use of harmful substances that prioritise crop yield to the detriment of soil health in croplands damage organic content, affecting its health and turning soil into sand. In turn, it causes disturbance to crop yield, water scarcity, loss of soil biodiversity, climate change in the lack of carbon retention and other consequences that can be measured in productivity levels that are in decline in most of the lands of the Rhine Basin. The map (Figure 4) brings together data from biomass productivity in grasslands, forestry and croplands, the richness of organisms in the soil, the potential for carbon storage, the soil organic carbon levels and the trend in above-ground vegetation biomass productivity.

At the surface level, landscape fragmentation results from a paradigm of urbanisation with little concern for ecological integrity. The map (Figure 5) bundles trophic function, connectivity and natural dynamics in the landscape, reflecting the extent to which anthropogenic defaunation, fragmentation of the landscape, and the continued extraction of natural resources have disturbed ecosystems. (Fernández, Torres, Wolf, Quintero, & Pereira, 2020) An exception to overall low integrity is the Natura 2000 sites, illustrating the potential of those areas to compose a backbone supporting efforts to increase ecological connectivity across European landscapes if connected in comprehensive spatial planning. A network of infrastructural spaces, as new hybrids of conservation and intervention, would become a new paradigm for urbanisation that account for more-than-human life in its course.

Lastly, the atmosphere continues to be depleted not only by energetic landscapes but in many forms of industrial production. The map (Figure 6) adds particulate matter to GHG emissions from croplands to provide an instant of overall harmful exhaustion of human productivity in the air.

The map (Figure 7) bundles the indexes of a mapping of conditions in the subsurface, surface and atmosphere. Taken together, it portrays the low ecological integrity and high degradation of ecosystems in every landscape outside agglomeration zones. It exposes that the overall geopolitical “sustainability” project is unfitting to respond, perpetuating damages in its mitigation efforts. Precisely, transcending the situated responses, this narrative's argument is to invest in a territorial response to global processes.

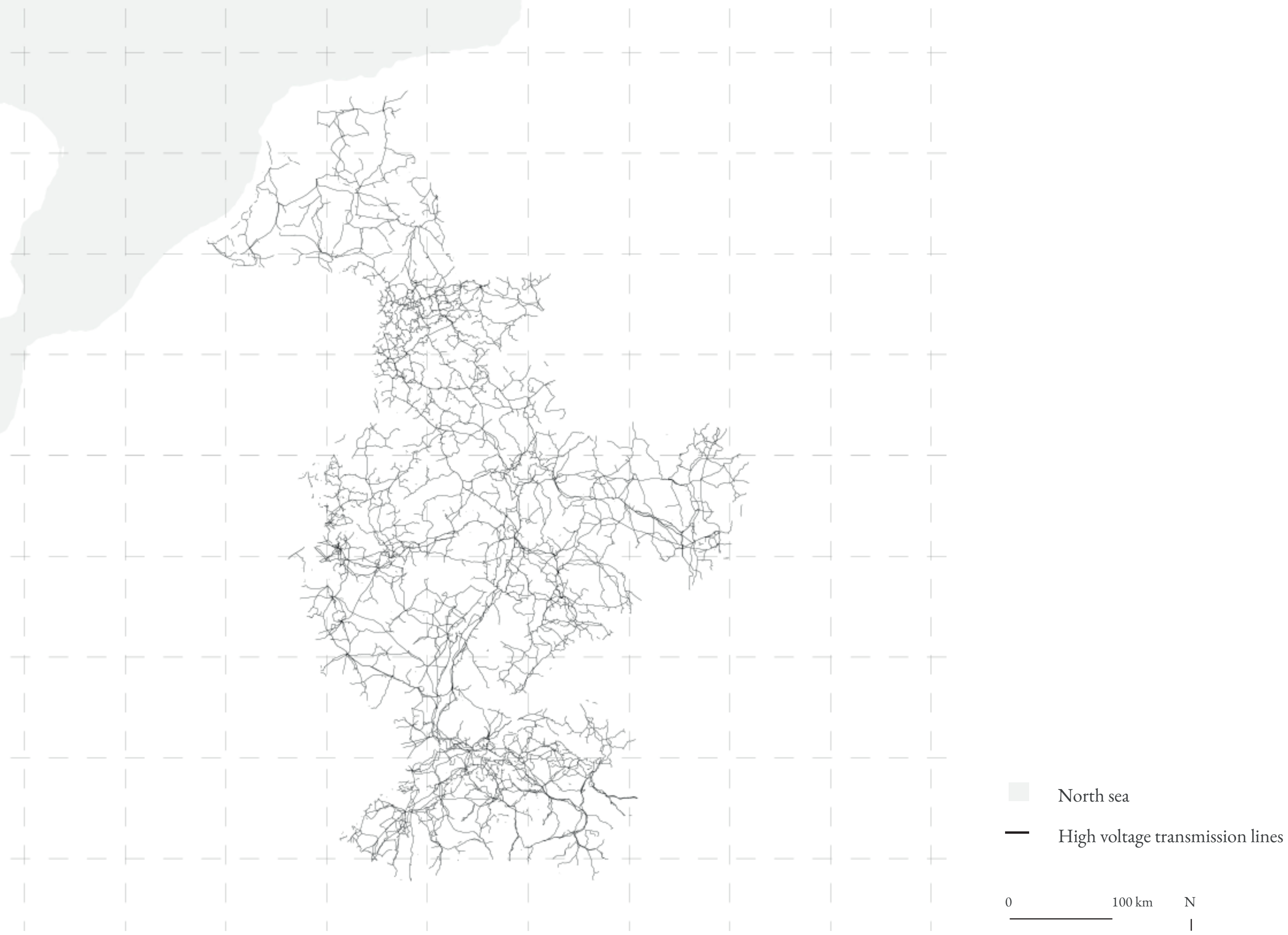


Figure 8: High-voltage transmission lines over the Rhine Basin

RESULTS

Projection: Cartography

At this moment, it is possible to turn from analysis and anticipation to projection. Working with the landscapes highlighted by the "Inheritance" and "Anticipation" sections, "Projection" proposes an alternative way of understanding territorial and regional integration with trans-scalar infrastructural landscape design and management proposals for the future operational landscapes of Europe.

The spread of the high-voltage electricity grid (Figure 8) is the first inheritance of some infrastructures that created convenient territorial conditions and can be well used in the future. Power is usually transmitted through overhead powerlines, supported by transmission towers, generating a vast network of connected lines crossing almost all the territory of the Rhine Basin. Because of its danger to human life, it creates a human avoidance zone under and buffered by its lines. The region of these transmission lines usually overlaps with the future operational landscapes of energy because they do not penetrate denser areas of human inhabitation. This condition highlights the potential of those areas for renewable energy technologies to link to the grid and alter the management of adjacent areas through its deployment.

This map (Figure 9) shows the areas recognised as the main locations for the project grounding the 'energy transition' to renewables: the future operational landscapes of renewable energy production. Its vastness draws attention to its potential to become a "third landscape" where an alternative urban model can be validated.

As a crucial addition to finding the best locations for this network, the map (Figure 10) draws the main ecological corridors that connect high ecological integrity conservation patches are identified. (Fernández et al., 2020) With this contribution, the "Energy-Ecology Network" (Figure 11) takes shape.

The network is proposed around the high-voltage transmission lines following the proposed ecological corridors shown on the previous map. The initial buffer is 5km wide - considered a minimum to preserve an effective ecological corridor for many species (Beier, 2019) - and expands as it touches or connects conservation patches to keep landscape continuity.

Regarding energy, the potential of this area is enormous. The electricity generated in this area can fulfil the energy demand much further than the local context, distributing the electricity across the inherited grid. The close distance from the grid avoids losses and triggers the grid's renovation towards adaptation to renewable energy technologies (its retrofitting, renovation, and actualisation). From an ecological perspective, the connectivity in space strengthens the restoration of ecological functions around large areas of intensively used, fragmented and impoverished wildlife land. The connectivity also boosts the overall

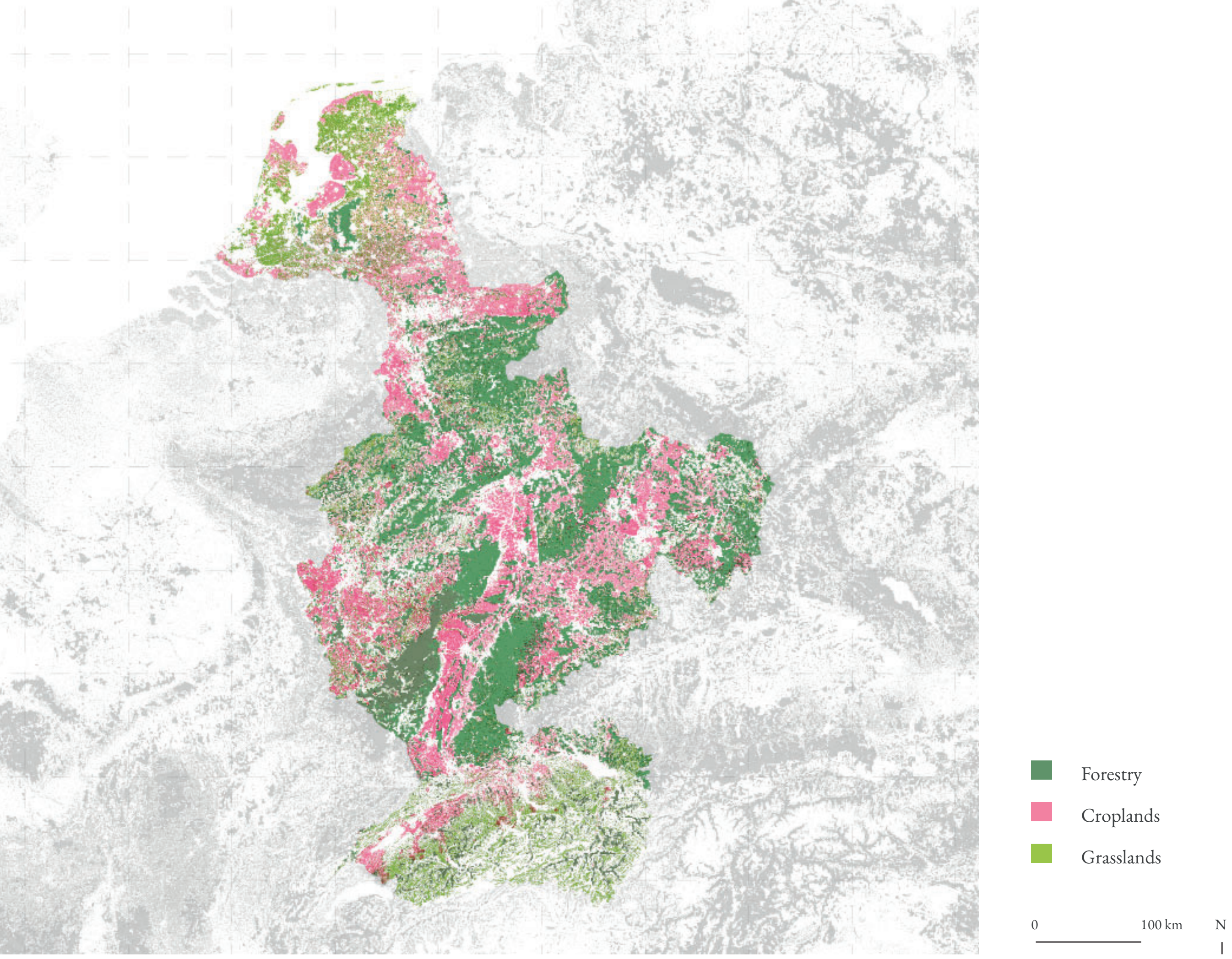


Figure 9: Future operational landscapes of energy

biodiversity resilience, making the movement of species and the genetic exchange possible as it provides habitats for fauna & flora. From an urban planning perspective, the current 'energy transition' is the moment to approach this 'new' space as the organiser of a new kind of urban network of energy generation and distribution, ecological connection and restoration and alternative human productivity and creativity - testing a reorientation of energy, food, and work into ecological frameworks in the operational landscapes of energy.

Several objectives are combined while deploying renewable energy technologies: (1) it connects higher ecological integrity zones to strengthen the basin's local and continuous ecological resilience. (2) It aims at maintaining or restoring the connected landscape with an alternative energetic-ecological management. (3) It creates the possibility of designing the ecotone between landscapes for energy, ecological purposes, and other land uses. (4) It addresses the long-term goal of restoring and conserving European biodiversity, functioning as a spatio-temporal "stepping stone".

Looking at the urbanisation paradigm it mediates: (1) It reuses the inherited pattern to propose a corridor that tests a new urbanisation paradigm. (2) It builds a conceptual tool, introducing transitional landscapes that surpass current dichotomies between the urban vs rural, conservation vs intervention, nature vs economy and society. (3) It composes a "third landscape" as a platform for an alternative understanding of productivity, composing hybrid landscapes for humans and more-than-humans. (4) It is an expanding project. It grounds a spatial planning process to deal with current or future energy transitions. Altogether, it becomes an alternative urbanisation pattern for European territorial and regional integration.

The following section will use typological transects to add resolution and speculate on the character of a region and its transition when approaching typical structures like highways, agglomeration zones, and others, bringing together several actions for the future operational landscapes of the energy transition.

Projection: the temporalities of energy

The graph (Figure 12) draws a cross chronology between environmental, energetic and biodiversity policies, directives, plans and key dates - historical and projected - from the rise of environmental concerns around the 1970s until the end of the current century.

It does so by tracking the exponential carbon emissions and loss of biodiversity acting as actors in the history of energy policies, directives and important actions. It portrays only a fraction of the interweaving relationship between energy and its relation to the web of life (Moore, 2018)

2030 is the closest deadline for predictions regarding the depletion of ecosystems and crossing planetary boundaries. It is characterised as a time towards an effort

Figure 10: Main ecological corridors that connect high ecological integrity conservation patches (Fernández et al., 2020)

to mitigate the consequences of centuries of Extractivism. For example, The EU Biodiversity Strategy 2030 aims to recover European ecological systems, and Trans-European Networks will be implemented around that date. Other policies for clean air, circular economy, the last round of the Common Agriculture Policy, and significant steps to decarbonise industries are due to that date.

2050 is viewed as a deadline for new systems to be fully operational. For example, the EU Biodiversity Strategy envisions "restored, resilient, and adequately protected" ecosystems. Cities like Rotterdam aim to be "net-zero". Fossil fuels are phased-out in many European countries, like Germany. By the time of the COP24, the European Commission prepared a zero-emissions strategy for the EU. In line with this request, the European Commission published the EU's vision for a "prosperous, modern, competitive and climate-neutral economy by 2050."

2100 already speculates for the transition to another technological possibility. It envisions that in a scaling-up of post-extractive forms of energy generation, the "Energy-Ecology Network" can get rid of its renewable energy structures and deliver a restored and connected landscape for Europe, becoming a new backbone for European urbanisation. The temporality for 2100 is a project to set the scene for the next century's urbanisation. Hopefully, in this urbanisation paradigm, the distinctions between technology, politics, economics, and ecology will be less clear, being all of these at once in different ways. (Bratton, 2021) To envision that, the terraforming project can start now in the future operational landscapes of energy.

Projection: The terraforming of future operational landscapes of energy

Terraforming is something that humanity does as it inhabits the Earth, and it adapts and is adapted to its conditions. It is also important to realise that "the response to anthropogenic climate change will need to be equally anthropogenic." (Bratton, 2019) In other words, the response to, for example, more parks, forests and different city and more-than-city landscapes is to reorient urbanisation towards a different paradigm, building other landscapes that compose a viable Earth for living beings. However, how would it look like, be governed, what is in there, and who can access them? The understanding of that continuous transitional process asks for the nuance not to design a solution but to speculate on an intentioned terraforming, with a design that mediates other ways of seeing the world.

The 'energy transition' theme is a hinge for projects that discuss the composition of hybrid habitats. Following that line of thought, the project invests in expanding the idea of NETs (Negative Emission Technologies) to include more than the biological or industrial modes towards a larger framework for NET as an intelligence of inhabitation. Biological NET is something a tree does in its bio-

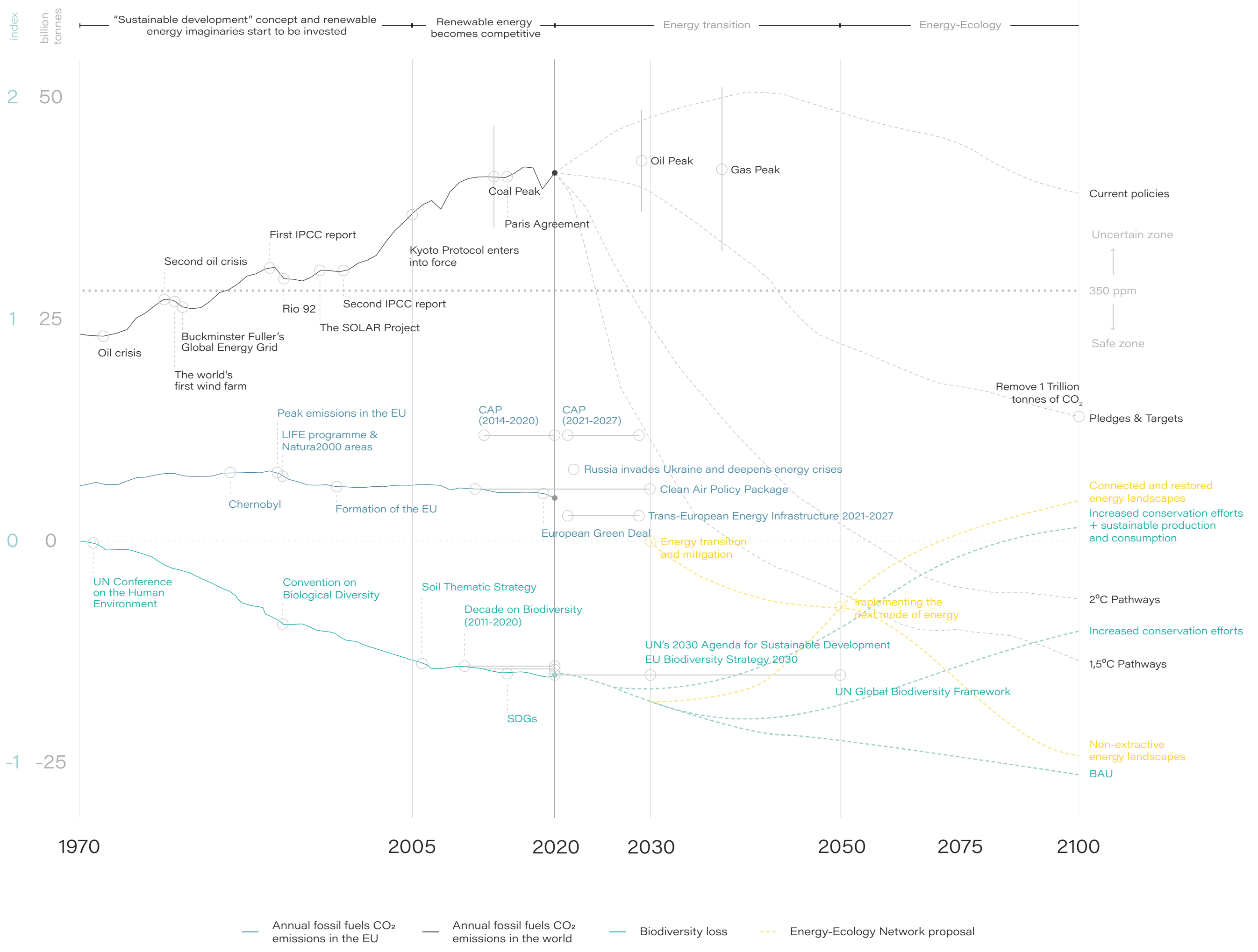


Figure 12: Cross-chronology between environmental, energetic and biodiversity policies, directives, plans and key dates

logical technological apparatus. Industrial NET has also become something humans do by building CCS plants to suck carbon back to deep geological strata. Urbanisation processes as negative emission technology mean the kind of terraforming that reorient sociospatial and environmental transformations unfolding in the operational landscapes of energy to recast the intense focus of climate action from metropolitan regions to include the wide range of urbanisation, especially the areas of forestry, croplands and grasslands.

For that reason, the last "Projection" part focuses on the configurations and elements of how each typology of energy landscape can behave in an instant of each energy temporality (2030, 2050, 2100). Forestry, croplands and grasslands receive the alternative paradigm of the Energy-Ecology Network and speculate on the interactions with many elements in its landscapes, testing its gradients when encountering uses like highways, railways and agglomeration zones of different number of inhabitants. Typological transects unpack the configurations and relations in these crucial landscapes through a longitudinal section of 5km, the initial buffer zone along the high-voltage transmission lines. It aims to demonstrate the composition of a new paradigm in time and space, demonstrating what must be interrupted, continued or made anew.

Woodland and forestry

The abundance of trees characterises forest land use and is an essential ally in addressing climate change and biosphere degradation. The separation of areas for no entrance and some sort of human 'retirement' from intervening in these zones must be reorganised as a process of urbanisation and not only regarded as conservation. The "Energy-Ecology" concept can provide a way to implement efficient ways to deal with forests welcoming practices for lower intervention or energy technologies that have lower disturbance to ecosystems than the actual use.

The typological transect of a forestry landscape (Figure 13) portrays the current condition, with the elements mostly found in the territory of the Rhine basin. The subsequent illustrations show the speculation until a new temporality of energy landscapes, with a zoom on one specific situation.

It is important to highlight the Natura2000 areas, mostly in forestry landscapes. Through the decades, the most important is to connect them to provide migratory paths for biodiversity to adapt to climate change consequences. Additionally, renewable energy technologies can organise hybrid landscapes to connect those areas inside the expanded buffer zone of high-voltage transmission lines. Every other land use patch must be directed for 'rewilding' through renewable energy technologies. For example, by 2030 (Figure 14), high-den-

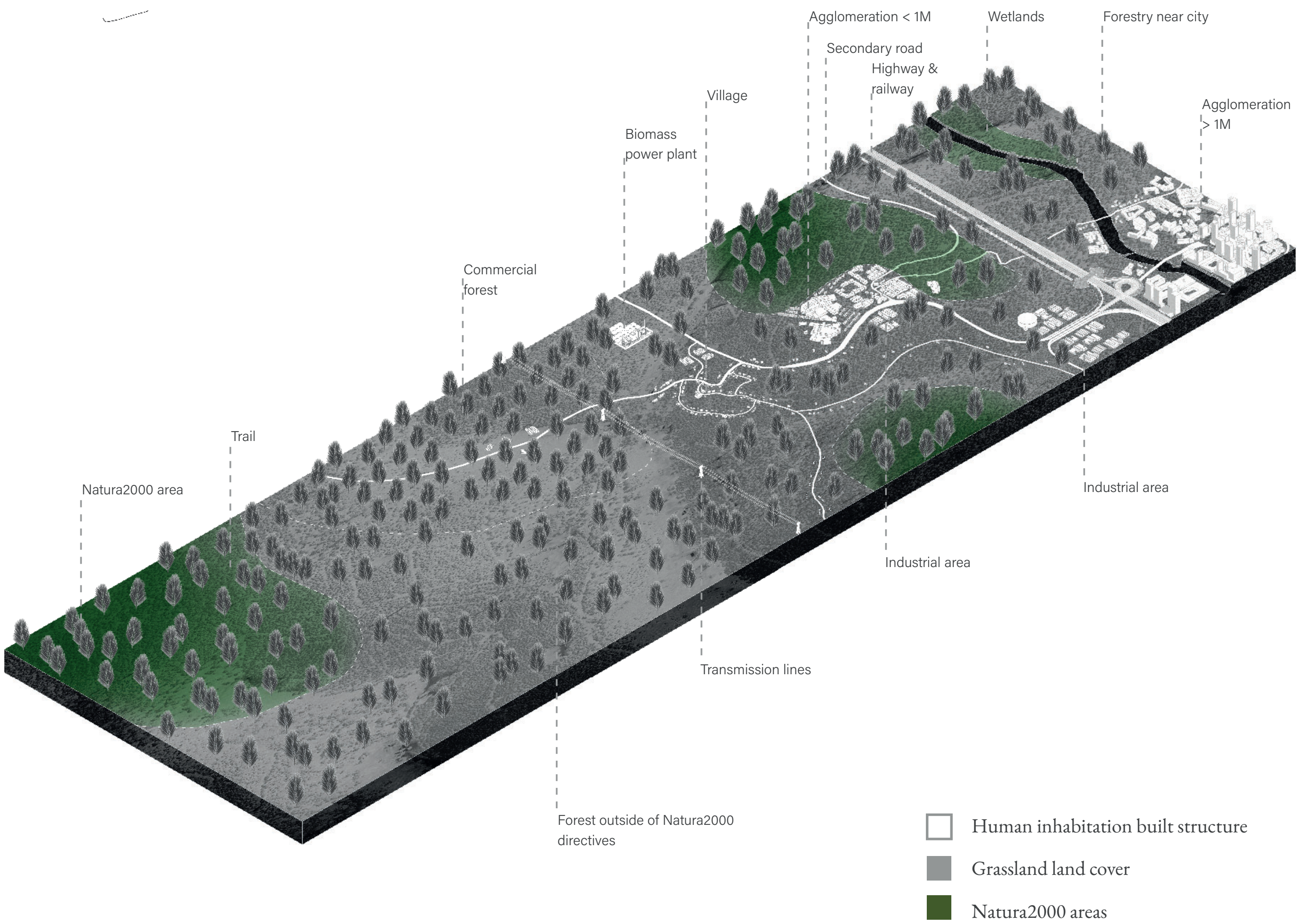


Figure 13: Transect for the territorial typology of forestry landscape in the Rhine Basin

sity of photovoltaic panels will be installed in a previous cropland area. By 2050 ((Figure 15), the same area will decrease its density of energy technologies and redirect more area for lower intervention. Multiplied in many regions, this action will create a hybrid of 'ecological corridor', recreational park and energy generation. By 2100 (Figure 16), as another 'energy transition' (hopefully to non-extractive technologies) is being realised, renewable technologies will give way to a fully realised forestry network that prioritises more-than-human habitats but does not exclude controlled human visitation.

Croplands

The speculative design of this typology (Figure 17) envisions new paradigms in response to energetic demand, climatic response and definition of ecological areas for expansion. Three relevant dimensions of present-day agricultural landscapes are land cover, land management and landscape structure. (Verburg et al., 2013) The Energy-Ecology Network is a novel landscape structure for croplands, balancing new values of energy and ecological provisioning. Its land cover is varied and not taken into consideration in the resolution of this study, being relevant when encountering local situations. The land management aspect is, however, highly important. How the vegetation, soil, and water are treated in agricultural practices yields highly different spatial outcomes, with higher productivity or degradation.

To better understand the significant spatial heterogeneity of agricultural landscapes across the Rhine Basin and to propose changes in landscape functions and values, it is necessary to understand some forms of management that produce a certain quality in the landscape. Also, to understand with which elements the Energy-Ecology Network is being implemented. Instead of addressing a location, this method explores the variety of agricultural landscapes to recognisable elements that could be relevant for policy-making at the interregional scale. The developed typology comprises a diversity in composition, spatial structure and management intensities. This form of representation serves as an assessment to assist and visualise landscapes' influence on environmental change.

Among many types of croplands, medium and large-scale intensive arable lands are a common sight around the Rhine Basin. In that case, models of regenerative agriculture must become the new norm for restoring degraded soil and fostering natural processes' recovery and resilience. It would act to revert the common association of intensive arable land with intensive feed crops that degrade the soil with high amounts of nitrogen input and GHG emissions. In that case, agrivoltaics can be combined with farming, especially in vineyards regions, optimising crop yield and quality with renewable energy production. (Figure 18)

A particular situation is of croplands that stand in between forestry patches. In the run-up to 2050 (Figure 19),

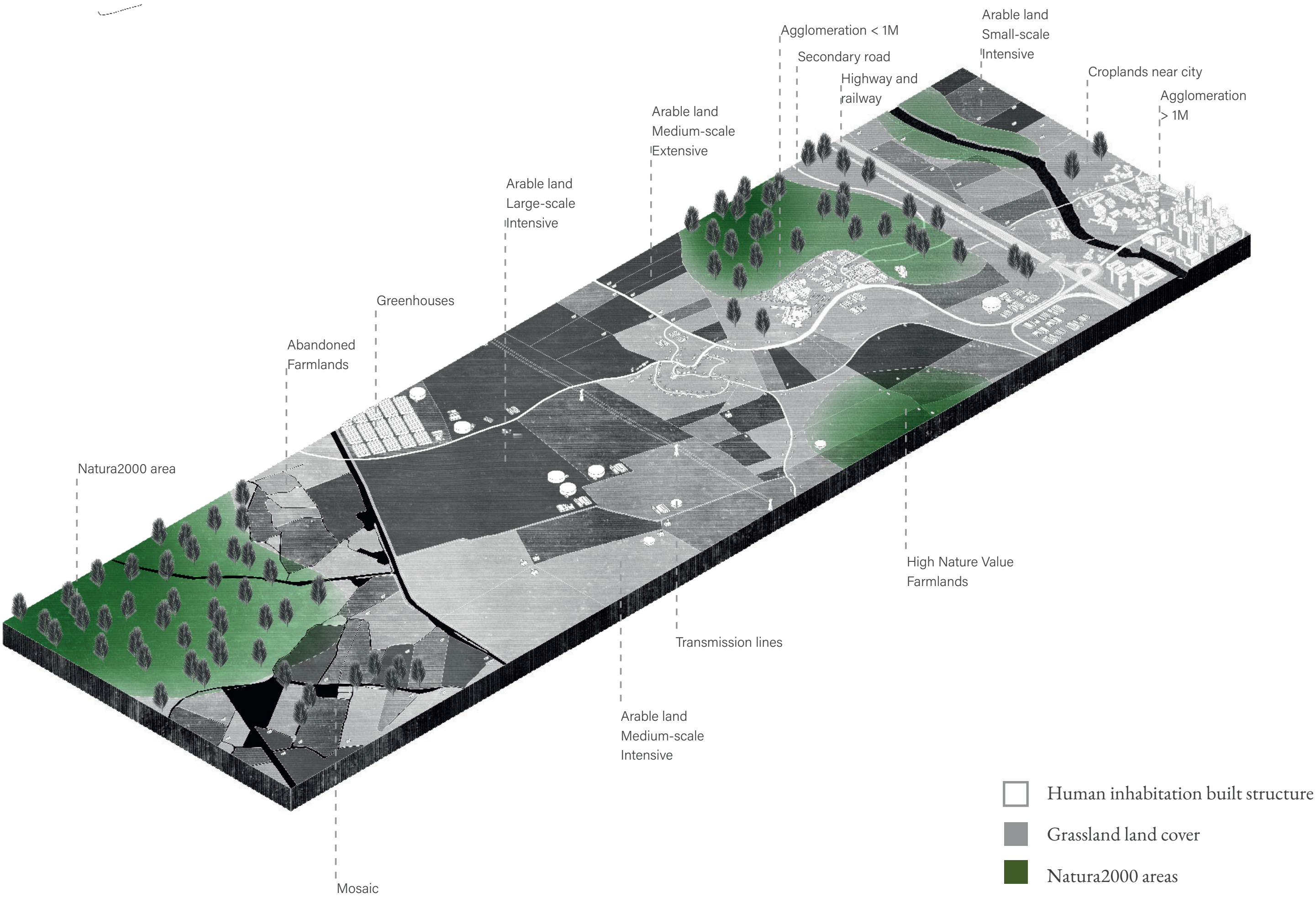


Figure 17: Transect for the territorial typology of croplands in the Rhine Basin

these are designed to include renewable energy production. At the same that it is implemented, it raises the possibility of designing its ecotone according to the different needs of an area. Ecotones could be designed for recreation and become a continuous park shared by humans and more-than-humans. Renewable energy is produced like never before, but at the same time, an ‘ecological corridor’ appears following the transmission lines.

Grasslands, heathland and shrublands

The temperate grassland biome comprises large open areas of grasses and shrubs, where trees can be present but are infrequent. There are many grasslands in the Rhine Basin boundaries, and here they are gathered as an ecosystem. Its further particularities should be designed in other resolutions according to local circumstances.

The ecosystem recognised as grasslands (Figure 21) holds an essential part of Europe’s biodiversity. Its conditions are ideal for a rich diversity of species and are especially important for birds and invertebrates, providing vital breeding grounds. In relation to human habitats, they are the source of a wide range of public goods and services, ranging from meat and dairy products to recreational and tourism opportunities. In addition, they act as carbon ‘sinks’ and are a vital asset in reducing levels of GHG in the atmosphere. Fulfilling all those functions, they are a crucial part of the Energy-Ecology Network, being the most flexible.

It is vital to mention the links between agricultural and grassland habitats. In the Rhine basin, it is hard to find a grassland ecosystem that has not been modified and, to a significant extent, has been created and maintained by agricultural activities. These grasslands are maintained through farmers’ grazing or cutting regimes, including a large amount of increased farmland abandonment, which is predicted to continue in Europe over millions of hectares (mostly of low-productive land) in the next decades. This scene allows these areas to transition with alternative management policies to provide energy as it recovers landscapes with higher-value nature. As the balance tilts towards increased biodiversity, many benefits are also enjoyed by humans; for example, the reduction of fire risk through the browsing and grazing activity of large herbivores.

There are many examples of grasslands near cities. These are areas that are usually taken for housing expansion or formed by the abandonment of previously inhabitation use - dwelling or industrial. The urbanisation of these zones, as an expansion of the city, can receive an alternative proposal in the Energy-Ecology Network. It is here proposed to focus on high levels of educational, cultural and recreational use among renewable energy technologies. For example, housing and other urban functions among industrial carbon capture and storage technologies, batteries, photovoltaic panels considering spatial quality, new models of wind turbines and geothermal stations. It is a learning space for the nearby city to learn about energy intertwined with a new way of inhabiting the Earth.

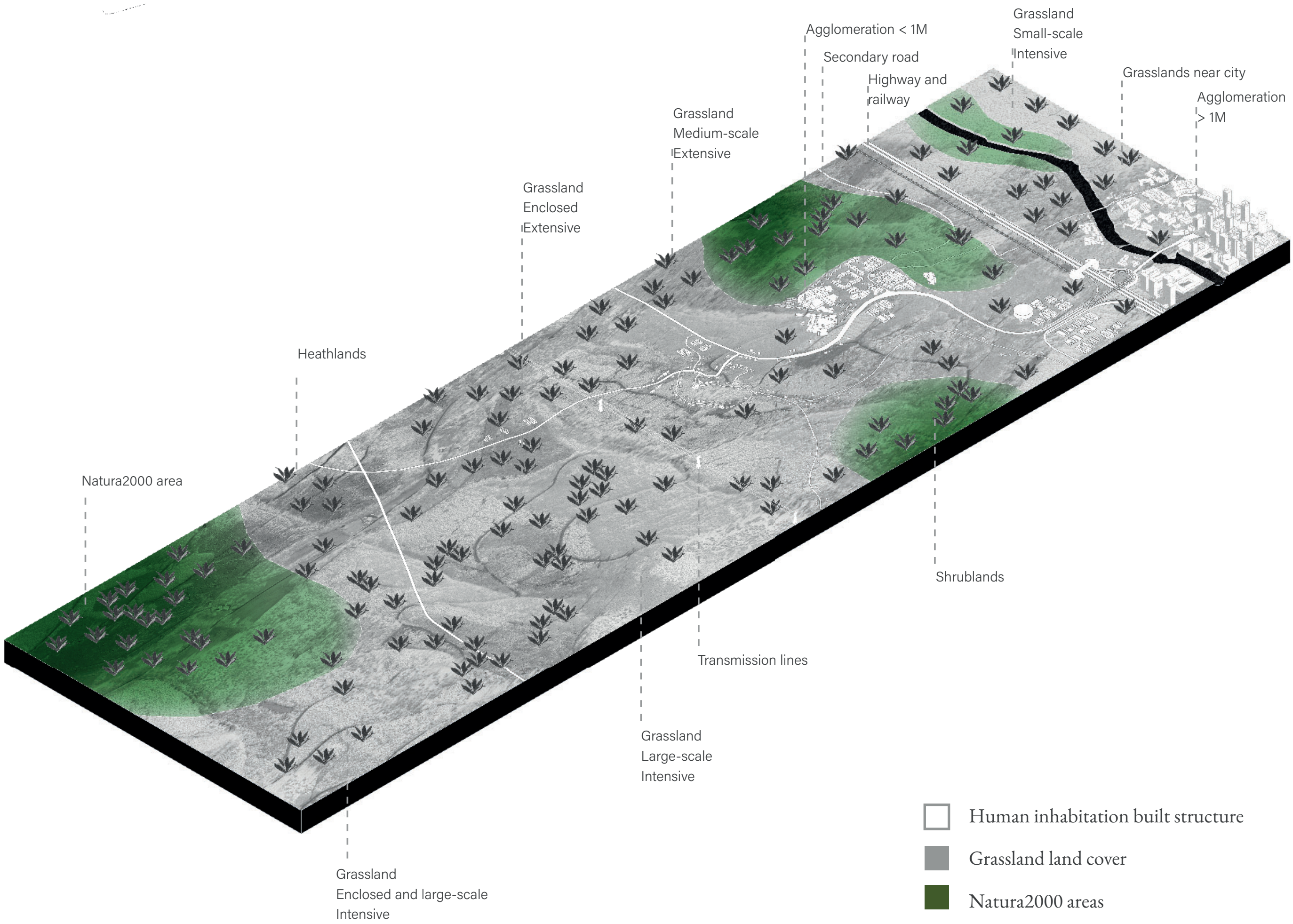


Figure 21: Transect for the territorial typology of grasslands in the Rhine Basin

CONCLUSIONS

The project concludes by providing a couple of assumptions to understand the convergence of the social, climatic, energetic, and ecological crises with the urbanisation of the Rhine Basin territory. First, it demonstrates that the relation to energy carries human habitats through every new paradigm of spatial possibilities. The concept of 'energy transitions' underscores the infrastructures that organise every new urbanisation paradigm. Second, the investigation indicates that croplands, grasslands and forestry are the future operational landscapes of energy. These are the next frontier for the scaling-up of renewable energy technologies. Third, the project's main outcome is to prove that energy landscapes can mediate socio-ecologically just urbanisation for future modes of energy production in the Rhine basin and Europe. Fourth, "Energy-Ecology" is a conceptual and methodological tool for introducing transitional landscapes that surpass current dichotomies between the urban vs rural, conservation vs intervention, nature vs economy and society. It invests in grounding a perspective that overcomes the human-centredness of Earth's inhabitation. It demonstrates the necessary "retreat" in space and "retirement" in time for the project of a viable planetarity on Earth. Lastly, the territory of the Rhine Basin transcends the vertical subsurface-surface-atmosphere continuum and the horizontal administrative boundaries of countries. It is the limit of an ecosystem bound by water, an element that forms the basis for living conditions on the planet. In that perspective, the "Energy-Ecology Network" proposes a more comprehensive Trans-European Network along the current energy grid with multifunctional corridors where renewable energy technologies are balanced with connection and restoration of landscapes. The project shows it is possible to communicate across disciplines and amplify intellectual experimentation through geospatial intelligence and visual-spatial narrative.

The design of the "Energy-Ecology Network" proposes a kind of "architecture of the territory". (Topalovic, 2016) It is a fitting engagement for spatial design methodologies, broadening the understanding of territory from the purely technical or administrative domain. This perspective creates the space for the design of different nature-based solutions (NbS) as intermediaries envisioning beyond the adaptation to the increasing climatic instability and becoming "stepping-stones" - in time and space - of new territorial conditions. It becomes part of a more applicable instrument for the city and more-than-city design, where societal and ecological visions are contemplated in the present temporality of 'energy transition'. From the perspective of the International Union for Conservation of Nature (IUCN), NbS must address several types of societal challenges in an integrative manner and not be isolated for a single goal, so it involves collaboration and coordination of mul-

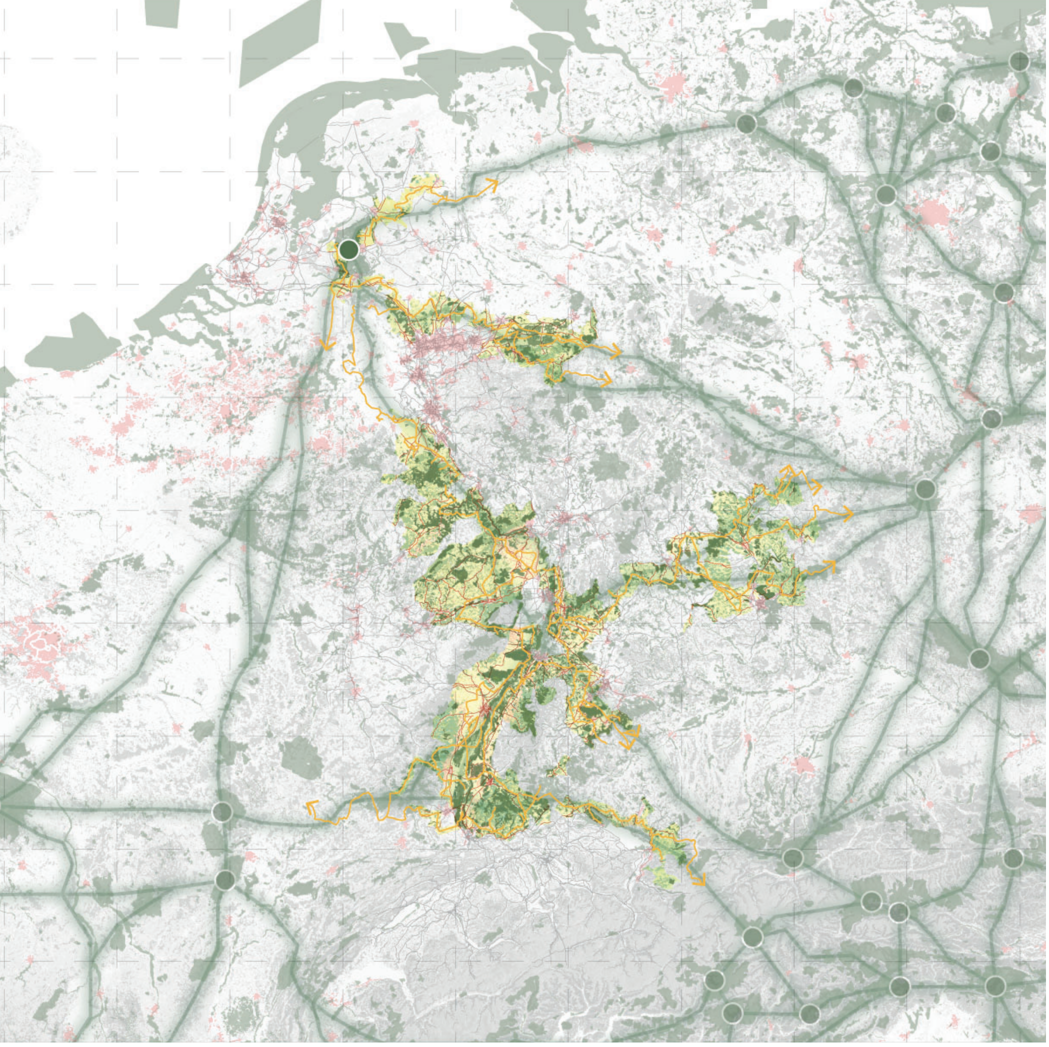
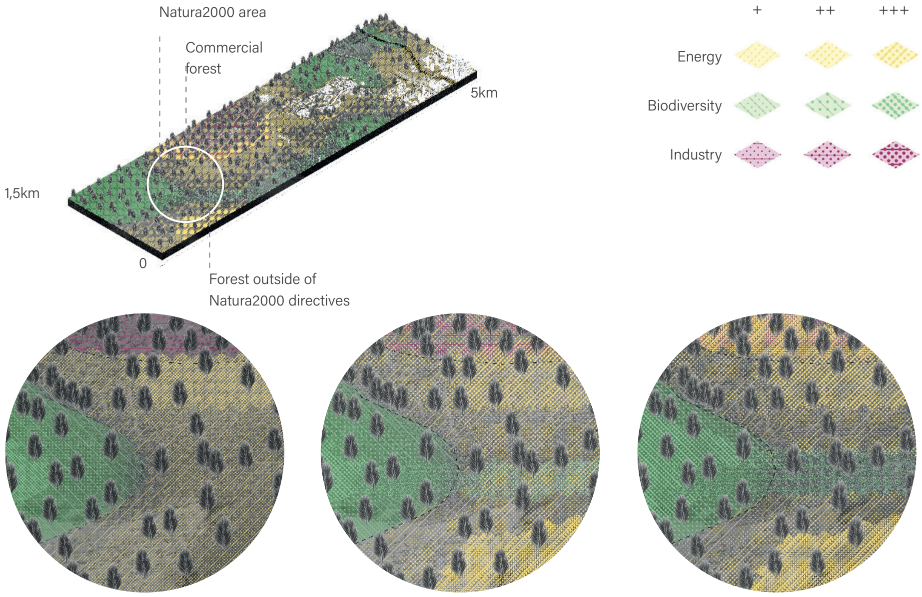


Figure 25: "Energy-Ecology Network" in the Rhine basin with proposed expansion towards the European continent

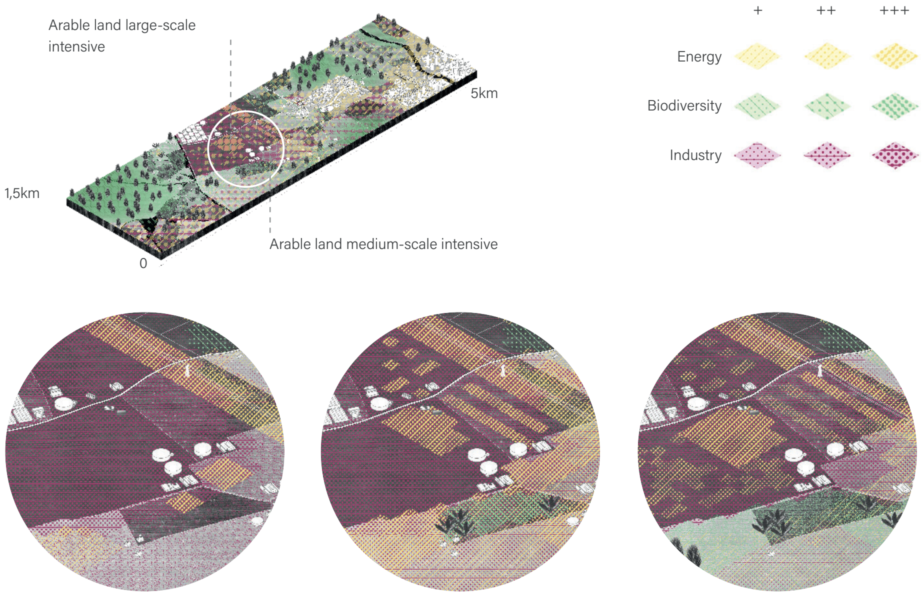
tiple stakeholders while building synergies across sectors. The next temporality of energy as a spatio-temporal project is included in a broader context of a planetary condition where the distinctions between technology, politics, economics, and ecology will be less clear, being all of these at once in different ways. (Bratton, 2021) Considering the design of NbS that attends this perspective contributes to a future urbanity when the dichotomies between the organic and non-organic, natural and artificial will be progressively surpassed, and hybrid habitats can be realised. Moreover, it shows that the territorial approach makes way for the project to be understood as an instrument for European integration. This project proposal could serve as a background for developing cross-sectoral and cross-governance policy instruments and grounding a framework for rethinking European networks beyond the typical infrastructures, becoming an alternative way of understanding territorial and regional integration.

The challenge of a Trans-European Nature Network and a Trans-European Energy Network (if revised for decarbonised technologies, like renewable energy) can be linked through a broadened view of NbS as instruments for negative emission technologies as landscapes. It expands the goal of the transition to renewable energy to contemplate climate and ecosystem mitigation, adaptation and restoration in its operational landscapes of energy. It is possible to conceive and compose landscapes of solar and wind energy, batteries and transmission powerlines while implementing regenerative forms of land management that also address food provision, water regulation, soil protection and restoration and the fostering of fauna & flora habitats, inaugurating a new condition of urbanisation in the Rhine Basin.

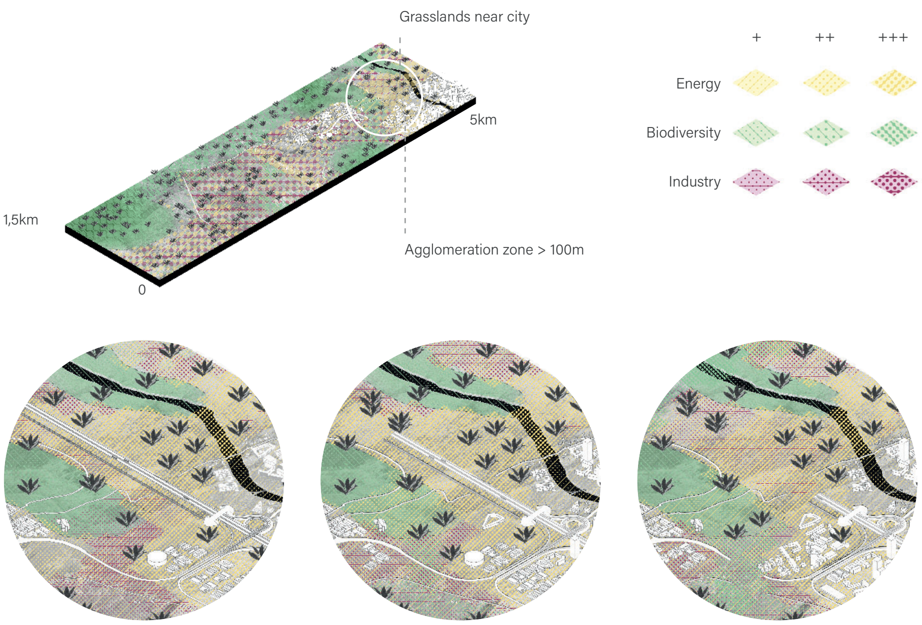
Finally, from a conceptual perspective, it offers a critique of current sustainability debates, engaging with post-capitalism and post-environmentalism questions with a grounded yet speculative narrative of 'energy transition' futures across the Rhine Basin. It does so by exemplifying the power of design to act as a catalyst for interdisciplinary knowledge integration through a combination of analytical and creative tools, with an emphasis on bringing together geospatial analysis with research-by-design tools and workflows. Speculative territorial design can be used as a platform to discuss, investigate and reorient urban theory and spatial planning as a philosophical, technological and geopolitical force.



Figures 14 to 16: 2030, 2050, 2100 respectively



Figures 18 to 20: 2030, 2050, 2100 respectively



Figures 22to 24: 2030, 2050, 2100 respectively

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Practices

Experiences of Ecological and Participatory Wetland Restoration in the Guanacache Lagoons in the Cuyo Region of Argentina

Heber Sosa
Nidia Amaya

This article presents the results of ecological restoration actions with the participation of native Huarpe communities in the Ramsar Site " Lagoons of Guanacache, Desaguadero and Bebedero" in the province of Mendoza, in the Cuyo region of Argentina. Since 2011, the project has been working with local people to restore the wetlands in the area. In order to accumulate rainwater as a filling source and trap sediment to recover the old lagoon bottoms degraded by erosion, hydraulic structures were designed, embankments with clayey material, surfaced and suitably fixed to the lateral ravines of the gullies intervened. A total of 14 restoration projects were built in different degraded areas of lagoons and marshes associated with the Desaguadero River. With these interventions, some 1000 ha of wetlands are being restored, which has contributed to improve the associated biodiversity and to recover ecosystem services, such as access to fresh water and improved grazing for livestock production, the main economic activity of the local community. Thanks to this initiative, some 300 families living in the area have benefited in environmental and economic terms.

INTRODUCTION

According to globally available data, just over 35% of the world's wetlands are known to have been lost since 1970 to date, at a rate three times the rate of forest loss[1]. As reported at the 12th Conference of the Parties to the Convention on Wetlands in Punta del Este, Uruguay, in 2015, the global extent of wetlands declined by 64-71% in the 20th century[2].

This reduction has had a direct impact on the biodiversity of wetlands, with an estimated 81% decline in the abundance of freshwater species since 1970, a greater percentage than that experienced by other types of ecosystems[3].

It is for this reason that wetland restoration has become a necessity to conserve wetland biodiversity[4]. Ecological restoration comprises a range of activities in a variety of contexts, in some cases allowing the recovery of ecosystems that are indistinguishable from natural systems, and in others only the recovery of specific attributes or functions[5].

The Guanacache lagoons are located in Central-Western Argentina, in the Cuyo Region, at the foot of the Central Andes, between 32°12 "S - 67°30'W and 33°57' S - 66°39' W. This area belongs to the Central Montane Wetlands Region[6] and is crossed by the Desaguadero River Basin, considered the largest fully developed area within the Argentine territor[7]. The climate is temperate arid continental with regional average rainfall of less than 300 mm and an average temperature of approximately 15º C[8] (Figure 1).

The lagoons are part of the Ramsar Site "Lagunas de Guanacache, Desaguadero y del Bebedero" and cover a total area of 962,370 ha.[9]. Their wetlands are formed at the confluence of the Mendoza and San Juan rivers and the outflows of the Bermejo river[10]. Seasonal inputs from the Layes-Tulumaya system (Mendoza) and the Agua river (San Juan) shape what was once the lacustrine environment, giving rise to the Desaguadero river[11].

Today, the lagoons are in continuous deterioration, which is part of a long process of desiccation that has been going on for about 200 years [12]. At the beginning of the 20th century, they were considered to have been lost due to lack of water[13] as a result of the development of irrigated oases for agricultural purposes in their main catchment area[14].

One of the causes of the deterioration of the system is the loss of hydromorphic soils due to backward erosion caused by landslides and floods that occur after heavy summer rains, a situation that substantially modifies the structure of the basins of the main wetlands of the Ramsar Site. The channelling of watercourses leads to an increase in the velocity of surface flows[15], favouring water erosion and the development of gullies in the main receptors[16] (Figure 2).

All these changes have led to a significant reduction in the area of wetlands, affecting biodiversity and the traditional activities of their inhabitants. The communities living in the site today reclaim the wetlands as part of their culture; to recover the pastures, farming techniques, fishing, and handicrafts, among other productive activities that have been lost over time[15].

During the baseline studies in Lagunas de Guanacache, carried out for the prospection of the wetland restoration projects, more than 150 erosion gullies were surveyed, these being gullies up to 10 metres deep located in sectors where these wetlands used to exist.

The involvement of the local communities in this project is of paramount importance for its development, and in turn has generated a process that has directly benefited the local stakeholders. In recent years there has been a greater tendency to promote the participation of communities and citizens in

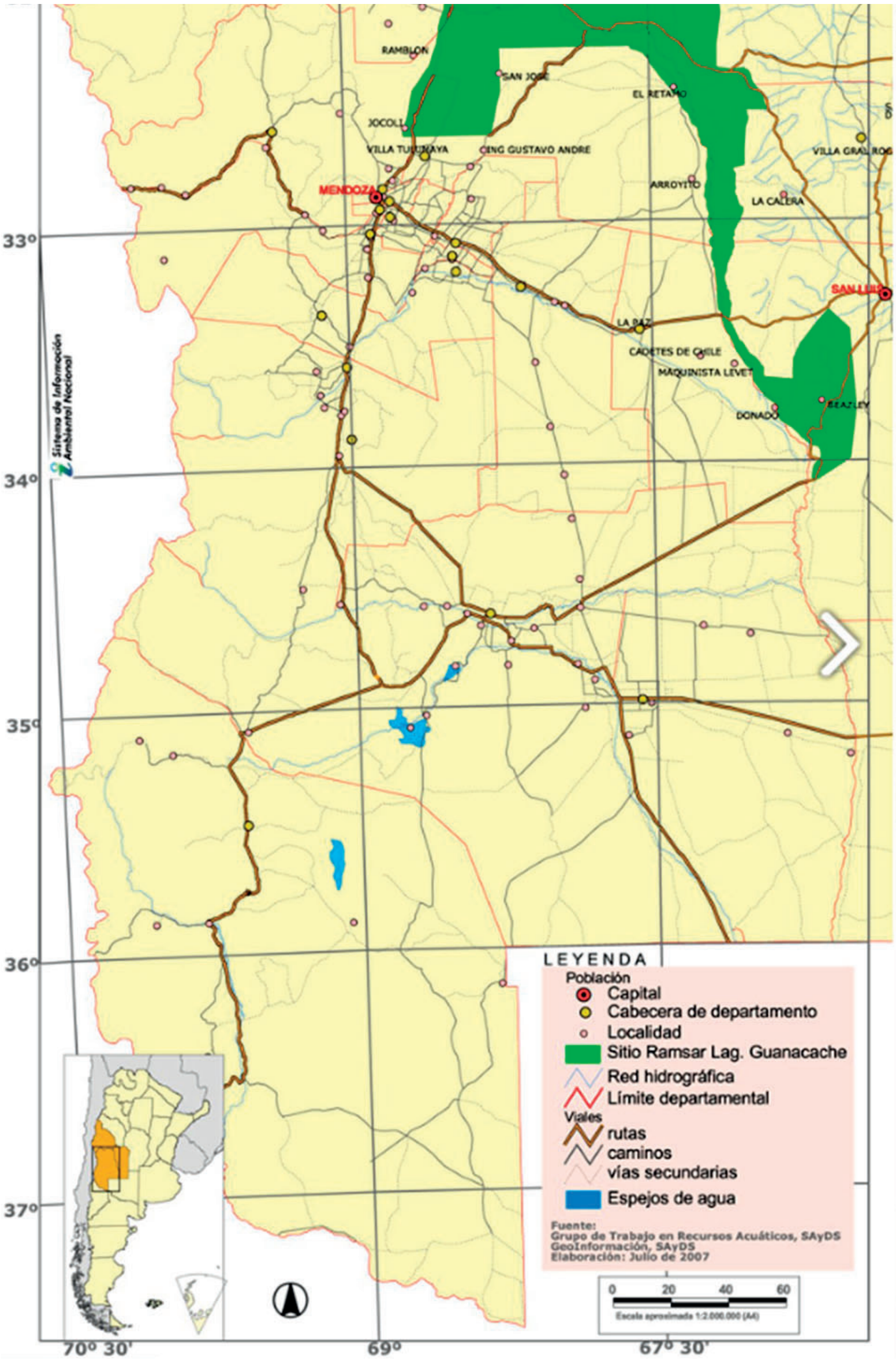
1 Ramsar, 2018
2 Davidson, 2014; Ramsar 2018
3 Quintana, 2020
4 Stevens et al., 2003; Taft et al., 2002
5 National Research Council, 2001; Zedler, 2000
6 Kandus et al. ,2017
7 Bereciartua et al. ,2009
8 Sosa & Guevara, 2017
9 Sosa, 2007
10 Torres, 2015
11 García Llorca & Cahiza, 2007
12 Hernández & Chiavazza, 2009
13 Marzo & Arias, 1975
14 Abraham & Prieto, 1981
15 Sosa & Amaya, 2015
16 Ulaco & Funes, 2006; Sosa & Amaya, 2015

development programmes that improve their well-being[17], and this project is a demonstration of the benefits of participatory processes.

Although the participatory approach may require more time for the formulation of comprehensive proposals since it requires meetings and workshops, this project is inclined towards participatory restoration where the villagers (livestock farmers) are involved from the drafting of the project based on their needs, to the monitoring for the control of the projects once they have been completed.

This paper presents the results of 10 years of ecological restoration actions in wetlands of the Ramsar Site with social participation, aiming at the recovery of their ecological character and the improvement of ecosystem services for the direct benefit of local families.

17 Norton, 2004



01

01 Location of the Ramsar Site in the Region of Cuyo, Argentina

MATERIALS AND METHODS

The actions were carried out within the framework of the Restoration and Conservation of the Ramsar Site of the Lagoons of Guanacache, Desaguadero and Bebedero, implemented by Fundación Humedales/ Wetlands International together with the local community (Huarpe native communities) with the financial support of Fundación Vida Silvestre Argentina (at the beginning of the project) and later of Fundación Avina, in an uninterrupted period of 10 years from 2011 to 2020.

A total of 35 workshops were held in the different communities belonging to the Ramsar Site, and agreement meetings were held with local authorities. It was possible to work with a sufficient number of leaders or representatives in order to ensure and validate the decisions taken through the signing of minutes.

The workshops were open to the communities, and the group meetings for each activity were convened only for the beneficiaries, who permanently supervised each action developed in the restoration process. In order to confirm the places to intervene, field trips were carried out in the company of livestock farmers, representatives and technicians, indicating the potential benefits and disadvantages of each place.

Representatives of governmental institutions (provincial and municipal) participated in different instances to ensure dialogue with the villagers and to strengthen the possibility of permanent management.

Ecological restoration methods were applied, taking into account technical documents (Ramsar 1999, 2002, 2012, 2012, 2013, 2015 and 2018) and recommendations from SER (Society for Ecological Restoration) (2004), and following the principles and guidelines of the International Union for Conservation of Nature (IUCN)[18].

For the restoration projects, embankments of different sizes were constructed according to the type of wetland to be intervened. The work sectors were georeferenced, taking into account gully sections and longitudinal slopes, together with geometric parameters. The embankments were raised with a backhoe using local materials, suitably compacted (clayey sediments) and lined with geotextile panels fixed to the ground with 50 mm x 6 mm iron stakes[19] in order to collect rainwater and act as "water and sediment traps"[20].

After the rainy period (January and February), calculations of accumulated water (in volume) were carried out. For this purpose it was necessary to record the height of the water level reached in the embankment and to measure the length of the fill upstream of the embankment. Accurate rainfall information is not available in the area, so it was necessary to rely on external sources[21] to obtain rainfall data for the area, which are estimated based on cloud refractance from satellite images. To verify the biodiversity response, birds were selected following the parameters established by Paracuellos & Tellería[22]. Indicators of bird richness and abundance were measured using 500 m transects in the sectors affected by the restoration works, with seasonal frequency from 2015 to 2019.

To visualise changes in the vegetation surrounding the works, LandSat - OLI sensor satellite images from 14 April 2013 and 17 April 2020 were used. Digital analysis of selected scenes was applied, opting for the Normalised Difference Vegetation Index NDVI, which makes it possible to estimate and identify the quality, quantity and development of the vegetation[23].

18 Keenleyside et al., 2014
19 Sosa, et al., 2012
20 Vich and Gudiño 2010, Sosa, et al., 2012
21 www.accuweather.com
22 Paracuellos and Tellería, 2004
23 Arboit and Maglione, 2018

02

02 Gully formation due to backward erosion. Guanacache 2007 (Photo: H. Paradella)

03

03 “La Pasarela” Project with accumulated water after the rainy period of 2018

RESULTS

From March 2012 to March 2020, a total of 9,141,216 m3 of rainwater accumulated in the restoration works sectors, distributed gradually over 9 years of operation. The first three works were constructed during the spring of 2011 and by the summer of 2012 they were operational (with the capacity to collect rainwater). The remaining works were constructed gradually, bringing the total to 14 completed works by 2018 (Figure 4). The accumulation of rainwater on construction sites depended on two factors: 1- the amount of millimetres of rainfall during the season and 2- the sector where the rain fell.

In 2012, rainfall was sufficient to accumulate water in the 3 works built up to that time, containing a total volume of 51,194 m3. In 2013, with a total of 6 works constructed, water was collected in only 4 of them, with a total accumulated volume of 800,604 m3. The following year the rainfall was not enough to accumulate more than a quarter of the water accumulated in the previous year.

In 2015, 1,113,399 m3 of rainwater accumulated in 8 of the 9 works built for that year. For the years 2016 and 2017 the rainfall was more localised and in relation to the previous year, the accumulation was higher considering that only 5 and 4 works operated with a total of 847,218 m3 and 1,123,713 m3 respectively.

By 2018, all 14 restoration works had been constructed at the Ramsar Site. 2018 was the record year for rainwater harvesting, with 9 works accumulating a total volume of 2,930,045 m3. In the following years 2019 and 2020 the accumulation of water decreased. Surprisingly, in 2020, with a total of 10 works in operation, they only managed to accumulate a total volume of 347,619 m3 (Figure 4).

The filling period begins with the first rains (December-January) and ends with heavier rainfall events, generally in February-March. The moments of filling (total or partial) of each reservoir depend on the local rainfall. Similarly, the accumulated volume of water is the result of the millimetres of rainfall, the water runoff in the sector and the amount of rainfall during the season (Figure 6).

Larger works tend to keep the water accumulated for longer, completing an annual cycle. In the case of the largest works (e.g. La Pasarela), in the summer season of 2018 it accumulated a maximum of 1,760,000 m3, and the water in the reservoir lasted from one year to the next (Figure 3).

Year	Number of works built	Number of works with water	Water accumulated (m^2)
2012	3	3	51.194
2013	6	4	800.604
2014		4	261.600
2015	9	8	1.113.399
2016		5	846.218
2017		4	1.123.713
2018	14	9	2.930.045
2019		9	1.665.824
2020		9	347.619

04

Projects	Max accumulate d x work (m^2)	Peak year
Pasarela	1758572.80	2018
Puertita	204997.00	2018
Chayito	39100.00	2014
Pedernales 1 & 2	32785.00	2018
Padernal 3	6253.20	2015
Camperito	6940.80	2020
Sepultura	2821.5	2015
Caballos 1 & 2	53798.00	2018
Las Marias	245273	2019
Pozo Alambrado	7407	2019
Pichanilla	642000.00	2018

05

04 Restoration works constructed in the different years of the project and their performance in terms of rainwater accumulation in m^3

05 Table of restoration projects (with their local names) showing the years of maximum rainfall accumulation in m^3

AFFECTED SURFACE AREA

24 Casaño et al.; 1998

With the operation of the 14 projects, some 1000 hectares of wetlands (former lagoon and marsh bottoms) and related surrounding environments (hydrophilic vegetation communities and Prosopis flexuosa woodland) are in the process of being restored (Figure 6).

ACCUMULATED SEDIMENT

The deposition of solid material in the water accumulation zone is produced by the summer sediment dragging from the feeding basin, depending on the intensity of the rainfall, the slopes, the degree of compaction of the natural collectors and the type of terrain[24]. Accumulated sediment was measured by means of fixed point recordings and yardsticks placed in the field. Of the total of 6 sites measured, an average of 0.96 m. of accumulated sediment was obtained, with a maximum value of 2 m. in 8 years of site operation (Figure 7).

BIRD RESPONSE

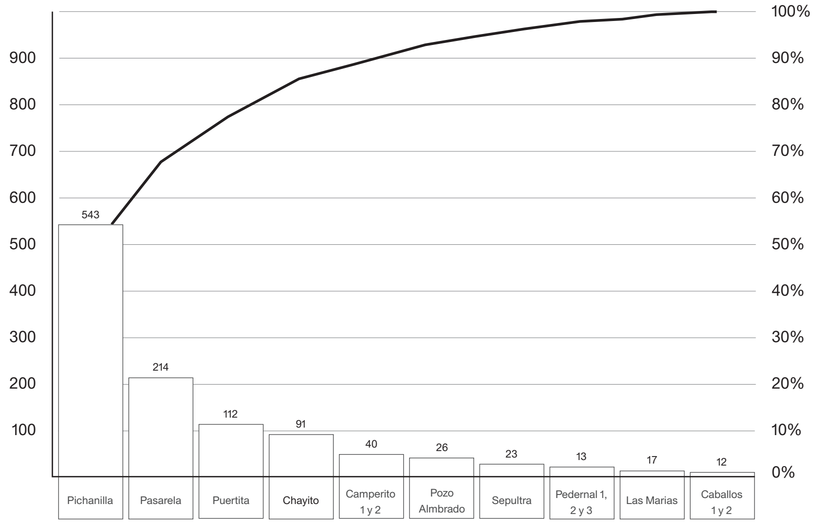
A total of 85 bird species, belonging to 15 orders and 27 families, were recorded in the restoration sectors. Of these, 60 species were terrestrial, 23 aquatic and 2 related to wetlands. The first species to appear in 2015 were the ducks Anas georgica, Anas bahamensis and Oxuira vittata, the common shelduck Vanellus chilensis, the plover Tringa melanoleuca, the common moorhen Fulica leucoptera and the thick-billed maca, Podilimbus podiceps. The rest of the waterfowl species were added in the following years to complete the richness of 23 species recorded until the summer of 2019, always depending on the presence of water in the works (Figure 8).

COMPARATIVE ANALYSIS OF SATELLITE IMAGES

According to the distribution of NDVI values in the sector under analysis (La Pasarela construction site), it can be observed that the statistical ranges of the minimum and maximum values of the index have increased between 2013 (Figure 9) and 2020 (Figure 11)

In relation to the behaviour of the NDVI index, the average value increased slightly (0.020) in the period between 2013 and 2020. This value is sufficient to see the change in the surrounding vegetation with the naked eye (Figures 10 & 12)

In the workshops and meetings held in the field, a good level of representation was achieved thanks to the commitment of community leaders and livestock farmers to the project by working on the projects and subsequent adjustments (Figure 13). Through the participation of the state government, the institutional strengthening and management capacity of the communities was achieved. The network of institutions and organisations related to the project and the territory was expanded (Figure 14).



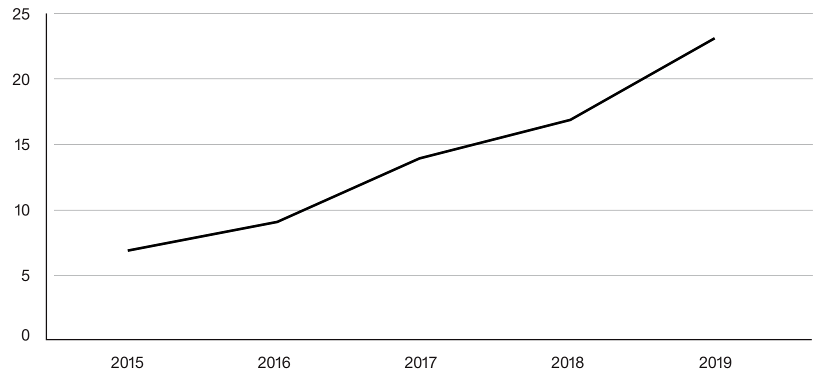
06

06 Graph of the surface area covered by water of each restoration project and its area of impact on surrounding environments

Obra	Sedimento acumulado (m)	Tiempo en anos
Pasarela	2	8
La Puertita	1	8
Padermal 1	0.8	6
El Chayito	0.6	7
Padernal 2	0.4	6

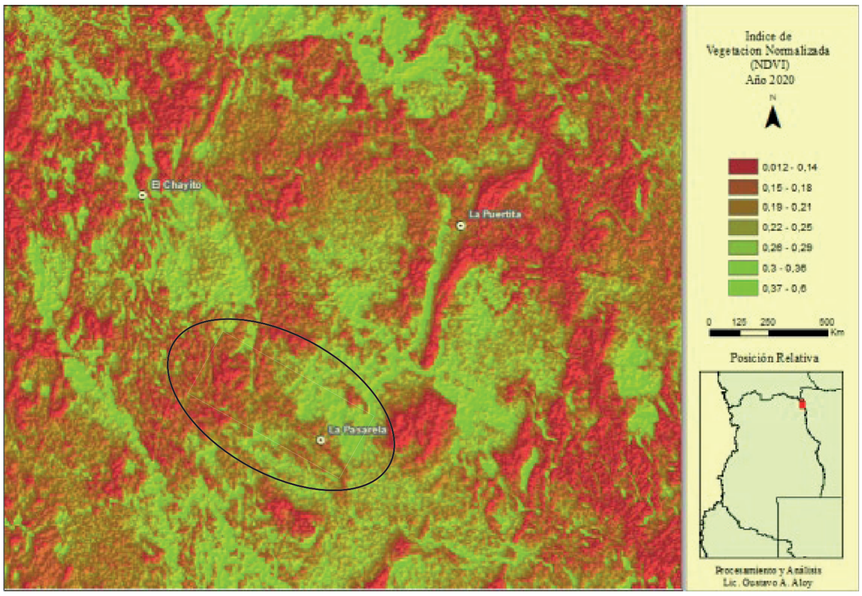
07

07 Sediment accumulated in projects with measurements



08

08 Waterbird richness at restoration sites over time.

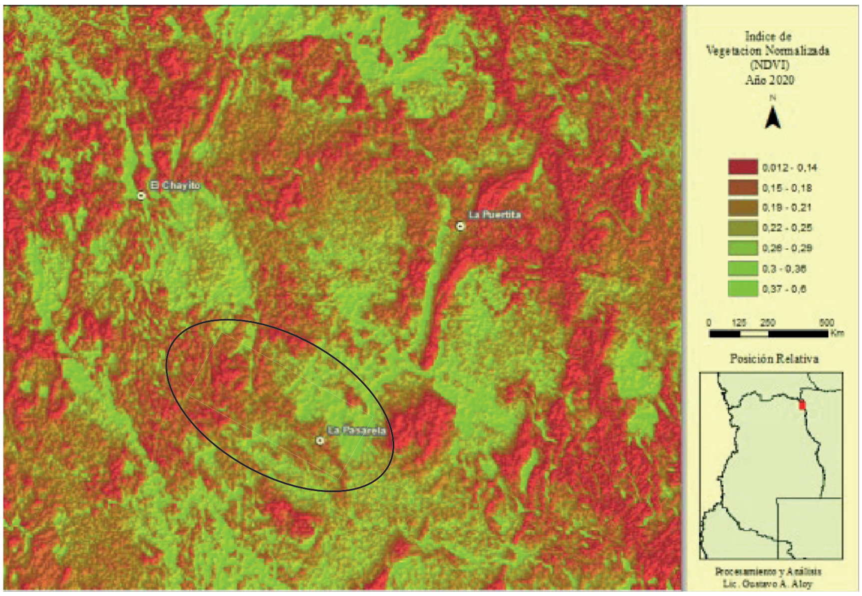


09

09 Image from 2013. La Pasarela project sector (projects in operation for 2 years)

10

10 La Pasarela project in March 2013 (circled on map). Photo on the left shows the environment upstream of the construction site. Photo on the right shows the construction site



11

11 Image from 2020. La Pasarela project sector, El Retamo (project in operation for 9 years)

12

12 La Pasarela project in March 2020 (circled on map). Photo on the left shows the environment upstream of the construction site. Photo on the right shows the construction site

13

13 Workshops in the field with local livestock farmers. Actions were decided in the field

14

14 Workshops with technicians and local institutions in which community representatives also participated.

CONCLUSIONS

This project demonstrates that it is possible to initiate a process of wetland restoration by using rainwater as a source and retaining sediment in erosion gullies, through the construction of works with local material and the use of new technologies such as the use of geotextile membrane as a protective liner.

With the restoration process underway and the works in operation it was possible to accumulate up to 4 hm3 of rainwater in a good rainy period. Much of this water can remain in the system until the next summer period.

With the accumulation of water in the works, it was possible to retain up to 2 metres of sediment. This material, deposited at the bottom of the gullies, contributes to the recovery of the eroded soil. This raises the base levels of the gullies to their original levels.

The effect caused by the accumulation of water and sediment over nine years in 14 constructed projects, contribute to initiate a passive restoration process in an area of just over 1000 ha. of wetlands and surrounding environments.

This is reflected in the positive response of the bird community and in the passive recovery of vegetation as expressed in the green index analysis through satellite imagery.

At social level, some 300 families of livestock farmers benefited directly, whose animals benefit from water accumulated in intervened areas and natural pastures strengthened thanks to the operation of the restoration works.

With regard to community participation and project ownership strategies, the following has been achieved: 1) Improving the capacity for self-management before the relevant institutions to address the maintenance of works; 2) Incorporating the issue of wetlands and their need for restoration in assemblies; 3) Increasing interest in managing funding for projects related to access to water. 3) Increased interest in the management of financing for projects related to access to water.

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Closing the Implementation Gap of Nature-based Solutions

The case of Water as Leverage - Cascading Semarang

Begoña Jaimerena

Nature-based Solutions (NbS) can help cities to become more resilient and climate adaptive. But more often than not, their implementation is reduced to awareness-raising pilot projects with limited chances of upscaling. The strategic plans that integrate these solutions, are hardly translated into investment plans, creating an implementation gap for NbS.

The Water as Leverage – Cascading Semarang project, addressed this gap as part of the development of an innovative, sustainable, bankable and implementable design proposal that considers an inclusive approach. It started with a shared narrative that defined a theory of change, through the development of the full investment case and implementation strategies.

The lessons learnt from that project, showed the urban planners and designers are in a unique position to drive the process of closing the implementation gap. Their comprehensive understanding of the urban dynamics, paired with the skills to lead the development of an innovative vision and shared narrative, can trigger the transformative changes that are needed to face current and future urban challenges. Furthermore, a collaborative approach enables ownership and allows the integration of relevant knowledge throughout the process, including environment, finance, and society.

INTRODUCTION

Cities around the world face increasing challenges that threaten their resilience, as several climate-related, social, economic and environmental issues interact[1]. These complex challenges require multifunctional and sometimes complex solutions that are capable of addressing them in a sustainable and inclusive way. Nature-based Solutions (NbS) are commonly envisioned as a way forward in the pursue of more resilient urban development. Thanks to their co-benefits, they are encouraged as a way to create more liveable, sustainable and inclusive cities, addressing different societal challenges.

The implementation of NbS requires partnerships and collaboration across sectors. This is needed to involve the different expertise needed, but also to unlock the access to funding and financing. Often, NbS projects are publicly funded, but this limits their implementation at scale. There is also the private sector, but a problem arises because existing investment systems and procurement processes are not meant for this type of solution. NbS are capable of addressing several challenges at a time, while also providing co-benefits to the environment and communities. But NbS can change over time, and those changes can in turn influence their performance. So, while the proponents of NbS might refer to the multifunctionality and co-benefits of these solutions, the project implementers and financers think of assets and are interested in the risks that NbS entail.

There is an evident gap between the NbS plans and how they can be implemented, or more precisely between strategic plans and investment plans (i.e. funding and financing for implementation). To bridge that gap, it is necessary to develop a suitable project preparation, to ensure the sustainability in service delivery in the long term.

CLOSING THE IMPLEMENTATION GAP

Nature-based Solutions (NbS) are a fundamental part of new approaches that enhance urban resilience, enable the mitigation of water risks and a win-win between economy and environment[2]. Unfortunately, the implementation of NbS at scale remains limited. Often, NbS are implemented as awareness-raising pilot projects following parallel processes from mainstream procurement practices. In addition, water security strategies and plans present a more integrated and comprehensive approach and can include a suitable combination of measures, including NbS, but are not easily implementable. There is a gap in the translation of the NbS pilots and water security strategies and plans, into a clear phased investment plan. This includes the funding and financing necessary for implementation and is needed to convince potential project sponsors and ensure buy-in. The gap between strategic planning and investment planning is known as the implementation gap.

There is a lot of expertise developing strategic plans for water security that is fundamental when planning for NbS for this purpose, with good synergies between NbS and grey infrastructure (e.g. hybrid infrastructure). However, the access to funds for their implementation is limited. Most investments in NbS are currently carried out by the public sector. This can be a constrain, especially when public funding is scarce, and uncertainties related to NbS performance over time are high. But the implementation of NbS at scale does not have to rely solely on public funds. It can also make use of private funds, or a combination of both, to prepare a full business case (Figure 1).

1 World Bank, 2021
2 Altamirano et al., 2021

For that, it is important to have a project sponsor and project developer who are willing to take the risk of implementing NbS, in order to unlock the access to financing and translate plans into investable propositions.

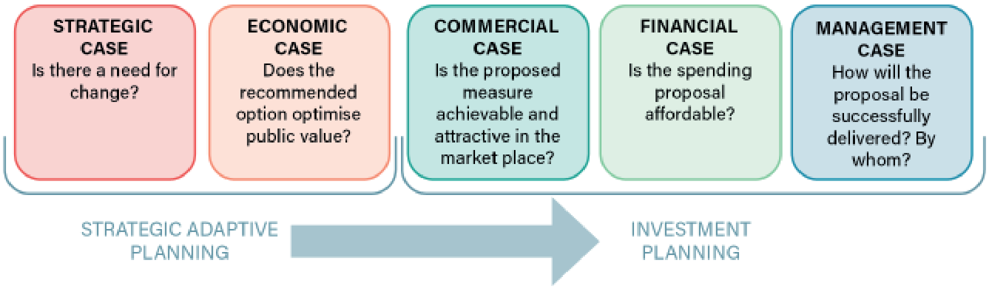
Closing the implementation gap is challenging. Existing project delivery and finance arrangements are often thought from a grey infrastructure perspective. There, grey infrastructure is seen as an asset with a clear function. But NbS are multifunctional, and can provide several co-benefits, which can be very appealing for users. However, to make that contractually feasible can be too complex and for project developers it might be easier to focus on grey infrastructure instead, minimizing the risks. There is also a challenging perception about some of the aspects related to NbS, which sometimes prevent us from implementing them. Some of them are:

- Future - proof investments: how future-proof are NbS
- Create demand for investments in NbS and governance structures for collective investments: how to ensure that money is invested in NbS
- Create markets for implementing NbS

The bridge needed to close the implementation gap between strategic and investment planning is a suitable project preparation process that shows a clear pathway to move from one to the other. At the core of it, is the development of investable NbS propositions that allow the upscaling of NbS and contribute to change our development paradigm. It also requires the alignment of language and interests between NbS proponents and project financiers[2]. There is a range of NbS proponents, from communities that propose small scale interventions in their neighbourhoods, to local governments that plan city- or region-wide NbS projects.

The project preparation process includes the creation of phased NbS or hybrid infrastructure, grouped in clusters if necessary, that can be absorbed by formal public investment planning processes. A suitable implementation and financing arrangement needs to be developed for each measure or cluster of measures. To do so, NbS needs to be understood and designed in terms of the function it has, the services it provides, and the actors that are willing to pay for it.

The achievement of the full business case depends on the development of the strategic, economic, financial, commercial and management cases. First it is necessary to zoom out and place the NbS or hybrid project into a larger economic development context, to strengthen the strategic and economic cases. This increases the chances of accessing multiple funding sources from different sectors. The strategic case for NbS, includes the theory of change, showing how they can trigger a paradigm shift and helping to position these solutions in many political agendas. This is where urban planners and designers can have an important role, contributing to set a robust strategic case with a visionary shared narrative and a suitable set of measures. Then, the economic case focuses on optimising the value, while conducting social cost-benefit analysis. Afterwards, by zooming in on specific NbS or hybrid projects, or cluster of projects, it is possible to develop the commercial, financial and management cases (Figure 2). This includes the definition of a governance structure, allocation of risks and responsibilities, alignment of incentives and the design of a fit for purpose implementation arrangement. There are multiple options there, ranging from 100% public to 100% private implementation. Supporting all the cases, is the enabling environment, which includes institutions, stakeholders, the community and others who make possible the implementation of successful NbS at scale.



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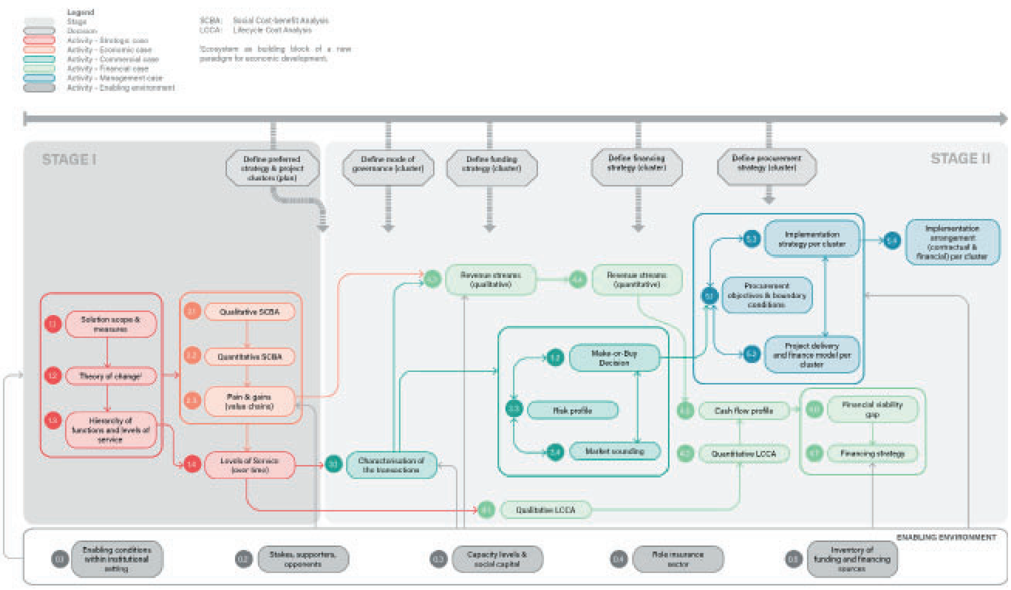
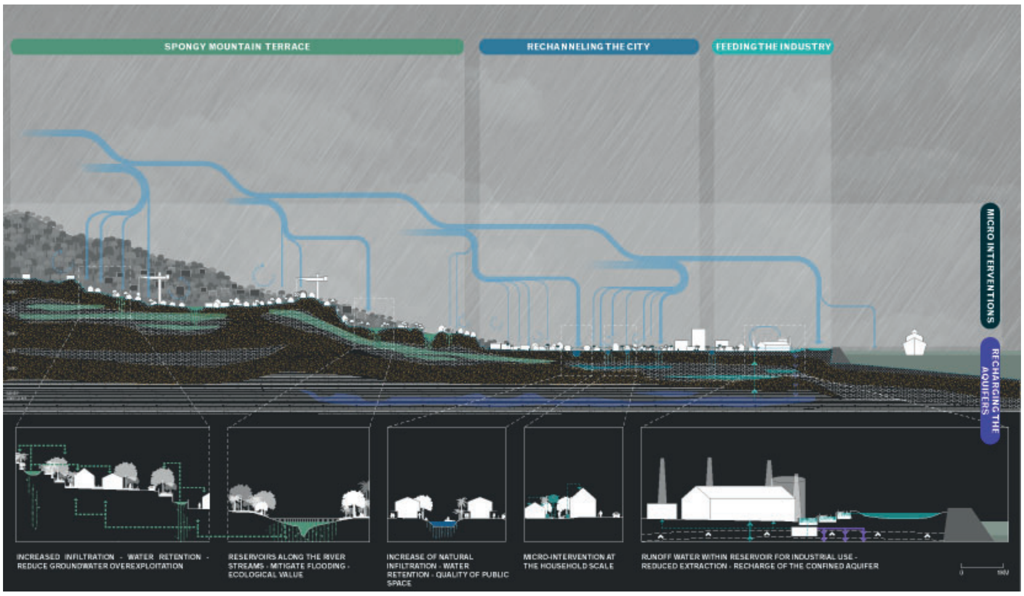
01 Overview of the full business case[2].



02

02 Roadmap to develop the five business cases[2].



03

03 Cascading Semarang implementation strategies. © Cascading Semarang team

THE CASE: WATER AS LEVERAGE - CASCADING SEMARANG

Water as Leverage is a programme promoted by the Netherlands Enterprise Agency (RVO), on behalf of the Ministry of Foreign Affairs, and in collaboration with other international organizations. Its aim is to tackle urban water-related challenges in an inclusive way, by developing innovative, bankable and implementable design proposals that serve as catalysts for a transformative change. These proposals would contribute to leverage water for urban climate resilience.

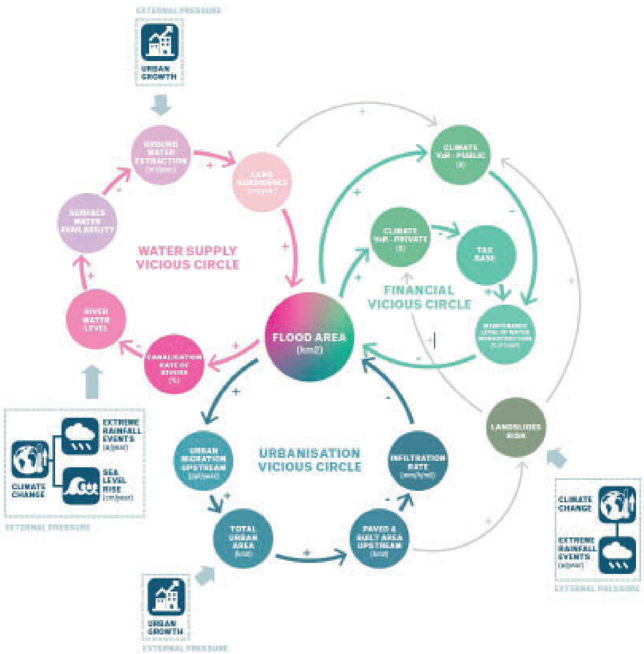
In its first version, this programme focused on resilient cities in Asia, with Semarang being one of the chosen cities. Semarang is one of the biggest cities in Indonesia. It is urbanizing rapidly, and it is regularly affected by flooding partly due to how the water is managed, with the over extraction of groundwater. The current water management strategy in Semarang relies on drainage into the sea, but a new strategy is proposed to enable a more efficient and sustainable use of resources.

In this project, the approach was to look at water not only in terms of risks and constrains, but rather to understand the opportunities it presents, and how it can become a motor for sustainable economic development. This means looking at challenges from the perspective of multiple sectors from the beginning and use water to generate value and make the benefits of it visible. The project proposed five implementation strategies based on the different urban typologies: spongy mountain terrace, rechannelling the city, feeding the industry, recharging the aquifer and micro-interventions. Through the typologies, the idea was to set in motion a win-win effect between climate, water and economic development goals.

As part of the project, there was also the aim to develop an enabling environment for private sector participation while developing a fit for purpose arrangement that works within the current environment (i.e. regulation and legal environment), all with the intention of reducing the transaction cost of upscaling and replicating the implementation strategies but also looking to increase the competitiveness of the private sector in Semarang, including small and medium enterprises.

The implementation strategies proposed included a combination of NbS with grey solutions (hybrid solutions) to deliver the expected levels of service. For example, the strategies spongy mountain terrace focused on capturing rainwater upstream, to reduce runoff and contribute to reduce flood risks downstream. It includes measures such as resilient residential developments with improved foundations and green areas, reservoirs, purification ponds and other related water infrastructure, sustainable urban drainage systems like bioswales, and nature conservation areas.

The methodology was based on a design that integrates the development of the full investment case for NbS. First, are the strategic and economic cases. NbS needs to be placed in a bigger economic narrative, looking at the strategic fit of NbS and hybrid strategies for the wider economic context. This defines the theory of change, explaining how the investment in NbS as part of the programme can drive a paradigm shift. Then, the current dynamics were mapped to better understand how water is managed, especially groundwater and its relation to land subsidence. At this point, vicious cycles (Figure 4) regarding water supply, finance and urbanization were identified, and so are potential ways to change them into virtuous cycles by using NbS and hybrid strategies in a new theory of change (Figure 5).



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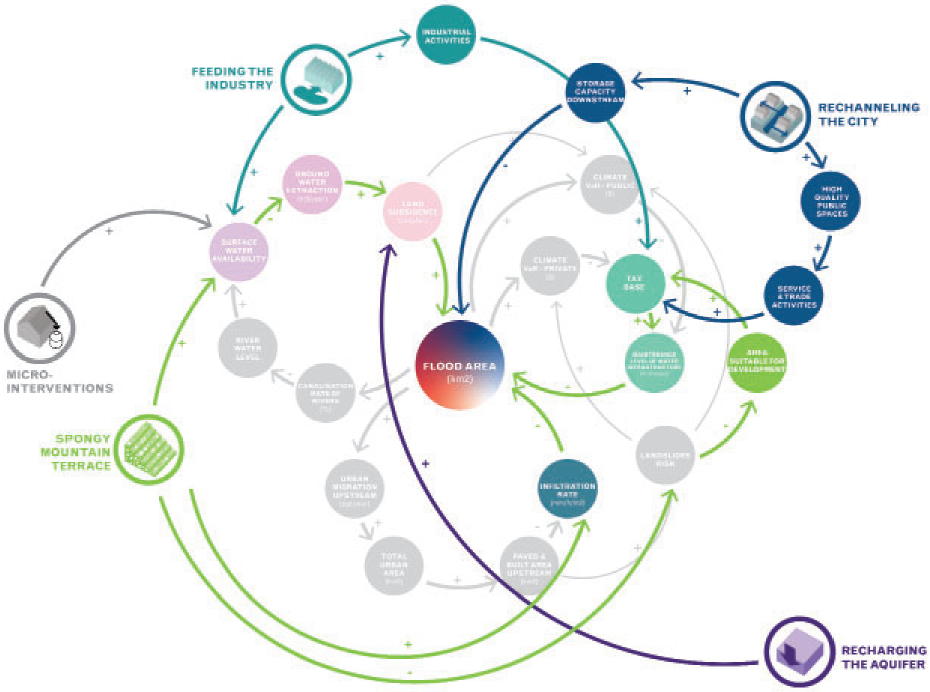
04 Vicious cycles identified in Semarang. © Cascading Semarang team



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05 Theory of change for Semarang, developed collaboratively together with stakeholders. © Cascading Semarang team

As part of the strategic case, several measures were defined, and then grouped in clusters of projects that comprised structural measures (both NbS and grey) and non-structural measures (e.g. awareness, monitoring). The development of the economic case focus on assessing the value for money of the measures, by performing cost-benefits analysis. Those focused on the expected effects on the environment, society, economy and institutions, as well as the effects on three economic agents: individuals, producers, and government.

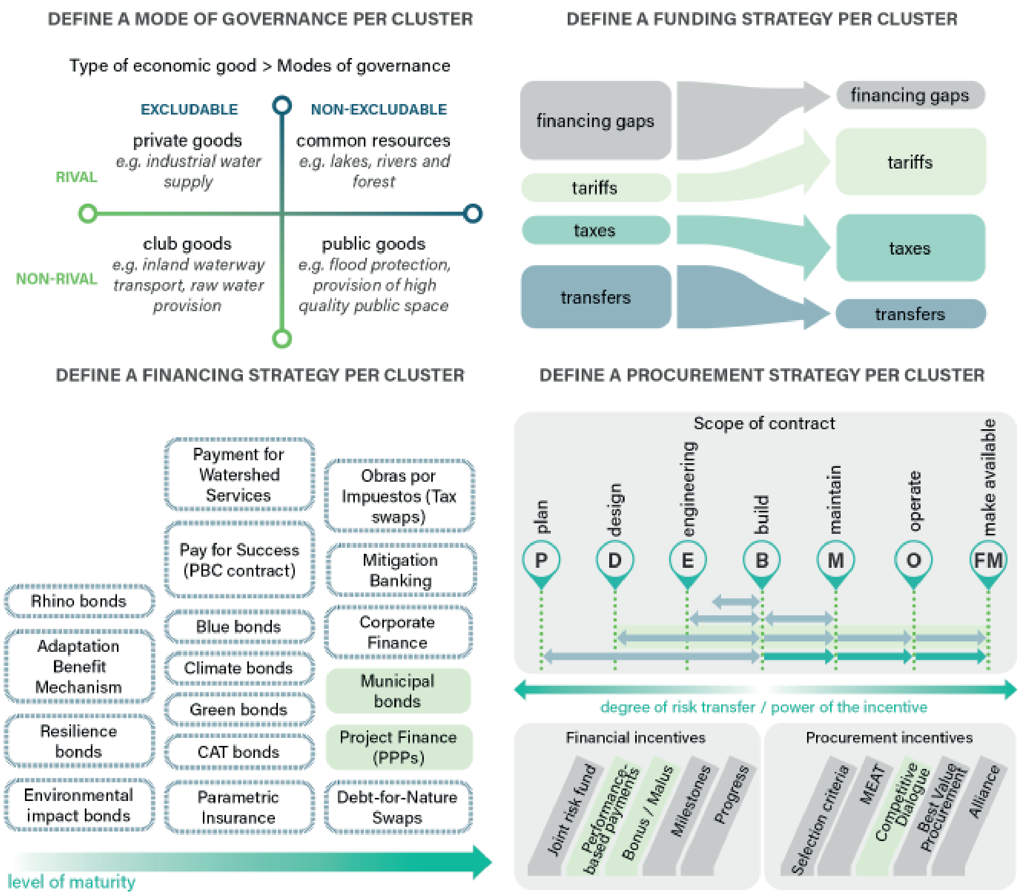
Later, as part of the commercial, and financial case, the cash profile of the projects was defined, as well as the level of service that can be guaranteed over time, and the risk. This is the risk that NbS are contributing to reduce, but also the risks that they face during the entire life cycle that can threaten the functionality of the project. It is important to define a hierarchy of functions, ideally between 2 and 4 linked to one specific service. This way the arrangement of the contract that allows the payments by different target groups becomes feasible. This also sets the base to the potential use of blended finances.

NbS can also be developed as part of mosaic projects. These are projects that serve multiple markets depending on where the demand is. This allows for the stacking of the funding from multiple benefits like carbon offsets, water quality credits, etc.

Finally, as part of the management case, the implementation arrangement is finalized, considering the measures defined, as well as the services they provide. It starts with the definition of the mode of governance, understanding services as a type of economic good, then the funding strategy, and financing strategy. Afterwards, it is time to define the procurement strategy (Figure 6), identifying who is going to be involved in which phase of the project implementation, and if NbS are going to be packaged or not.

The families of implementation arrangements for NbS for water security are: (i) public project procurement, (ii) privately driven water stewardship, (iii) collective investment schemes/investment funds and (iv) environmental markets. Public procurement refers to when the public commissioner contracts water services from private suppliers. Privately driven water stewardship refers to when a private commissioner contracts NbS projects for Corporate Social Responsibility (CSR) or to introduce efficiencies in their value chain. Collective investment schemes and investment funds refers to the assets owned by the fund, called a portfolio and managed by a fund manager. Environmental markets refer to an ecosystem service itself that is marketed and sold as a commodity to a beneficiary in the context of a dedicated market, usually subject to oversight by a regulatory body.

A cost-benefit analysis looked at the mains services provided, the co-benefits identified, the costs of the implementation, both at one location and at scale over a longer period for the complete strategy. Based on that, a blended finance strategy (public-private) was developed for each strategy, together with an implementation arrangement.



06

06 Financing Framework building blocks, necessary to develop the implementation arrangement[2].

CONCLUSIONS

Urban planners and designers, as NbS proponents, can be in a unique position to address the NbS implementation gap. They have a comprehensive understanding of the urban dynamics and can lead the creation of a theory of change and a shared narrative to kick-start the development of the strategic case. This is the first step in a larger collaborative project preparation process. By aligning interests in this shared narrative, as well as the language used, ownership of the process and its result by stakeholders is developed from the start.

To access funding and financing for NbS, is necessary to develop the full investment case for each of the NbS projects or cluster of projects. But often, NbS proponents are organisations with limited involvement in public and private investment planning processes. This results in awareness raising NbS pilot projects that are hard to upscale, instead of investment projects. When shaping NbS as investable propositions, they could attract funds from either public or private organizations, maximizing the chances of successful implementation.

Different actors in the NbS implementation process have different interests, mandates and language. The latter refers to more than just the concepts used and what they mean, and it can easily hinder communication if left unchecked. For example, NbS proponents might have a concept design, but project developers need to understand the assets that are part of it, and financiers might be more concern about the risks associated with it.

Understanding NbS in terms of functions, services provided and cost, and linking that to beneficiaries and actors potentially willing to pay for those services, allows a clearer organization and prioritization of measures, and their phasing over time. Not only that, but there is the need to clarify and agree on a hierarchy of functions and associated levels of services that enable acceptable trade-offs during the complete life cycle of NbS: design, implementation, maintenance and monitoring.

Moreover, the level of service of NbS can change over time, which represents a risk for financiers. It is important to map the life cycle of NbS and the expected level of service over time, as well as the expertise needed, to identify who should be involved in which part of process. By doing so, projects can be phased in a way that the project is delivered at a low cost, with high quality and minimum risks. This also involves the

There is an evident difference between traditional grey infrastructure projects and NbS ones. This calls for the reconsideration of traditional procurement processes, and even public investments. Moreover, NbS proponents need to improve their project preparation skills to be able to bridge the communication gap with project developers and financiers. This would result in NbS projects that are shaped differently so they can make the investment case, whether that is with public or private resources, or a combination of both.

[About public-private-science collaboration in NbS investments] "This revolution in understanding could then inform a new generation of planning, project origination, project preparation and procurement tools and models that guide the selection of the most transformative and effective infrastructure investments." [3]

3 Altamirano et al., 2021, p12

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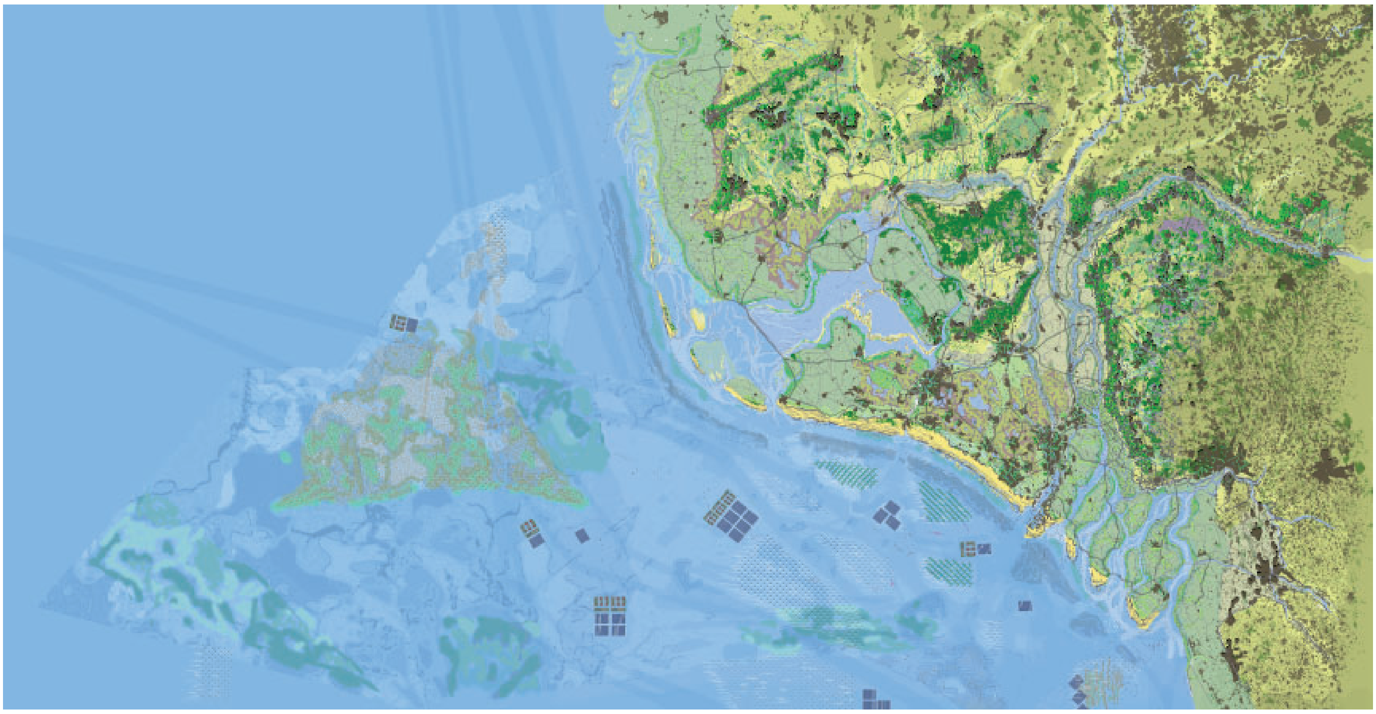
A nature-based perspective for the Netherlands in 2120

Michaël van Buuren

This article elaborates on the method of “research through design” in spatial and landscape design. It includes a further explanation of the method in which three questions are central. At first theoretical backgrounds of research through design are highlighted: what is it? It is stated that he sequence of deduction and induction connected by making creative leaps are the most crucial elements. Second, the added value of the method is stressed. It maybe the only way to contribute to complex or ‘wicked problems’ that characterize present development of landscapes. Finally a working method for the use of research (through) design is proposed. The project “A nature-based perspective for the Netherlands in 2120” illustrates a potential outcome of this way of thinking and working.



INTRODUCTION

Climate change, urbanisation, biodiversity, rising sea levels, extreme weather and increasing food production: these are just a few of the factors that help shape the spatial planning of the Netherlands. There appears to be a need to look to the future. With these factors in mind, what will the Netherlands look like a century from now? Wageningen University & Research has drafted a vision on what it believes a future-proof Netherlands could look like in 2120[1]. The design is an integral vision in that it considers the spatial planning of the Netherlands in 2120 from various perspectives, such as agriculture, biodiversity, sustainable energy, water and the circular economy. The map is not a blueprint, but a projection. It shows the Netherlands as it could look in 2120 if nature-based solutions are prioritised.

Main point of the project was to put forth the discussion about the role of nature in the Netherlands through design. The use of designing ways of thinking and acting – as is apparent from a great deal of literature – is a method that has been widely described and applied in many fields and (scientific) disciplines. Underpinned by many applied studies that examine the nature and revenues of what we call "research (through) design"[2]. The field of Landscape Architecture can therefore stand on strong shoulders. Nevertheless, we can state that – specifically in design practice – the (scientific accountability) of design work can and may need to be improved.

RESEARCH THROUGH DESIGN

The sequence of deduction and induction is crucial for design research (abduction together)[3]; steps connected by making creative leaps (Kleefmann, 1984). These leaps imply the creative interpretation and integration of (existing or new) knowledge and insights, results of deduction, in order to formulate possible solutions for the issues at hand. Bridging the 'gap' between now and tomorrow – based on (different) normative starting points, Kleefmann called this. But also the way back: the 'testing' of possible solutions for desirability, feasibility, feasibility by putting these

1 Baptist et al., 2019
2 Van Buuren, 2022; Van den Brink et al., 2017; Schön, 1983
3 Schön, 1983

performances, as Kleefmann put it, 'on the anvil' of – social and/or scientific" criticism. The 'deductive' step. In this way, images arise of what we 'could like' or 'functioning prototypes of the landscape'.

An 'agile' search process then develops, in which better or more appropriate solutions are created through further insights into the nature and characteristics of the issue. Repetition of deduction, induction and new creative leaps between them is characteristic. The designer has a role in this as a 'bridge builder' ('boundary spanner').

The diagram that depicts the nature of research (through) design shows five crucial parts of design that follow each other in random order, criss-cross[4]. It concerns: formulating (for example of the problem or goal), synthesizing (possible solutions, visions, etc.), visualizing (literally: imagining ...), reflecting (more contemplating and thinking about formulated issues, possible solutions) and organizing (of the total work process, involvement of stakeholders, etc.). It is essential to realize that "a design process" can start with each of the components mentioned and that the components do not have to follow each other in a fixed order.

Before going into the added value of research by design, it is necessary to specify the 'object of study'. Precisely because – as indicated above – the design is a generic method that can be applied in many disciplines. In this contribution, referring to the Netherlands in 2120 perspective, that object is referred to as 'the landscape'. That explains the title of this paper on "research (through) landscape design".

The concept of landscape is interpreted broadly here. It concerns a physical whole, the spatial result of an interplay between processes of abiotic, biotic and anthropogenic nature. The nature and speed of these formative processes differ, which means that landscapes are always changing. At the same time, the landscape can be seen as a phenomenon, with – certainly – three dimensions. Referred to by Jacobs[5] as "matterscape, powerscape and mindscape" respectively. The multidimensional character of this landscape concept also refers to the three major scientific fields, those of the exact sciences, societal and human sciences respectively. Fields with their own 'types' of scientific mores and criteria, which can make it difficult to design landscapes in a scientifically responsible manner. It requires careful choices of methods, transparency and accountability.

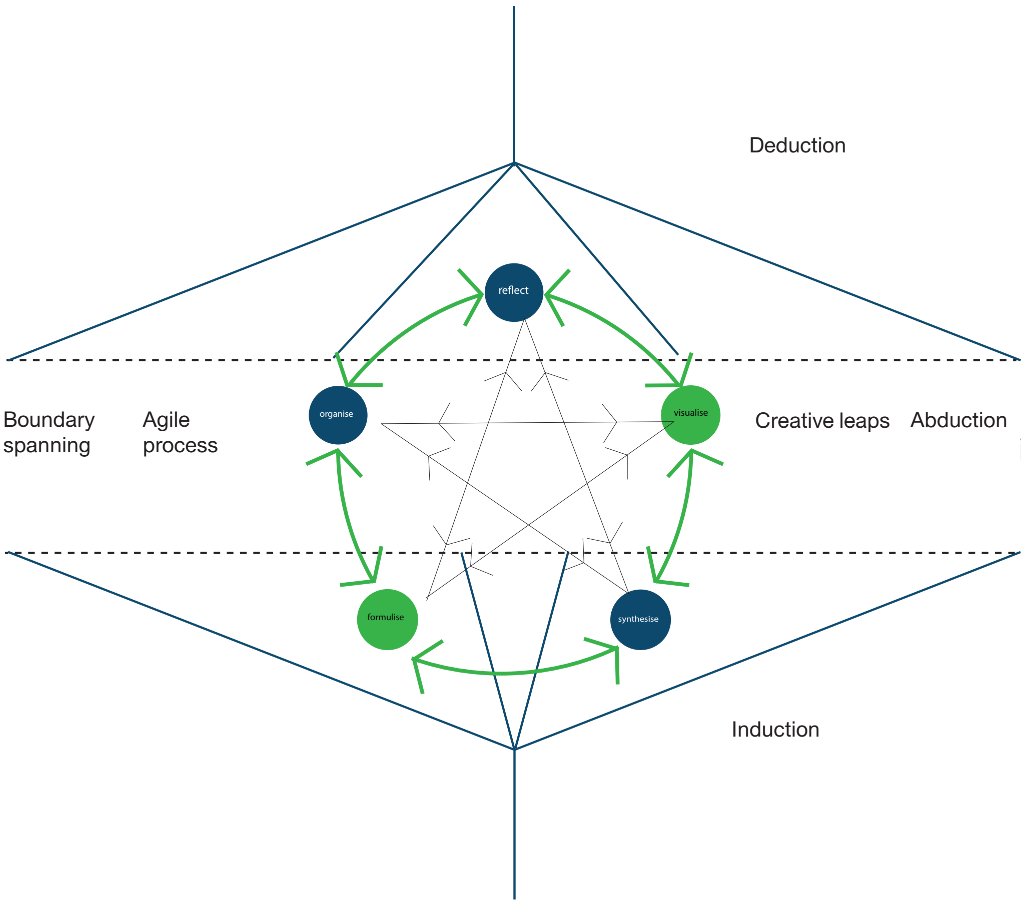
A second complexity concerns the fact that this broad conception of the landscape concept makes every (spatial) issue a "wicked problem". Characteristic of such issues are the incomplete, contradictory and at the same time constantly changing conditions, which frustrates looking for potential solutions in a 'simple' or linear way; in fact that kind of separate, partial solutions stand in the way of offering fundamental ways of overcoming or dealing with wicked problems. This is due to the many interdependencies; a partial solution often raises new problems. Several authors[6] advocate a design approach as an adequate way to tackle these unstructured issues. Making "creative leaps" and the "cyclical and agile design process" form the basis for this. Or, as Vroom[7] put it: "design is about investigating situations that are not yet known". The Netherlands in 2120 project and the good and broad social reception is a good example of the added value of landscape research by design. With a designing attitude and the agile process, you get to know the landscape – in the specific context and at the relevant scale levels – and their 'users' better and better. A way of

4 Lawson and Dorst, 2009
5 Jacobs, 2006
6 Cross, 1982; Buchanan, 1992; De Jonge, 2009; Leifner et al. 2014; De Zwart, 2015
7 Vroom. 2006

thinking that does justice to the fact that working on the future is a process in which (new) choices can or must be made time and again. Our society and culture is dynamic, with varying likes and dislikes, wishes, desires, norms and values. There are always different 'transition paths' ahead. The Netherlands is never 'finished'; panta rhei.

Finally, the role of the designer as "boundary spanners"[8]. Designers are trained and educated to connect different fields of knowledge and assignments, to bridge differences between organizations and stakeholders with their (visual) representations of future situations and to realize cooperation. Crucial elements in research (through) landscape design are the development of 'spatial concepts' or (strategic) solutions, the development of 'design principles' and the implementation of 'design workshops'.

8 Van den Brink et al., 2019 and Kempenaar et al., 2021
9 Van Buuren, 2022



01

01 The nature of research (through) design (Van Buuren, 2022)

THE FRAMEWORK

The framework that is outlined for a concrete approach to a research (through) landscape design (figure 2) serves as a guideline for actually deploying this way of working[9]. It is a 'framework' because each design process or project requires its own tailor-made approach to do justice to the physical and cultural situation on site, the specific task(s) and administrative context. The various phases distinguished in the figure are:

1) Inventory and analysis: This phase is about getting to know the area in question and the existing tasks and their coherence. Inventory refers to the collection of (existing) knowledge and insights in this regard. Analysis implies an 'assessment' of it: what do we think of it. Ultimately resulting in a problem definition, in which the most relevant (design) assignment(s) is (are) formulated.

2) Solution directions: The phase of searching for – and choosing – one or more solution directions starts with a problem definition or with a formulation of (a) design assignment(s). These follow, for example, from an inventory and analysis phase carried out earlier in the same project. But can also come from another 'external' source (an earlier project). Working on the solution direction can then be the starting point of the project in question. It is even conceivable that a planning process from one of the 'design phases' did not lead to a satisfactory outcome. And other or new solutions are conceivable.

3-7) Sketch design and beyond: 'working across the scales': The last four phases show great similarities in terms of sequence of activities. The main differences have to do with the level of detail and elaboration of the designs (or plans) that form the result. The scale of the designs will therefore vary from international to regional to local and in great detail. Often – but not necessarily – the area under consideration is also less and less extensive. Previously developed 'design principles' will be worked out step by step in a more concrete manner, matching the characteristics, qualities and opportunities of (the 'genius loci' of) the landscape in question.

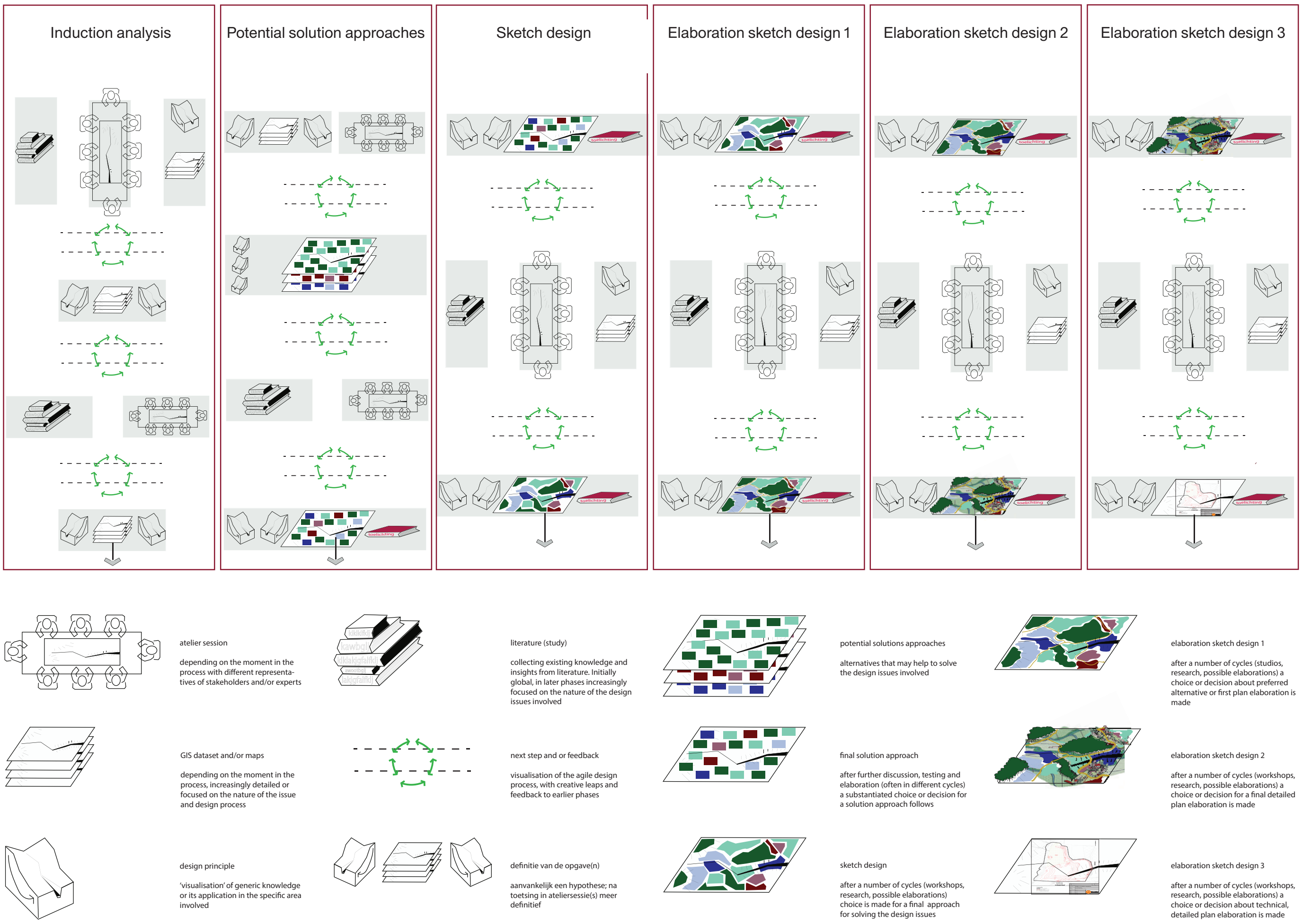
An essential element of the model for landscape design research is what we call “working through the scales”. That is to say, in every design project – certainly the adjacent, ‘higher and lower’ spatial scale levels are always relevant. At the very least, you include them in inventories and analyses. Precisely in line with the many connections and relations between the (landscape) forming systems and processes of different nature.

It is also important to realize that an ‘agile’ design process can actually start at all of the phases distinguished in the framework shown. To then be rolled out further in random order, depending on the ‘interim’ insights and ‘discoveries’ of the ongoing process.

It is also crucial to realize that each of the phases always contains inductive and deductive elements and methods. Although – almost always – a kind of ‘beginning’ arises through a phase of ‘inventory and analysis’, this is not a plea to try to start finding “all the information possible available” first. On the contrary: a good start also includes the “design” (synthesis) of a good problem statement followed by thorough reflection and testing the statement. This provides direction for further inventory and analysis (or follow-up research). In the same phase or in a next.

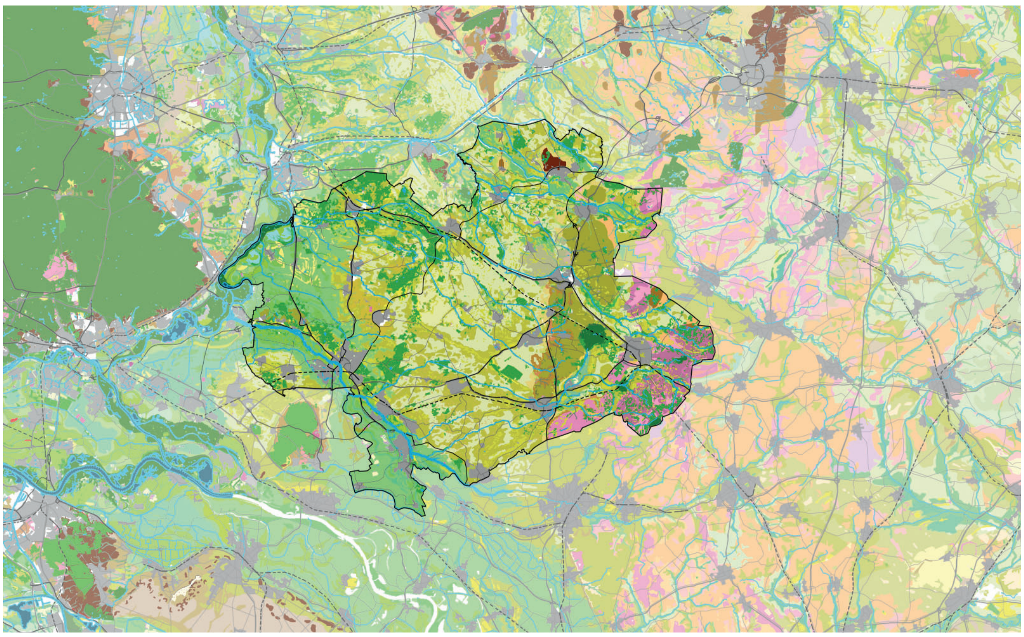
Here too, the Netherlands in 2120 – and in particular the various follow-up projects aimed at different spatial and temporal scales – is a good illustration. Incidentally, the start in 2019 can be qualified as a project in which the first, but especially the second phase of the framework are applied.

Design principles depicting nature based solutions for two landscape types from the Netherlands in 2120 perspective. Existing situation (Figure 3) and future situations (Figure 4). Pleistocene sandy areas (Figures 3 and 4); “wadden” coast (Figures 5 and 6).



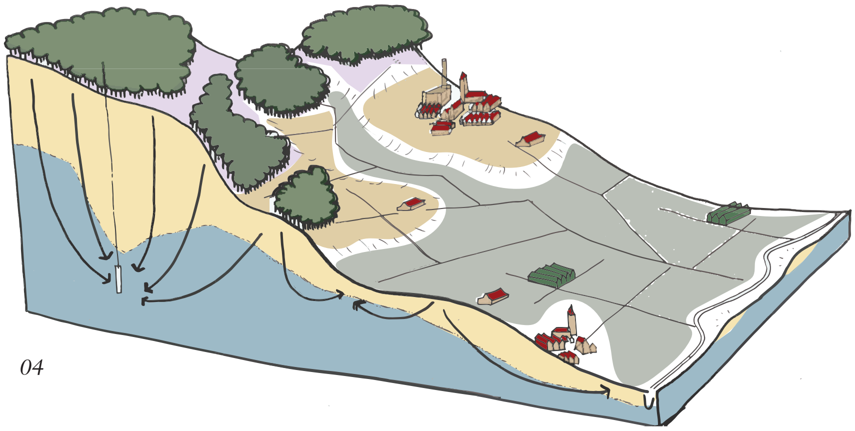
02

02 The framework that is outlined for a concrete approach to a research (through) landscape design



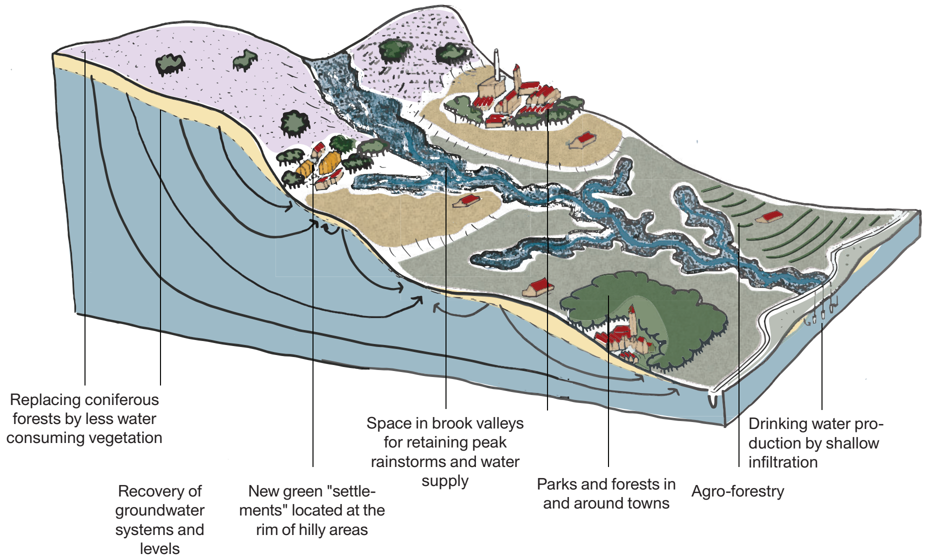
03

03 Map, showing the 'natural systems' as result of the inventory and analusis phase of the project "8terhoek" (the eastern part of the province of Gelderland) (De Rooij en Sluijsmans, 2021).



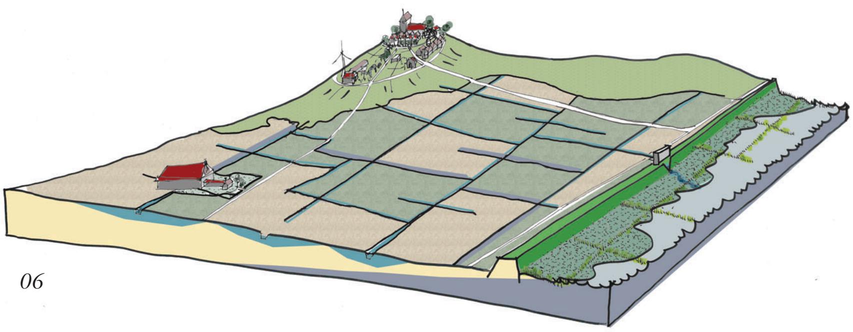
04

04 Pleistocene sandy areas in the higher part of the Netherlands - Existing situation



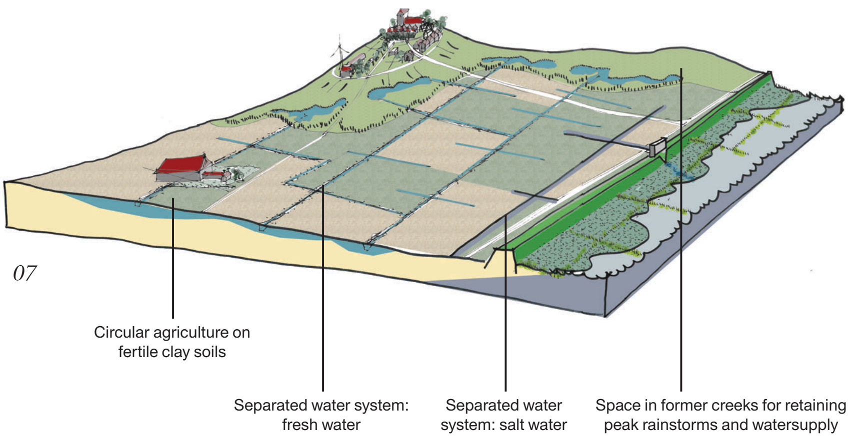
05

05 Pleistocene sandy areas in the higher part of the Netherlands - Future situation



06

06 Clay polders in the north of the Netherlands - Existing situation



07

07 Clay polders in the north of the Netherlands - Future situation

CONCLUSION

With this approach it has become clear that research (through) landscape design is a valuable addition to the methods and working methods for (applied) research. This provides scope for deploying (landscape) designers in the daily practice of institutions and institutes that operate at the interface between science and application in practice.

The added value of research (through) landscape design is that it offers an approach to deal with "wicked problems" of the future (spatial) development of the Netherlands and beyond. But also because of its strategic significance for scientific research and advice. Making designs, or the "working prototypes", necessitates bringing together ('integrating') very different (results of) scientific disciplines. Applying this – via design ateliers and design principles – immediately involves a "test" of the extent to which that knowledge actually offers realistic solutions. But it also contributes to formulating new research questions from practice, where existing knowledge does not yet appear to be adequate. And thus to knowledge gaps and follow-up research. Needless to say, the Netherlands in 2120 project already proves its (great) value here, illustrated by the many follow-up projects and initiatives.

SUMMARIZING PROPOSITIONS

1. Research (through) landscape design forms the basis of the perspective "A more natural future for the Netherlands in 2120". Further development requires a sharper scientific interpretation of the method. This report is a first step in that direction.

2. There are many scientific publications on research (through) design from many disciplines and fields of science. The most essential characteristic of design is the use of creativity to bring together, interpret and apply existing insights and knowledge about landscapes under fundamental changing conditions (in space or time) that create wicked problems as at present moment.

3. Making creative leaps from the 'existing' to the 'future' and vice versa – where induction and deduction alternate – is, in my opinion, the main added value of research by design as a method.

4. Research (through) landscape design is about investigating situations that are not yet known. In other words: to creating functional prototypes of the landscape of the future.

5. The focus on landscape means positioning systems, processes and functions in their spatial context, coherence and different time and spatial scales.

6. The alternation of the combination of inventory, analysis and synthesis (abduction) in all phases of the design process efficiently leads to the right match of existing knowledge, (possible) solutions and new research questions.

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Dictionary

Delta

The International Space Station was flying 255 miles above the border between Sudan and Egypt near 1 a.m. local time when an Expedition 60 crewmember photographed this oblique view of the Nile River and its delta.. Image by NASA, September, 2019.

Cornelia Redeker

Delta (noun) /ˈdeltə/ [1]
- the fourth letter of the Greek alphabet
- a change in a figure or amount
- an area of low, flat land, sometimes shaped approximately like a triangle, *where a river divides into several smaller rivers before flowing into the sea.*

Deltas, in all their variations, are originally dynamic landscapes shaped by natural morphological transformations. They are defined by the transition of tributaries flowing towards the river's main bed to becoming an estuarine landscape with brackish lakes and a myriad of river branchings that eventually discharge into the sea. When we look at deltas, readable in any cartographic depiction as a triangular geometry, we are usually looking from a planar, birds-eye perspective. This fails to depict the slope of the river, but also its geological layers in its transition from land to sea. One of our most complex and vulnerable ecosystems is defined by flows and constantly changing gradient edges in a three-dimensional, rhizomorphous mesh. The salty waters of the sea are held back by the pressure of the current that is in turn produced by the given topography of a gradually declining slope towards the sea that moves the river's freshwater and nutrients to saturate and fertilize the landscape. The brackish zone between the river and the sea can be seen as the delta's highly productive edge expanding to become its own biome. Deltas differ according to the respective climate zone and geology which, along with their degree of urban and industrial development, also define their varying vulnerability to sea level rise and saltwater intrusion.

Deltas are sites for urban and port development, industrialized agri- and aquaculture and, in the case of the Nile, land reclamation of its lakes and into the adjoining desert to extend agricultural land. As low-lying lands, they are also the most vulnerable in terms of sea level rise both in terms of saltwater intrusion and urban exposure consequentially leading to large-scale migration. In their current state, river deltas can be seen as an amalgamation of industrial misconception and a barometer for the state of urgency we are in. Transhemispherically, this shows in our reliance on food imports, expected increase in displacement due to sea level rise, hurricane induced storm surges and our overall incapacity to curb our ecological footprint to mitigate adverse impacts of climate change in time to avoid Armageddon. Beyond the threat from the sea and a decrease in self-sufficency, deltas are at the end of the line and thus strongly defined by the hinterland and the way the river has been anthropogenically transformed upriver. The way we have engineered different river segments to become industrially productive through large-scale hydrological transformations have turned the softness, unpredictability and autarky of dynamic river landscapes into ones exposed to exterior forces aiming for longitudinal and latitudinal control of velocity, expansion and water level. Channeling riverbeds to accelerate and deepen the water channel for the sake of transshipment, the enablement of urban expansions into the flood plain and the erection of waterpower plants by building dams across the river to produce energy have largely destroyed the river's wetlands and deltaic ecosystem, with its abundant biodiversity reliant on seasonal dynamics to nurture itself and, in that way, us. Before the industrialization of our rivers, silt deposits were producing the most fertile soils. The rivers high water levels covered adjoining flood plains during phases of heavy rains or the melting of snow in the mountainous regions upriver. Ironically, it is exactly this hybris of supposed control that is now backfiring so hard on our river landscapes, and, at the transition to the oceans and seas, their deltas, as their final and most vulnerable segment regarding the adverse impacts this has produced across all sectors.

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1 Cambridge Dictionary, © Cambridge University Press 2020.

Delta (noun) /'deltə/ [1]
- the fourth letter of the Greek alphabet
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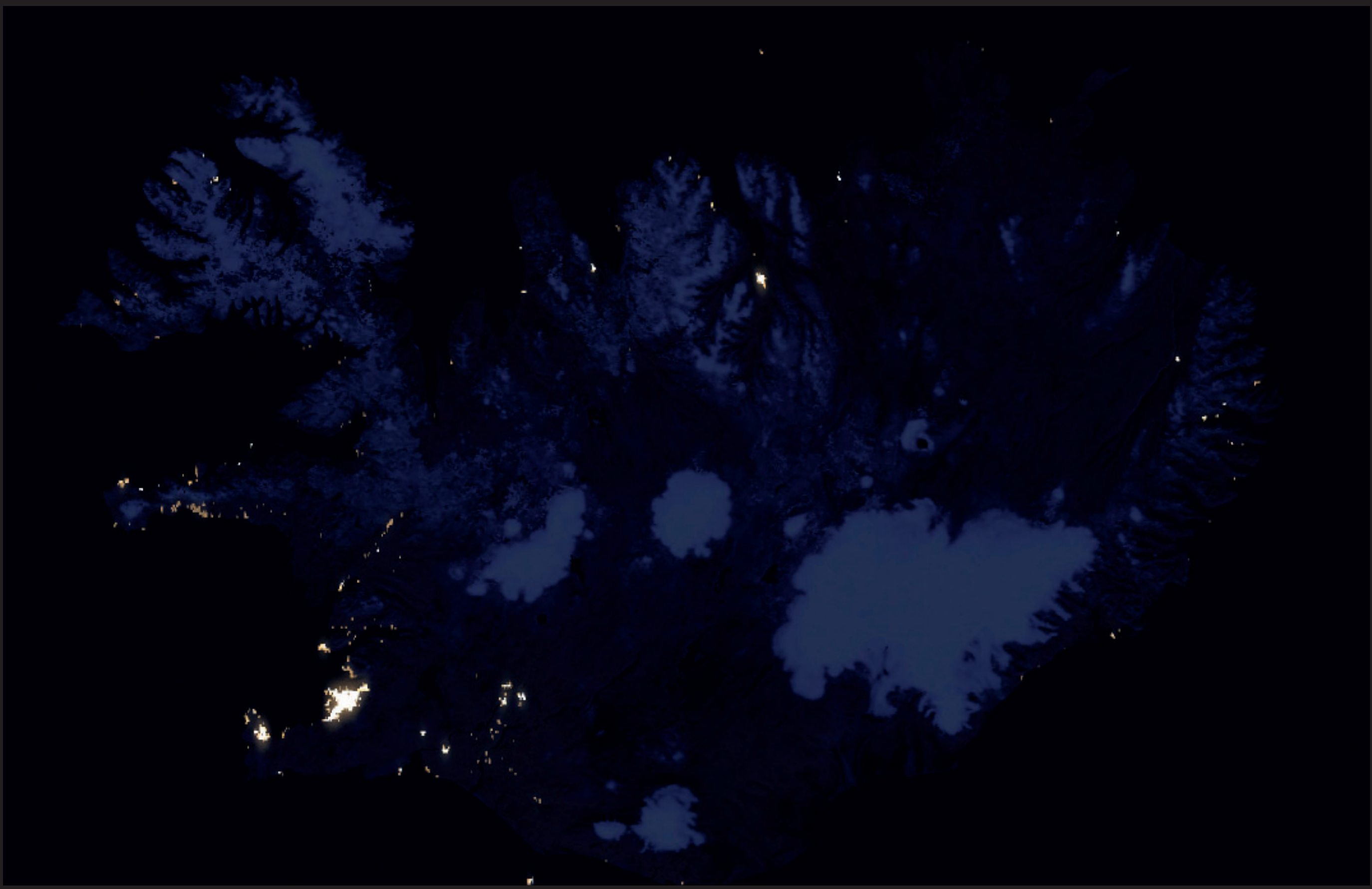
- an area of low, flat land, sometimes shaped approximately like a triangle, *where a river divides into several smaller rivers before flowing into the sea.*

Beyond niches, human-centric path dependencies are forcing us to continue with hard engineering to protect economic values of urban, port and industrial development against sea level rise and river floods while producing hydro power. As we carry on compensating a deprived landscape with fertilizers, the degeneration of the delta's inherent capacity to function as an ecosystem that is able to nurture itself and us continues.

Urbanism



Nighttime lights how the Icelandic landscape influences where people live. Image by NASA, May, 2017.

Giambattista Zaccariotto

Urbanism (noun) /3..bən.I.zəm/ [1]
- the type of life that is typical of cities and towns
- the process by which more and more people leave the countryside to live in *cities and towns*

Effecting city and territory transformation is the restructuring of the economic, social, and environmental systems. And in turn, the modification of city and territory defines physical conditions within which economic, social, and environmental systems can take on virtuous or perverse directions.

The term urbanism indicates a form of knowledge about the intentional construction and modification of the `physical´ city, its form, functioning and significance. Urbanism is the result of centuries-long critical and reflective process through making plans, projects, policies and historiographies. Out of this process, a body of ideas and concepts accumulated.

Over time ideas and concepts have persisted, renewed or innovated as to respond, in context, to changing urban questions. The history of urbanism is not a matter of succession or replacement of one concept by another, rather is a matter of accumulation of variety.

Focusing on the role of the project as a design-based critical and reflective process, five ideas of project emerged from recent and relevant EU experiences: exploration, interaction, integration, strategy, and curatorship.

Exploration

Demonstrated is the value of the project as a fundamental tool for constructing knowledge about the world we live in and not just as a simple vector of existing knowledge. In the context of a critical and reflective design-based process, ways of knowing are linked with modes of work; describing, i.e. classifying, that is about naming variety and change of things and images (ideas). Analyzing, i.e. taking things apart into various kinds of elements, is about specifying the composition of the `known´; experimenting, putting together elements is about understanding the effects of a new phenomenon. Key are visual forms of communication. Through these concrete operations, abstract concepts are invented or imported; differently from other fields such as literature or music, concepts in urbanism are materialized, i.e. turned into physical spaces that support movement and actions.

Interaction

The designerly exploration and spatial response to complex urban and territorial issues - economic, social and environmental - engages a plurality of actors with their interests, views of the world, values (images) and actions. Contextual knowledge is produced during classifying, analyzing and experimenting. Information about participants' reaction get back to the same participants (feedback), allowing for clarifying conflicting and aligning interests and views. For example, the construction of experimental projects places the different actors in relation to possible consequences of their actions or non-actions. The circularity of the design process as inquiry and sensemaking moves away from the confidence in the `pre-vision' that defined the modernist, it is a search for what a possible.

Integration

The response to complex urban and territorial issues - economic, social and environmental – through projects in the context of a shared vision, uncertainty needs to be reduced and actions realized within a predictable time and budget. This requires integration. The project links and coordinates actors affiliated with administrative sectors and private organizations with the city playing the role of coordination, selecting strategic areas and strategic projects and their

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Urbanism (noun) /3..bən.I.zəm/ [1]
- the type of life that is typical of cities and towns
- the process by which more and more people leave the countryside to live in *cities and towns*

sequence in time, mobilizing `experts´, resources and promoters, and searching alignments of view, interest, budget and language. The project combines all `materials´ - landscape, infrastructure and architecture – in coherent wholes, seeking renewed forms of aesthetic, social, economic and ecological coherence on several scales.

Strategic

The term strategy is composed of two ancient Greek words,

`army´ and `lead´, `conduct´, origin in the military field of knowledge. Applied to urbanism and construction plans, projects or policies for the city and territory, the term strategy refers to both spatial and temporal dimensions of action. Strategy becomes, then, a matter of selecting certain actions in certain places to modify the city's spatial structure, selecting the timing and sequences for implementing the projects and identifying the kind of spatial relationships that the same projects will establish within their direct context and with a broader urban milieu. Strategic projects aim at transforming selected situations of the city or territory, which interplay serves as levers of a far-reaching renewal of urban or territorial parts. Each of these choices are made within specific economic, social and political conditions that the strategy puts to the test.

Curatorship

Today the cultural context in which the project situates is constituted by many actors with conflicting interests, values and views of the world. This plurality of identities challenges the possibility of urbanism meeting universalistic goals historically associated with it. The question is: how the project can create carrying conditions for both urban and territorial diversity and cohesion? The disciplinary challenge is linked to the more recent idea of the project as the explorative practice of inquiring and hypothesis testing and to a renewed, more articulated role of the architect-urbanist. The prime role of the architect-urbanist / landscape-architect-urbanist is to set out spatial conceptual frameworks and to provide guidance during the selection procedures, searching for coherence among the many actors involved and seeking a shared base of support.

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N.3 | Delta Challenges under Nature-Based Solutions Perspectices
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