New Systemic Project to Solve The Issues of Sea Level Rise in The Delta Regions in Vietnam and the Netherlands

Politecnico di Torino

New Systemic Project to Solve The Issues of Sea Level Rise in The Delta Regions in Vietnam and the Netherlands

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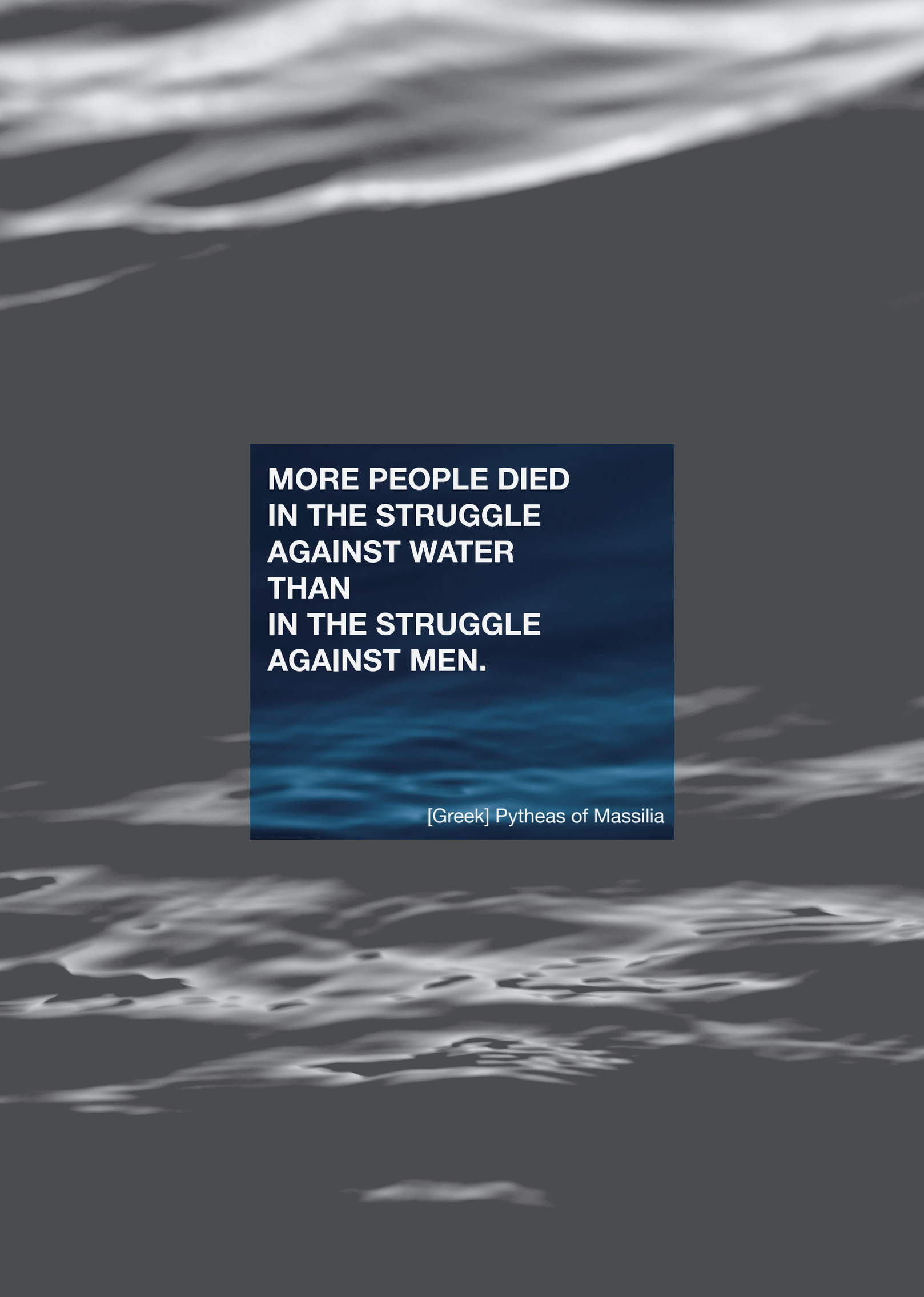

MORE PEOPLE DIED
IN THE STRUGGLE
AGAINST WATER
THAN
IN THE STRUGGLE
AGAINST MEN.
[Greek] Pytheas of Massilia

INDEX ○

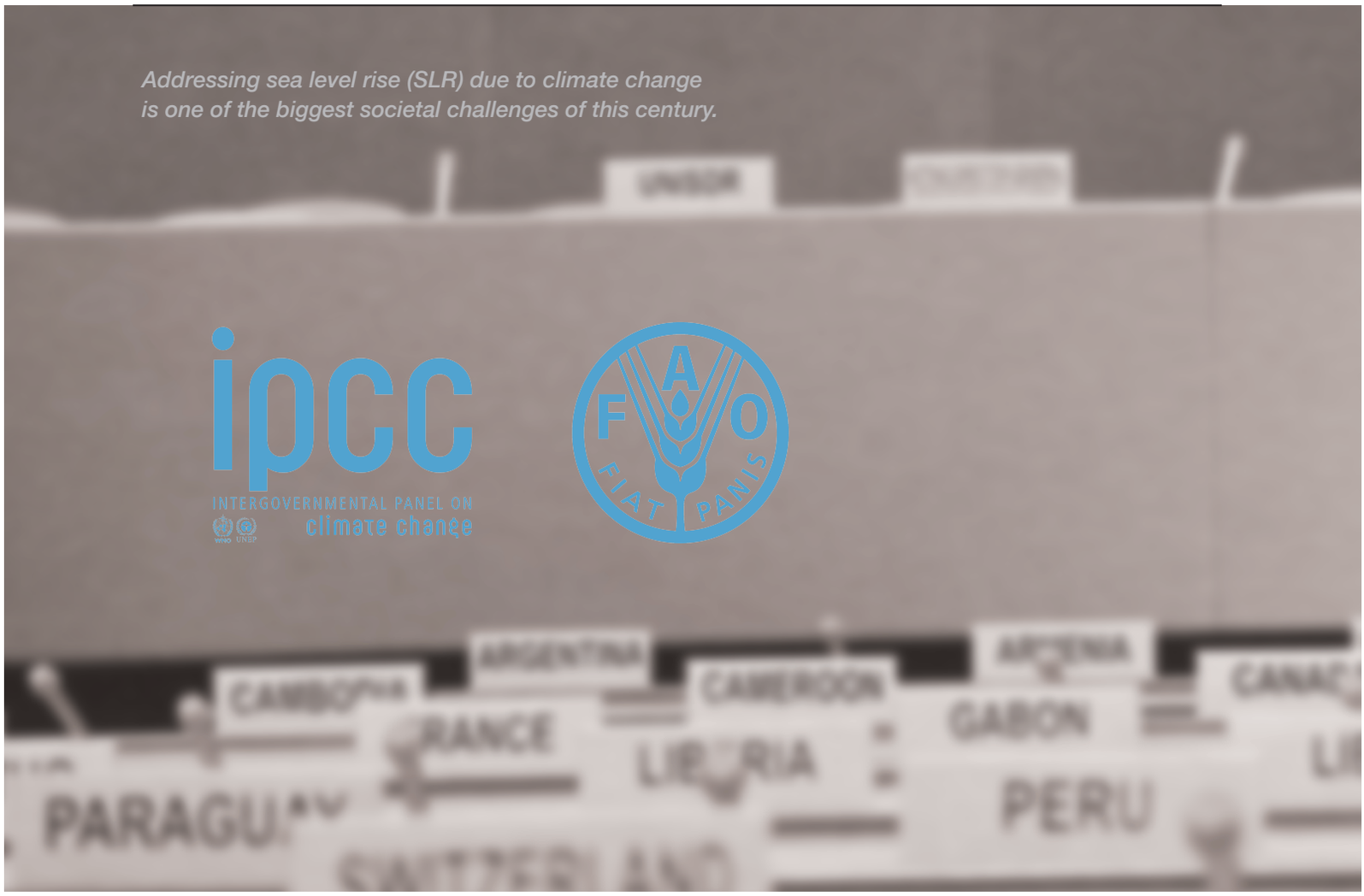
INTRODUCTION ○

Sea level rise has become a global issue in the face of intensifying extreme events. How can people living in deltas combine the existing local systems, resources and technologies to cope with the problems caused by sea level rise?

Most cities in deltas around the world are currently the economic and political centers of the countries in which they are located and are home to large populations. At the same time, due to the fertile land, the deltas have been reclaimed to provide the agricultural base for the countries in which they are located. For example, the Mekong Delta in Vietnam and the Rhine-Meuse Delta in the west of the Netherlands, the Nether lands has achieved the second largest agricultural country in the world through smart agriculture and technological innovation, but also faces the risk of seawater intrusion in the coastal area; because of the poor economic base of the Vietnamese people, most of the local people depend on mangroves, so it has caused disruption and damage to the mangrove ecosystem.

■ In the Netherlands, we realized the establishment of a vacant rooftop farm system by applying systemic thinking linked to the Dutch Diamond Program to promote local urban green and urban agriculture and provide new ideas for local systemic agricultural production models.

■ Through holistic and systematic analysis, we developed a nature conservation approach based on Can Gio, Vietnam. Through manual reinforcement and digital monitoring, combined with the help of the government and organizations, new opportunities will be created for the conservation of Vietnamese mangroves.



What the dilemma we are facing ?

According to the IPCC Special Report on Oceans and Cryosphere in a Changing Climate, global mean sea level (GMSL) rose by 17 cm in the 20th century and this phenomenon is accelerating.

IPCC Special Report on Oceans and Cryosphere in a Changing Climate (2019)

Globally, 5.67 billion hectares of land are experiencing biophysical degradation, with 1.66 billion hectares of agricultural land (29% of all degraded areas) already affected by human-induced soil erosion, soil nutrient depletion and increased salinity, and 4.026 billion hectares of land degraded naturally or by human activities. Coastal areas are more vulnerable to disasters such as coastal erosion, storm surges, salt water intrusion, and land salinization due to factors such as climate change and sea level rise.

The Food and Agriculture Organization of the United Nations (FAO, 2021)

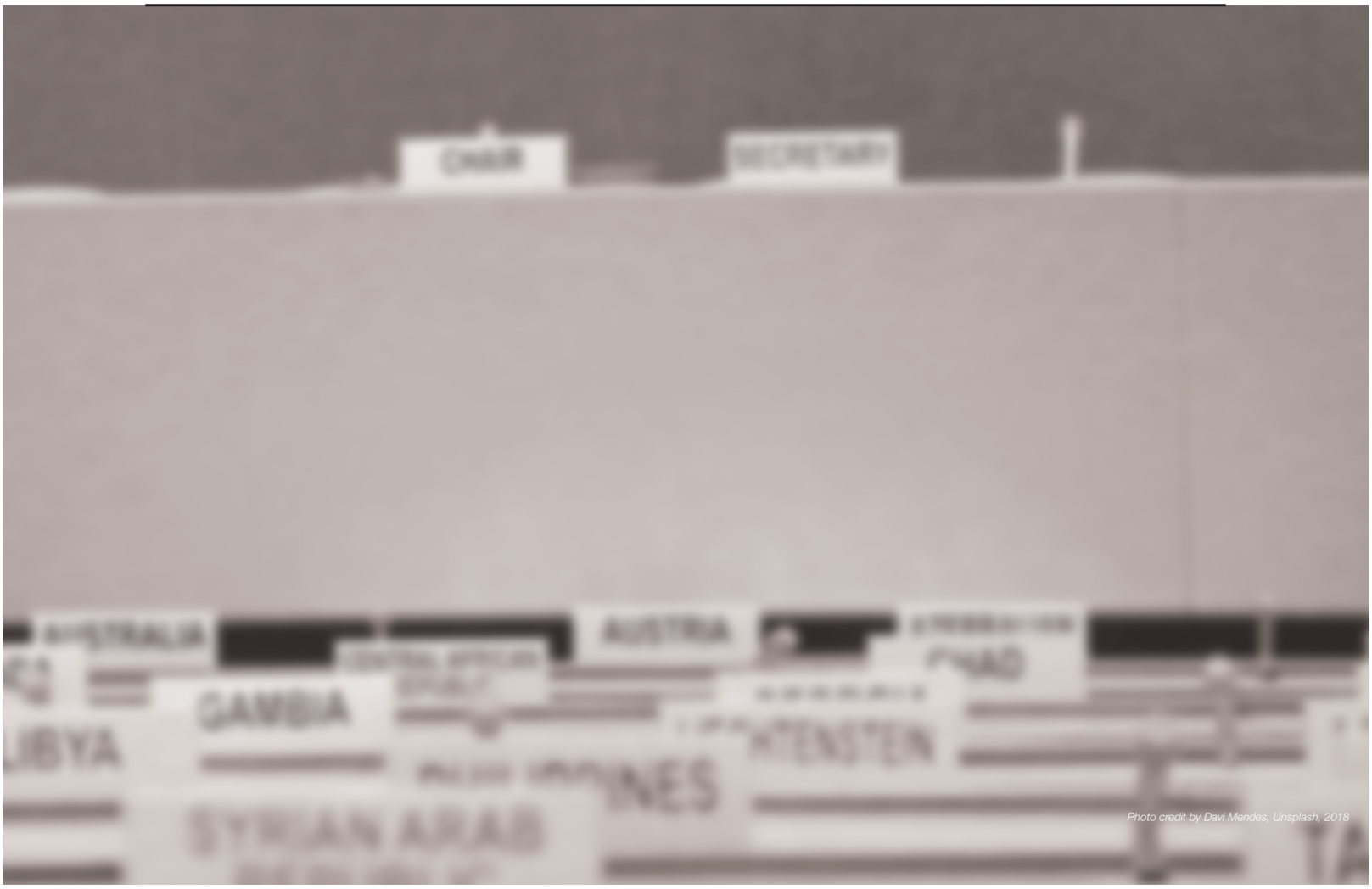


Photo credit by Davi Mendes, Unsplash, 2018

Risks to coastal areas from rising sea level

Permanent & short-term inundation

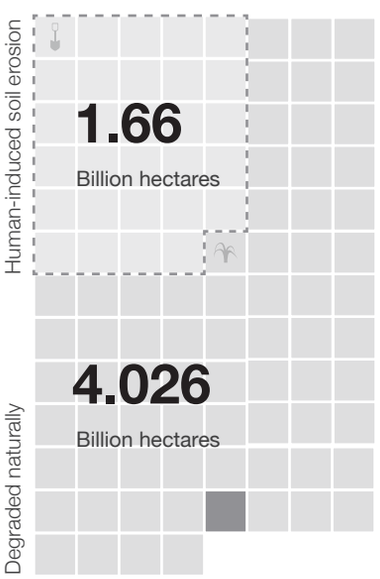
Salinization of soils & aquifers

Disruption of coastal ecosystem functions

The destruction of these ecosystems

Alteration of natural drainage systems

Proportion of natural degradation and human-induced soil erosion



5.67 Billion hectares

Global sea level rose by 17 cm in the 20th century.

17 Centimeter

Global sea level rose by 17 cm in the 20th century.

110 Million

People living in low-lying areas will face coastal hazards by 2050.

I METHODOLOGY ○

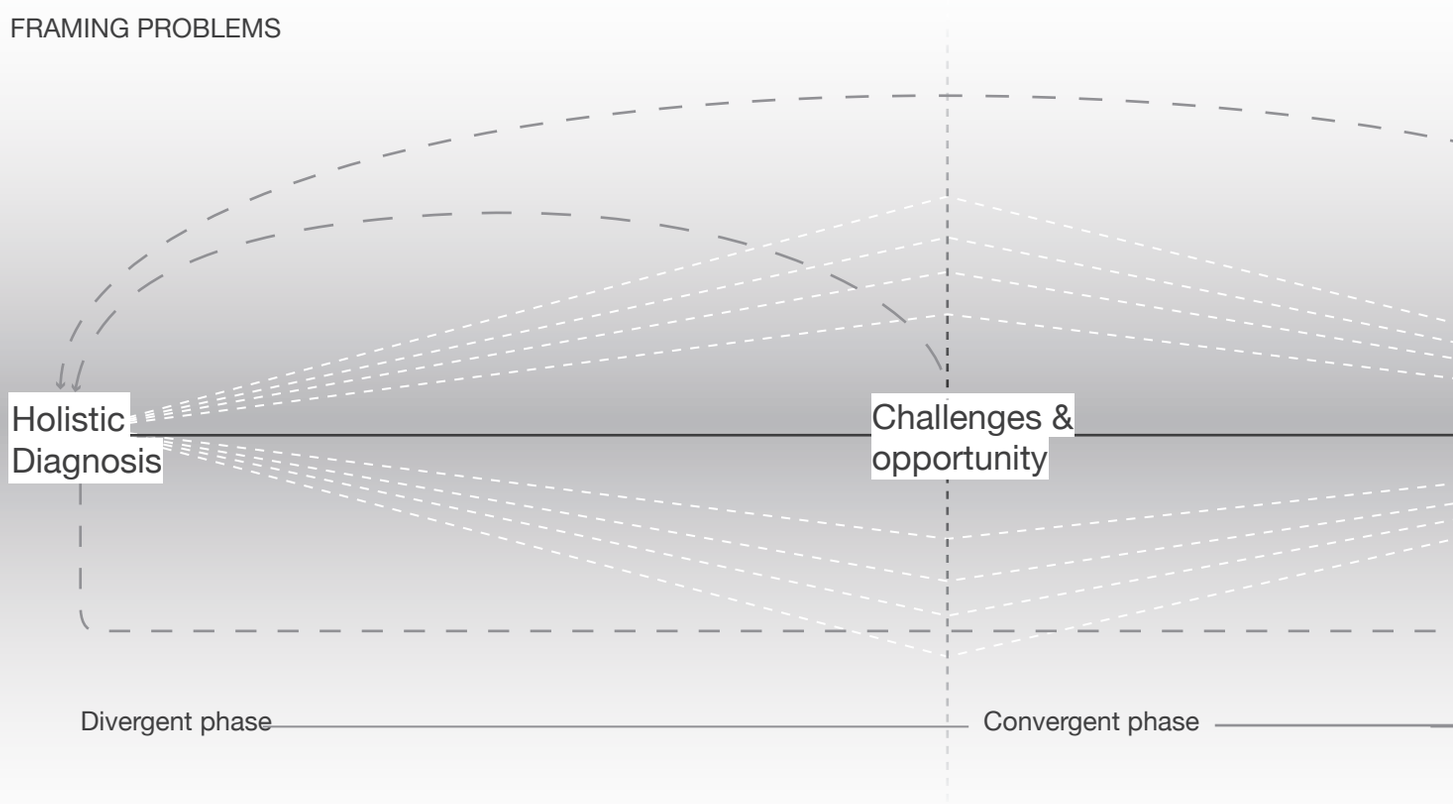
1.1 COMPLEX SYSTEMS .

Systemie Design is design discipline that provides practical tools to approach complex scenarios with holistic perspective while supporting active cooperation among the involved stakeholders(Battistoni et al,, 2019). "Complex systems" are described as non-linear, self-organising and emergent, operating in a complex reality (Barbero & Bicocca, 2017), The methodology of systems design is based on the interconnectedness of things themselves, managing each other's solutions. It is not an isolated thing, it is influenced by the local economic, environmental and social context of the time, integrating resources in order to enhance the identity of the local culture and generate development and collective well-being (Bistagnino, 2009).

1.2 SYSTEMIC DESIGN IN COMPLEX SCENARIO .

System design relies on complexity theory as a management approach and on design methods for project planning.

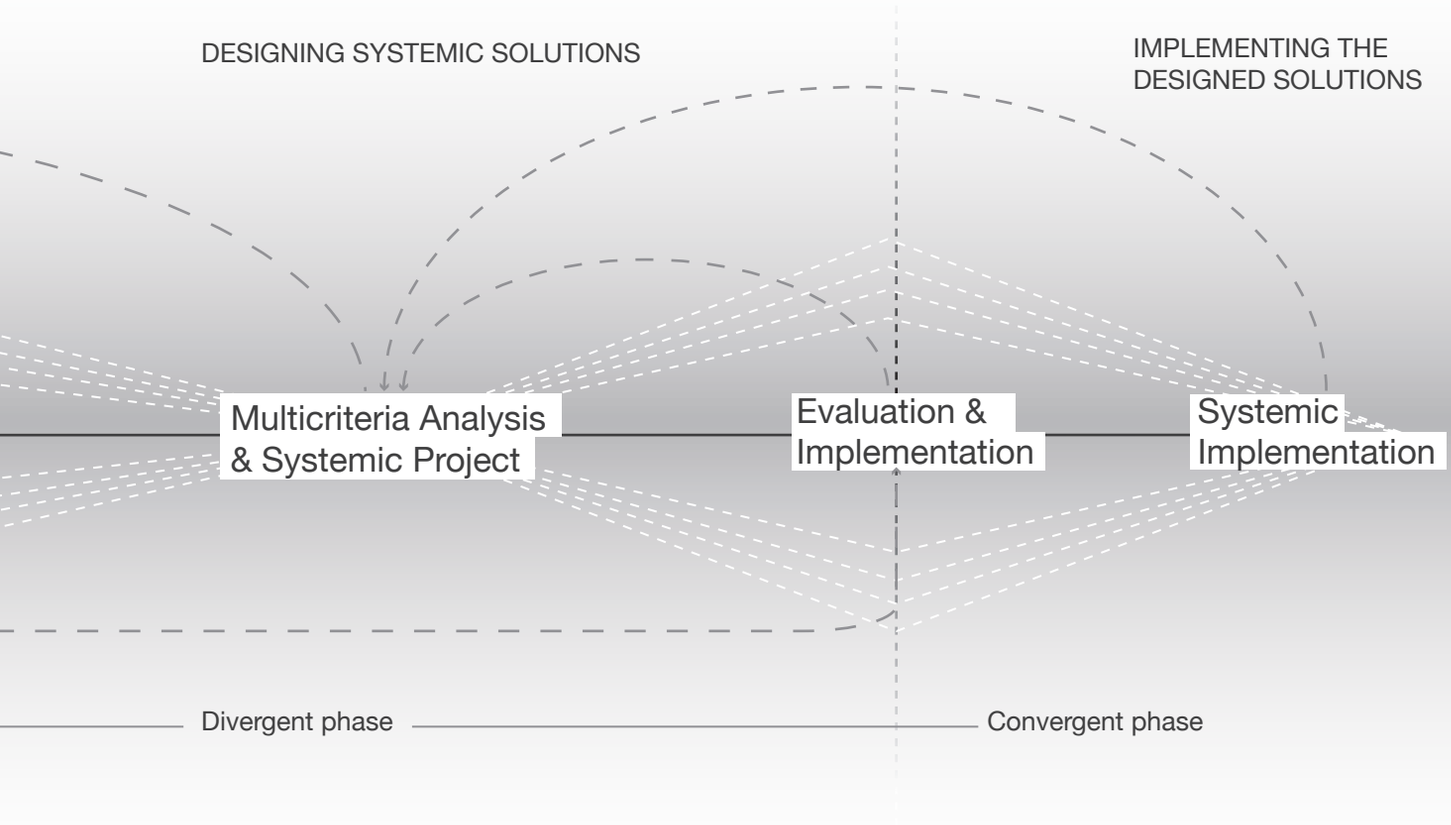
Graph1. Systemic Design to address complex systems



1. Holistic Diagnosis

The first step in the system design methodology is the holistic diagnosis. It requires a two-part holistic diagnosis, one for the area where the case is being analysed, as a local background check to understand the direct relationship and links to the case, and the other as a holistic diagnosis for the case itself or for the specific company. In this thesis, we have slightly fine-tuned the overall diagnosis by starting with continents, then moving on to countries and finally to regions.

In order to complete the diagnosis, we needed to first define the objectives and scope of the study, or rather explore themes and categories. Searching for existing cases and relevant methods to study and give an evaluation, and finally visualising the results and aligning the interpretation, we call this diagram Gigamap.



2. Challenges and opportunities

Combined with a holistic diagnosis of the preamble and supported by existing literature and practice, there are multiple potential opportunities for each critical element. The analysis within the area overlaps and interconnects so that the challenges become the starting point for value creation and new areas. In this step we can gain a clear picture of the challenges for the area in the existing context.

When we analyse the case in question again individually, we will arrive at some more solid recommendations that provide an achievable framework for the subsequent realisation of the solution.

3. Multicriteria Analysis and Systemic Project

The identification of opportunities needs to be selected through Multicriteria Analysis so that systems engineering can be driven.The multi-criteria analysis provides tools to assess opportunities and even relates to the five system design principles and the holistic diagnostic view.

After passing Multicriteria Analysis will be evaluated and selected to contribute to the development of strategic proposals so that action can be taken regarding the potential potentials that have been identified. The proposals are the result of a design creativity exercise and must undergo a validation process before the results of the system can be determined so that they can be implemented.

4. Evaluation and Implementation

This section is the last and the summary of the results, which needs to be carried out in three areas. The first requires a quantitative and qualitative evaluation of the impact, of the project in its different dimensions (micro, meso, macro) and on different time scales (short term, medium term, long term). This stage requires consideration of the environmental, social, economic, logistical and communication aspects in order to obtain a comprehensive understanding of the possible impacts. At the end this new set of strategies will give the actors involved in the implementation of the new strategies.

Multicriteria Analysis

SD Principles

OUTPUTS > INPUTS

The output (waste) of one system becomes the input (resource) of another, thereby increasing economic flows and new jobs.

RELATIONSHIPS

The relationships established generate the system itself. Everything in the system is a strategic element, and relationships can be internal or external.

AUTOPOIESIS

Maintain and reproduce yourself autono mously, define your own field of action and develop it together.

ACT LOCALLY

The context in which it operates is fundamental and takes precedence over the outside world: local human, cultural and material resources are valued and local problems are solved by creating new opportunities.

HUMAN-CENTRED DESIGN

The people associated with their environmental, social, cultural and ethical context are at the heart of the project. The result is a dynamic, complex system of relationships that gains a strong cohesion and awareness through connections, and thus the self-generating power of all the actions implemented.

HD Insights

ENHANCEMENT OF TERRITORY AND CULTURE

analysis of the possible relationship between opportunities and local culture.

LOCAL STAKEHOLDERS INVOLVEMENT

The main players on the island who could be involved in the new Cypriot agri-food system.

FUNDS AND POLICIES FOR THE SECTOR

to understand whether it is possible to develop new business models in the area that could yield many advantages.

II HOLISTIC DIAGNOSIS ○

Addressing sea level rise (SLR) due to climate change is one of the greatest societal challenges of this century.

According to satellite monitoring, by the beginning of this century, Vietnam's SLR was higher than the global average. Between 1993 and 2014, the average increase was 3.3mm per year. Phu Quy had the highest rate (5.5mm/year) and Hon Ngu dropped to 5.7mm/year.In the case of no intervention in today's carbon emissions, the sea level in the sea near Vietnam will rise by an average of 25 cm by 2050 and by an average of 73 cm by 2100(Ministry of Natural Resources and Environment [MONRE], 2016).

Since 1900

21 *cm*

Sea levels rising

0.13 *in/year*

By 2100, GMSL could rise by 0.28-0.55 m under very low emissions scenarios (SSP1-1.9) and 0.63-1.02 m under very high emissions scenarios (SSP5-8.5), relative to the average 1995-2014 value.

Sea levels have risen more than 8 inches since 1880, including 3 inches between 1997 and the middle of this year.Greater concentrations of greenhouse gases amplify the Earth's natural greenhouse effect, causing the planet to gradually warm. The most direct result of this is the rapid rise in global sea levels. Faced with such a situation, the earth has adjusted itself, the world's oceans absorb more than 90% of the heat from these gases, but this behavior is taking a toll on our oceans.

Low-lying coastal areas are one of the most vulnerable areas affected by climate change. We selected three large areas as the research area, namely the South China Sea and the Eastern Sea. The reason we choose these three regions is that these regions contain different economies, different political bodies, and different terrains.

World's 33 megacities
(***more than 10 milion people***)

22

Megacities are low-lying coastal cities

Live in low-lying coastall areas

680

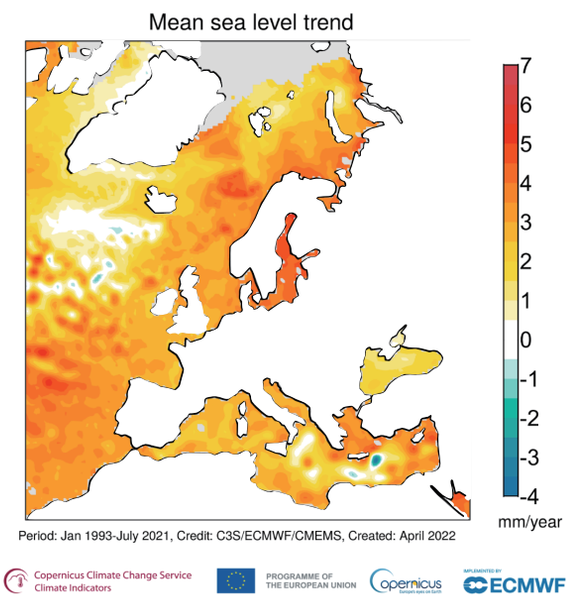
million

While more destructive short-term extreme climate events such as tropical storms, El Niño, and La Niña occur from time to time and cause greater damage in the short term, sea level rise is a long-term permanent change of state (National Oceanic and Atmospheric Administration[NOAA], 2016). However, changes in ocean dynamic conditions resulting from sea level rise can also have harmful impacts on land combined with other hazards, such as wave action breaking dikes, seawater intrusion, etc., or loss of ecosystems. Hundreds of millions of people could be displaced due to the impact of rising sea levels, leading to the inundation of major cities, loss of coastal infrastructure, increased saltwater intrusion, and damage to coastal aquifers, among many other effects.

2.2 EUROPEAN

HISTORICAL SITUATION .

Figture5. Sea level trends (mm/year) from January 1993 to July 2021 in shades of blue (from -4 mm) to red (to +7 mm).

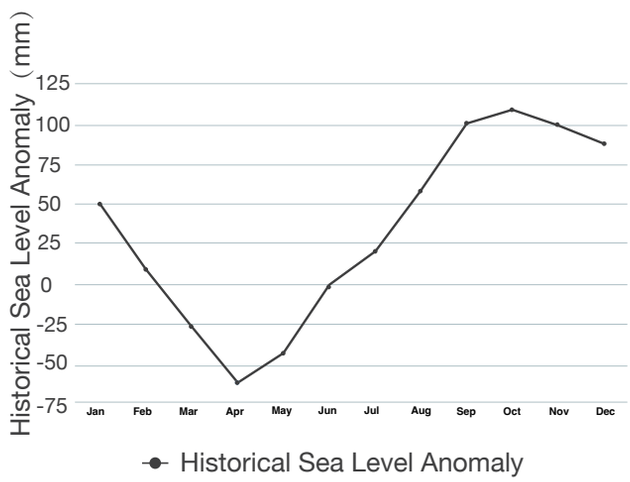


With the exception of the northern Baltic coast, sea levels are rising relative to land in most coastal regions of Europe. Both absolute sea level (measured by satellites) and relative sea level (measured by tide gauges) are rising in most European coastal areas, the latter being more relevant for coastal protection. There is considerable variation in the rate of sea level change across Europe. It is worth noting that, relative to the sea level of the land along the northern coast of the Baltic Sea and a small part of the sea level along the coast of the North Atlantic Ocean, the sea level is sinking. One of the reasons for this phenomenon is that the land height in some coastal areas is rising due to the vertical movement of the coastal land.

"1.2 to 2 Meters (3.3 to 4 Feet) of Sea Level Rise over The Next 79 Years."

the Netherlands Meteorological Institute (KNMI)

Figure6. Historical Sea Level for coastal Netherlands (1993-2015)



Climate change in the Netherlands has already affected the country. From 1906 to 2017, the average temperature in the Netherlands increased by almost 2 degrees Celsius (KNMI, 2022). The Netherlands ranks 1st in the EU in per capita CO2 emissions Fourth. These changes lead to an increase in the frequency of droughts and heat waves. Since most of the Netherlands has acquired land through land reclamation, the height of the land is very close to the sea surface, so the Netherlands is very vulnerable to sea level rise. The Netherlands is very sensitive to the impact of sea level rise. The climate change response has been driven by a number of idiosyncratic factors, including a larger green recovery plan in the EU in response to COVID-19 and climate change litigation, State of the Netherlands v. 25% of emissions to mandate climate change mitigation. By the end of 2018, CO2 emissions had fallen by 15% compared to 1990 levels. The Dutch government aims to reduce emissions by 49% by 2030(KNMI, 2019).

TERRITORY .

The Netherlands is low-lying, on the delta of the Rhine, Ijssel and Meuse rivers, with about 26 percent of its land below sea level (Netherlands Board of Tourism & Conventions, n.d.) .The highest point is 321 meters above sea level, bordering Belgium and Germany, and the lowest point is 7 meters below sea level. The surface area of land, plus inland and coastal waters, totals 41,543 square kilometers. The land area is 33,680 square kilometers, of which 54% is agricultural land.

There has been some reduction in agricultural land due to increased land use for housing and infrastructure. The Netherlands is a densely populated country with a population of over 17.4 million people (2020), with a population density of approximately 507 people per square kilometer in 2017. The climate in the Netherlands is expected to change significantly in the coming decades. Foremost among these is the effect of heat stress, with increased risk of flooding due to more extreme river discharge and sea level rise, more frequent failure of critical infrastructure such as power and IT, more frequent damage to crops or production resources, health Increased burden and loss of productivity, and changes in biodiversity.

The Dutch coastline is about 1000 km long (including all estuaries), in which the coastal area can be divided into three areas with different characteristics: the south-west with tidal inlets and islands, the centrally connected coast, the Wadden Sea coast and its islands of the northern region.

Figure7. Land use in the Netherlands

17 / 182
Notre Dame Global Adaptation Initiative (ND-GAIN)

31 / 182
ND-GAIN Vulnerability Index

15 / 192
ND-GAIN Readiness Index

109 / 180
Germanwatch Global Climate Risk Index(2000 19)

The central contiguous coast is about 350 kilometers long

75% of which consists of dune fields of varying widths, ranging from less than 100 meters to wide.

Nearly 50% of the European population lives within 50 kilometers of the coast.

85% of the Dutch and Belgian coasts and 50% of the German coast are below 5 meters above sea level.

Figure8. Flood prone areas in the Netherlands

	Dike rings	Flood-prone zone
Total area	55%	34%
Total urban area	62%	31%
Total population	67%	35%

Note: From Climatechange Post, n.d. (https://www.-climatechangepost.com/netherlands/coastal-floods/). In the public demain.

Historically, flood risk management in the Netherlands has benefited from building dikes that are high enough and strong enough to prevent flooding from happening again. Nearly two-thirds of the Netherlands is vulnerable to flooding from the sea or the Rhine and Meuse rivers, while the Netherlands' economic production is concentrated in those areas that are actually lower and below sea level, where nearly 70% of the gross national product is generated with these areas(Provide enough freshwater: WUR and delta management, n.d.). During the 20th century, the urban area in the flood-prone areas of the Dutch delta (river region + coastal region) increased approximately 6-fold. The increase in urban area in flood-prone areas led to an exponential increase in potential flood losses during the 20th century: by 2000, losses would be 16 times higher than in 1900. But catastrophic flood losses actually nearly doubled in 2000 compared to 1900 GDP and coping capacity.

CLIMATE .

Affected by the Gulf Stream, the oceanic features are obvious. The climate is mild in winter and cool in summer, with small annual and diurnal temperature ranges. Precipitation is more, evenly distributed seasonally. The annual temperature range becomes larger from west to east, and the precipitation becomes smaller and smaller. Generally speaking, the continental nature of western Europe gradually strengthens from west to east.

For low-lying deltas like the Netherlands, the possible impact of climate change-induced sea level rise is a major concern. The Netherlands is low in altitude, close to the sea, and has a mild, humid and windy climate. Summer is warm and humid(IPCC, 2019).

Figure9. Flood prone areas in the Netherlands

Between 1910 and 2009, the Netherlands saw a 25% increase in average annual precipitation, a 35% increase in average winter precipitation, and a 16% increase in average summer precipitation, a relatively strong increase since the early 1980s, with almost doubled. Most of these excesses occurred in the summer half of the year, especially with relatively strong growth after 1980, with a stark contrast found between the coast, where summer mean precipitation increased significantly, and the east and southeast of the country, where summer mean precipitation changed little compared.

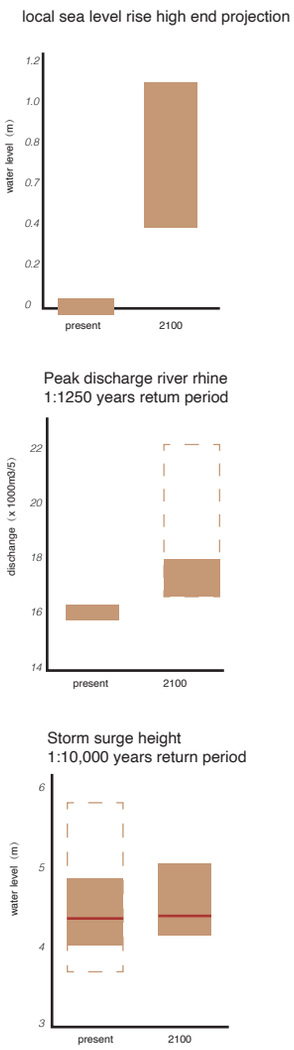


Figure10. Map of the Netherlands illustrating the combined threats of local sea level rise

Map of the Netherlands illustrating the combined threats of local sea level rise, possible changes in storm surges, and increased discharge of the river Rhine resulting from climate change on the country's food defense system along the coast (red) and along the river Rhine (light blue). The location of the port of Rotterdam is marked by a black circle. Besides the high-end scenario for local sea level rise, it also summarizes the high-end climate change scenarios for storm surge height (Sterl et al. 2008b) and peak discharge of the river Rhine (Beersma et al, 2008) for 2100. For the storm surge height, a best estimate (black line) and 95% confidence interval (red bar) are given. No significant change in extreme storm surge heights is anticipated. Note the narrowing of the confidence interval obtained by analyzing an ensemble of model simulations (solid bar) rather than observations (dashed bar) for the present-day conditions. The peak discharge of the river Rhine is projected to rise significantly due to precipitation changes over its catchment area (dashed blue bar). However, it is anticipated that uncontrolled flooding upstream, in Germany, will strongly reduce extreme discharge peaks before they reach the Netherlands (solid blue bar).

2.1 SOUTHEAST ASIA .

HISTORICAL SITUATION .

Most of the countries around the South China Sea are developing countries with large populations. Most of the economically developed areas of these countries are located in coastal areas. Rising sea levels will threaten the economies of these countries.

97 / 182
Notre Dame Global Adaptation Initiative (ND-GAIN)

126 / 182
ND-GAIN Vulnerability Index

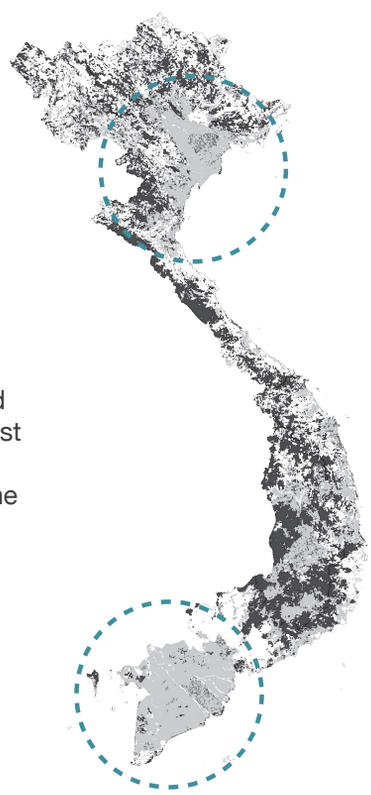
91 / 192
ND-GAIN Readiness Index

13 / 180
Germanwatch Global Climate Risk Index(2000 19)

Vietnam, one of the most vulnerable countries in the world, ranks 127th out of 182 countries in Notre Dame's Global Adaptation Initiative (Notre Dame Global Adaptation Initiative[ND-GAIN], 2022) and 180 countries in Germany Watch's Global Climate Risk Index 2000-19 13 bits. It is also ill-prepared for extreme events, heat and rising sea levels. Climate change is exacerbating the already substantial risk of riverine flooding; by 2035-2044, millions of people will be affected by extreme flooding each year. The costs of fighting climate change are already starting to dent Vietnam's growth. Preliminary calculations from the most recent Country Environmental Analysis (CEA) show that Vietnam will lose US$10 billion, or 3.2% of its GDP, in 2020 due to climate change impacts(Soumitra Dutta et al., 2020). Climate change not only negatively affects strategic sectors such as fisheries and agriculture, but also slows labor productivity growth. The exact cost is uncertain, but Vietnam's economic performance is not well reflected in national economic statistics, which often fail to account for the loss of natural and physical assets. Over the past five years, sea levels in rural Vietnam have risen by about 20 centimeters. What is clear is that sea-level rise amplifies storm surges and creates an additional threat of long-term tidal flooding. River flooding has become more severe as heavy precipitation has increased.

TERRITORY .

Vietnam is located on the mainland of Southeast Asia (Indochina Peninsula), covering an area of 331,688 square kilometers. The shape of the country is S-shaped, with a distance of 1,650 kilometers from north to south, but only 50 kilometers wide at the narrowest point from east to west(Chen et al., 2021).



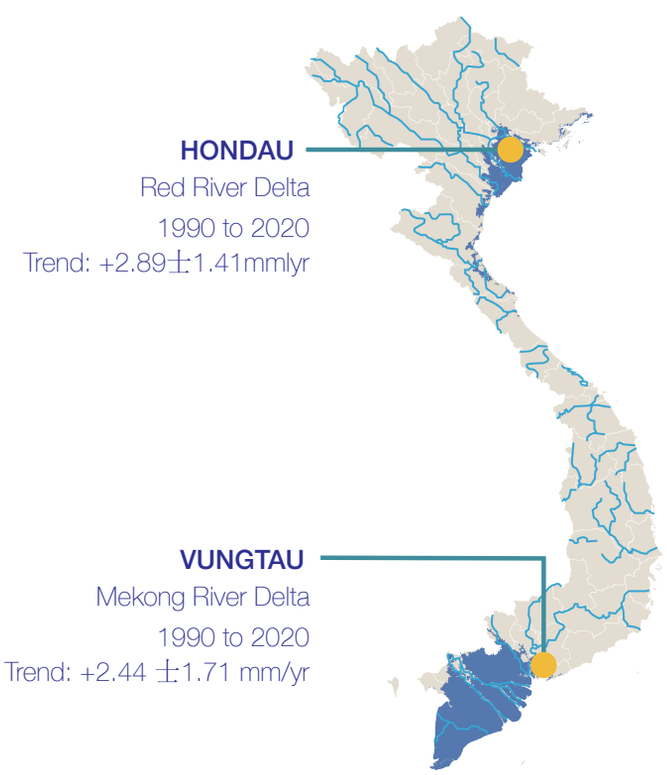
Three-quarters of Vietnam's territory consists of low mountains and hilly areas. Areas below 1,000 meters above sea level account for 85% of the country's land area. Mountainous areas above 2000 meters above sea level account for only 1%. The hills and mountains form a large bow stretching 1,400 kilometers from northwest to southeast, towards the East China Sea(Embassy of the socialist republic Vietnam[ESRV], n.d.). The highest mountains are located in the west and northwest, the highest peak Fansipan (3143 meters) is the highest in Indochina Peninsula. Closer to the East China Sea, the mountains are lower and usually end in a coastal lowlands. From Haiyun Pass to the south, the terrain is relatively simple. The long limestone ranges gave way to massive granite ranges, followed by a vast plateau behind the long mountain ranges to the east known as the Central Highlands.

Figure2. Vietnam Rural Environment And Land Use

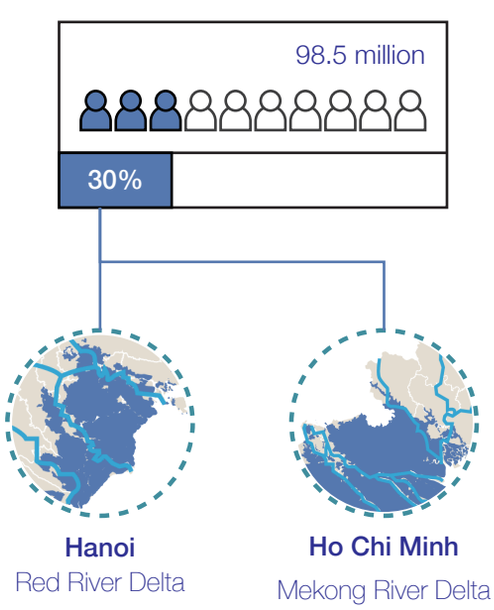
Forest Area	Arable Land 22.5%	Permanent Cropland 14.6%	Others
% of land area 47.2%	37.1%		15.7%

Dense population and rising sea level trends in the region	

A quarter of Vietnam's territory is a delta, divided into different regions by mountains and hills. Vietnam has two major deltas with fertile arable land, the 16,700 square kilometer Red River Delta (locally known as the Northern Delta) and the 40,000 square kilometer Mekong Delta (Southern Delta).



About a third of Vietnam's population lives in the Red River Delta and Mekong River Delta.



CLIMATE .

Graph3. Vietnam Climate Map

Climate trends observed in Vietnam: higher mean and extreme temperatures, lower rainfall in the north, higher rainfall in the south, and more frequent dry season droughts (Anh Ngoc Le et al., 2022).

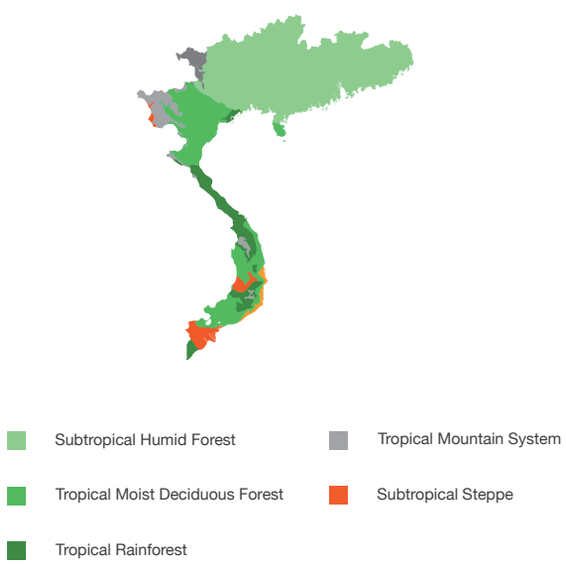
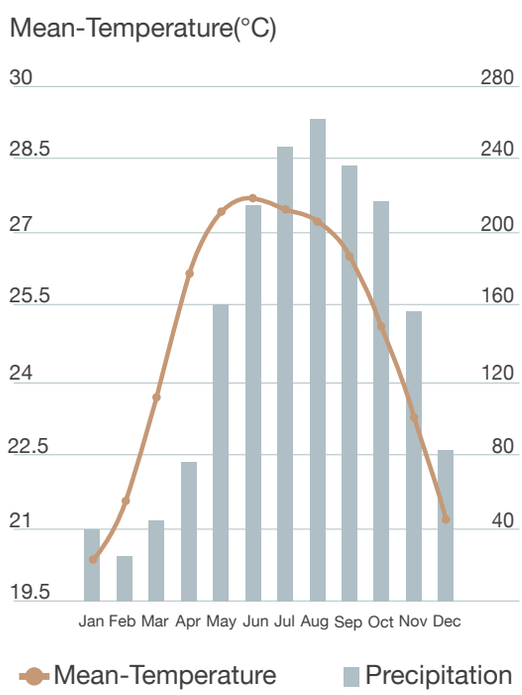


Figure4. Climate Vietnam average data within one year

The climate trends observed in Vietnam follow global trends: higher average annual temperatures and extremes, less rainfall in the north, more rainfall in the south and more frequent droughts during the dry season.



Affected by the terrain, the average annual temperature in the plains is usually higher than that in the mountains and plateaus. In the plain area, in the coldest December and January, the minimum temperature is only 5°C; while in the hottest April, the maximum temperature exceeds 37°C. But in some highlands, the seasonal changes are not obvious, and the temperature is between 21°C and 28°C all year round. The climate in different latitudes is also slightly different, and the seasonal differences in the northern half of Vietnam are more obvious than in the southern half.

In winter or dry season, generally from November to April, the monsoon usually blows from the north-east along the coast of China and across the Gulf of Tonkin, driving away a lot of moisture; therefore, winter in most parts of Vietnam is shorter than summer and rainy season Said to be relatively dry.

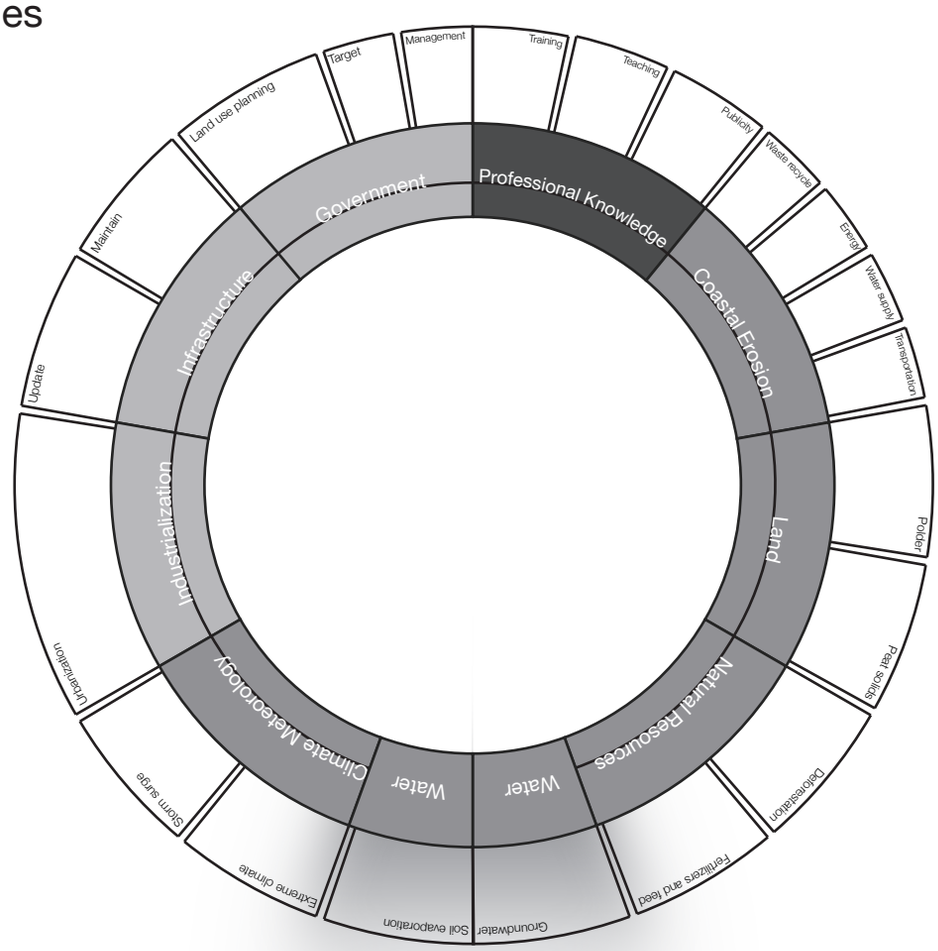
The summer monsoon, which occurs from May to October, blows moist air inland from the Indian Ocean in the southwest, bringing abundant rainfall. Annual rainfall across Vietnam ranges from 1,200mm to 3,000mm, nearly 90% of precipitation occurs in summer(Climate Change Knowledge Portal. n.d.).

III CHALLENGES & OPPORTUNITIES ○

In the area we selected, the Netherlands and Vietnam are also closer in terms of land composition, the vast plains are mostly deltas and both are facing severe threats of sea level rise. At the same time, the two countries are also big agricultural countries in the world. The Netherlands is the second largest exporter of agricultural products in the world after the United States. In 2020, the export value of Dutch agricultural products will be 95.6 billion euros (Horbach, 2021), Vietnam’s agricultural exports in 2020 will be worth US$41.2 billion (Truong Thi Quynh Van, n.d.). Agriculture is the pillar industry of these two countries, and most of the agricultural land is concentrated in the coastal plain delta area, so we chose these two countries as the follow-up research objects. As an island country in North America, the Bahamas's pillar industries are tourism and finance, and there are few rivers and lakes in the territory, so it is not suitable to continue to be the research object related to agriculture.

Through research, we found that sea level rise will not only damage coastal infrastructure and buildings, but also cause disasters such as salt water intrusion, land salinization and other hidden disasters that cannot be directly observed , and these disasters will seriously threaten the agricultural production and development in coastal areas.

The Netherlands Challenges



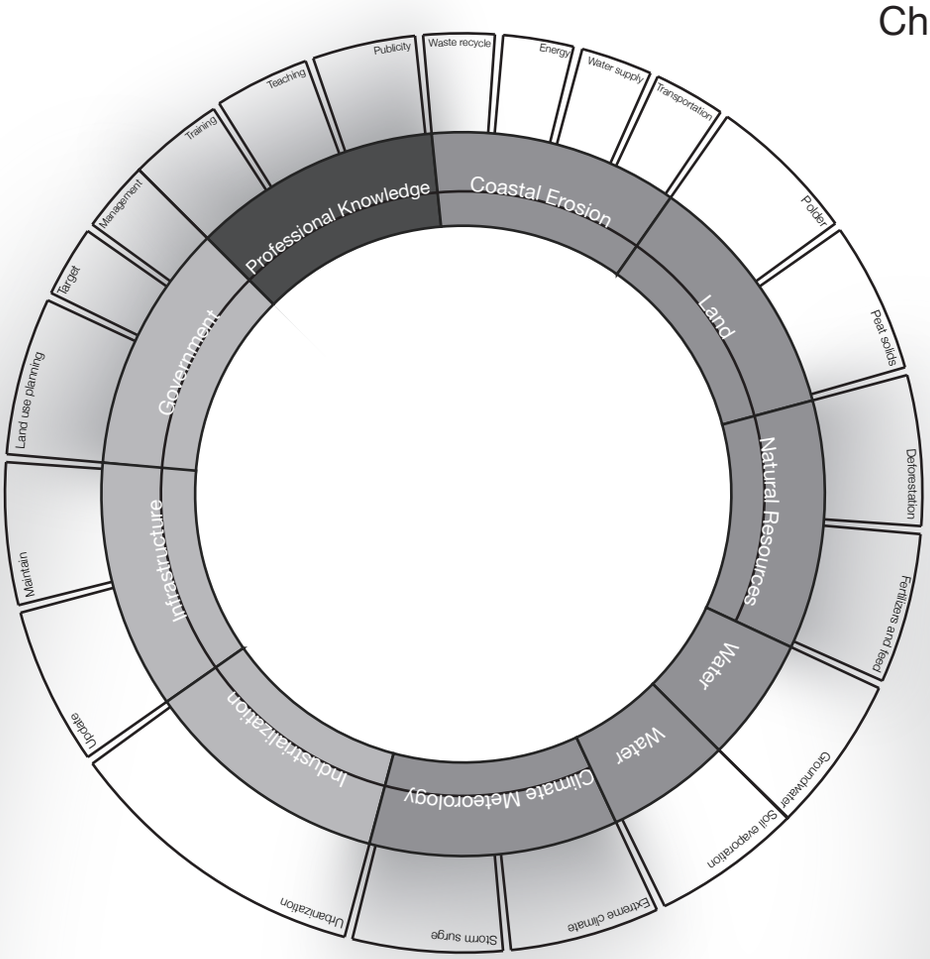
1. Low terrain
About half of the Netherlands is below 1 meter above sea level, and in many places it is even below sea level.

2. Estuarine flooding
During the European storm season, temperate cyclones bring many storms to the Netherlands. In order to avoid flooding of its territory, the Netherlands has built a lot of water projects.

3. Land subsidence
Grazing, urbanization, and groundwater harvesting have caused soil moisture loss, and thus the elevation of Dutch land is gradually declining.

4. Saltwater intrusion
In the Netherlands, 60% of drinking water comes from underground, and during the dry season all water used in areas with sandy soils comes from underground (Netherlands Water Partnership [NWP], 2007). This has led to increased saltwater intrusion in coastal areas.

Vietnam Challenges



1. Policy formulation and implementation

The Vietnamese government has established laws and regulations related to climate change, but the country's complex topography and climate change, with different problems in each region, have resulted in the inability to implement and enforce relevant issues on the ground.

2. Poor climatic conditions

Vietnam is affected by typhoons, tropical depressions and tropical storms, with heavy rainfall during the monsoon season, and the flow of the rainy season accounts for 70% of the annual flow, often leading to flooding in some less developed cities.

3. Over-exploitation of resources

Villagers privately use mangroves for mariculture and agricultural production. These activities have temporarily lifted tens of millions of local farmers out of poverty, but they have also led to the continued destruction of mangroves.

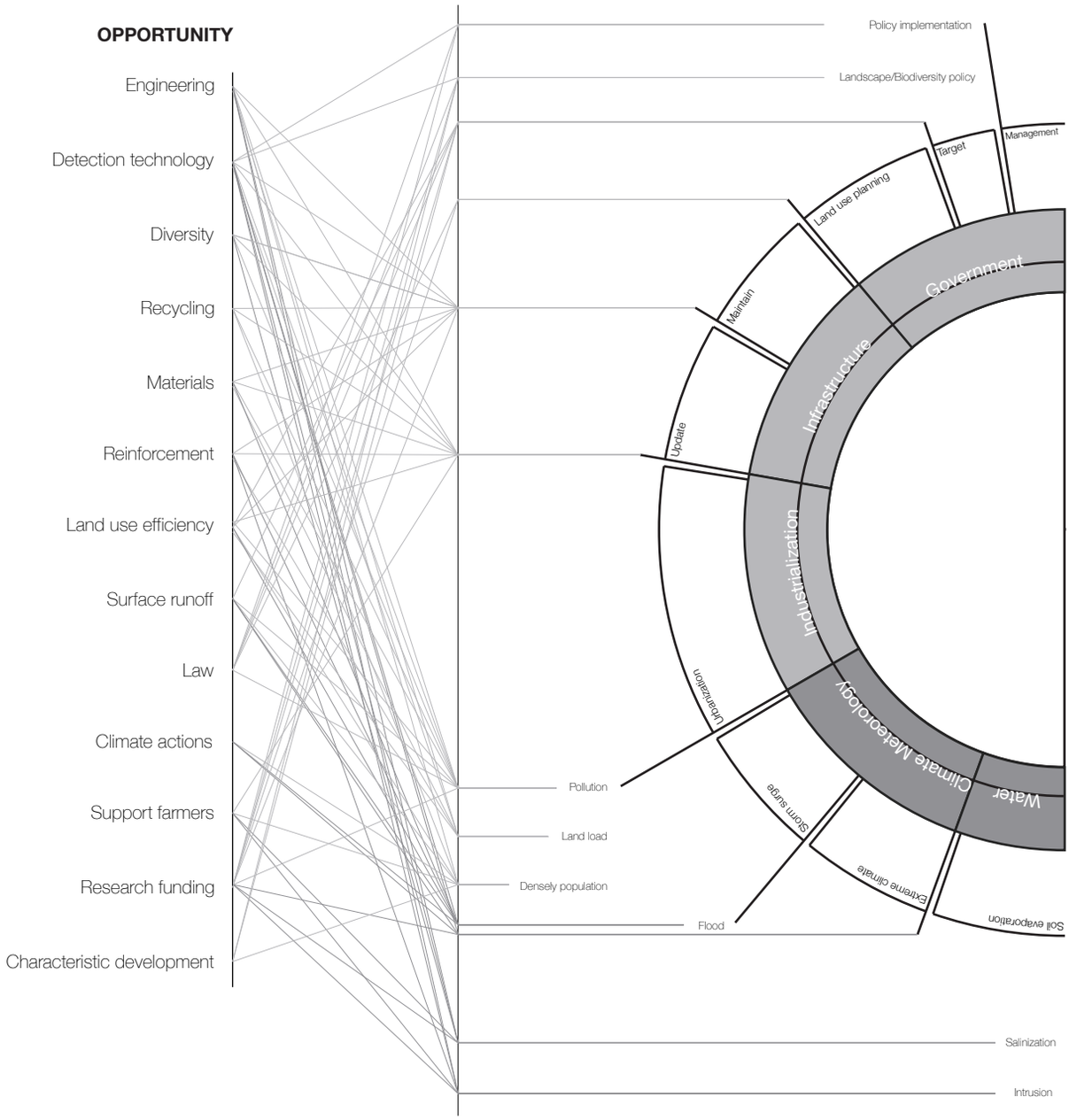
4. Insufficient education on climate change

Vietnam is in the "Golden Age of Population", but the quality of human resources is not high. The percentage of workers with more than three months of training and diplomas and certificates is only 23%-23.5% (General Bureau of Statistics. [GSO], n.d., 2018).

5.Decrease in river sedimentation

Water facilities and environmental management on both sides of the rivers in the upper Red River and Mekong River will result in a reduction of sediment and nutrients in the rivers. It not only leads to a decrease in the rate of land uplift but also affects the nutrients in the soils of the delta.

CASE STUDY	OPPORTUNITY
Maeslantkering	Engineering
Sand Motor	
The Hoa Binh Dam	
Bell Dredging Equipment	
Smart Drainage of Dutch Lowland	
NASA Data Analysis Tool	Detection technology
Remote Sensing	
SCAN-ICT system	
Electrical Resistivity Tomography (ERT)	
Watermachine	Diversity
Eendragspolder	
Floating Farm	
Room for the River	
Bali Plant Fiber Restoration Coast	Recycling
Coastal Restoration with Reefs	
MOSE System	
Sand Motor	Materials
Oyster Reefs Eastern Scheldt Pilot Project	
Amphibious housing	Reinforcement
Room for the River Regge	
Room for the River Regge	Land use efficiency
Watermachine	
Vrijburcht	
Room for the River Waal	
National Park De Alde Feanen	Surface runoff
Tràm Chim National Park	
Shrimp Agriculture Model	
Cá Mau Province	Law
Dutch Model	
The Can Gio Mangrove Biosphere Reserve	
Decision 667/QD-TTg	Climate actions
Decree No. 66/2021/ND-CP	
National Park De Alde Feanen	Support farmers
Tràm Chim National Park	
Klimaatwet(03-12-2022)	Research funding
Official funding $280 million (The Netherlands)	
Common Agricultural Policy Subsidy Programme（GLB）	
WARECOD	Characteristic development
NIOZ	
"Green Building"Seminar	
Netherlands development Organisation (SNV)	
The Afsluitdijk	



Challenges

1. Low terrain

About half of the Netherlands is below 1 meter above sea level, and in many places it is even below sea level.

2. Estuarine flooding

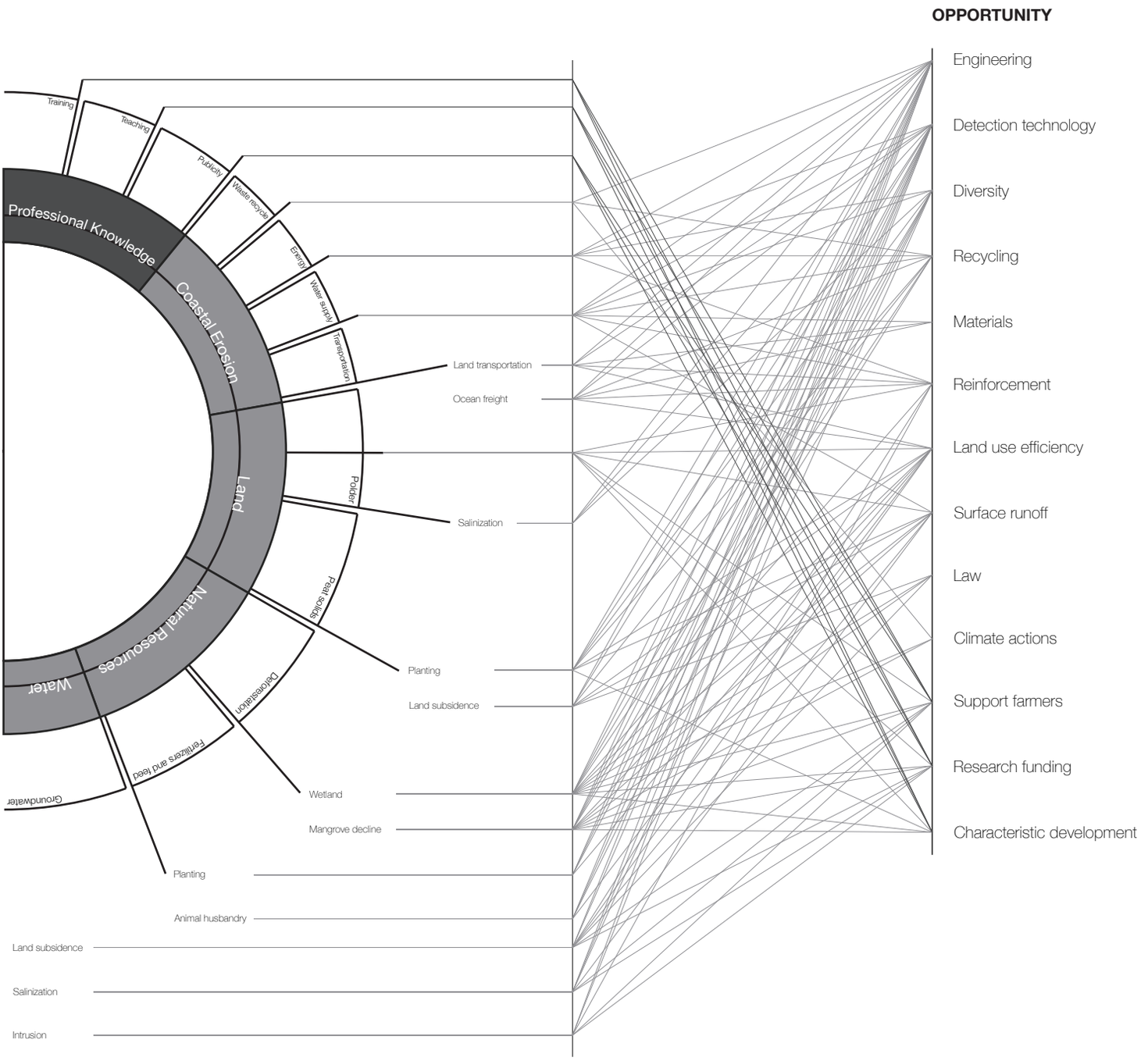
During the European storm season, temperate cyclones bring many storms to the Netherlands. In order to avoid flooding of its territory, the Netherlands has built a lot of water projects.

3. Land subsidence

Grazing, urbanization, and groundwater harvesting have caused soil moisture loss, and thus the elevation of Dutch land is gradually declining.

4. Saltwater intrusion

In the Netherlands, 60% of drinking water comes from underground, and during the dry season all water used in areas with sandy soils comes from underground (Netherlands Water Partnership [NWP], 2007). This has led to increased saltwater intrusion in coastal areas.



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Opportunities

1.National programs
The Delta Plan accelerates and intensifies efforts to combat the effects of inland flooding, heat stress, drought and urban flooding and the Dutch government's strong commitment to develop climate- and water-resistant spatial planning to better cope with extreme weather by 2050.

2. Innovation
The Netherlands is a world leader in innovation in many fields. The in-depth cooperation between many scientific research institutes, universities and enterprises has also enabled the Netherlands to have rapid and efficient technological innovation.

3. Development characteristics
Due to the creation of sluice gates and canal locks, the river became a freshwater lake. New flora and fauna gradually appeared around the lake. In order to adapt and protect this emerging natural area, the Dutch government established a national park to protect them.

4. Education level
The Netherlands is one of the most educated and educated countries in the world. This also means that innovative actions for climate will be understood and supported by more people in the Netherlands, and people are willing to try.

Opportunities

1.Government
Develop agricultural and rural development bills to promote the depth and breadth of the farm economy. Classify the farm economy, determine the farm economy standards, and make relevant detailed regulations on the construction and approval of relevant farms. Implement relevant laws and regulations to prioritize the development of a sustainable marine economic model.

2.Talent Development
Support the exchange between farmers and professionals, and support the activities of organizations so that projects that can be tested in experiments can actually be implemented on the farm and rice.

3.Sustainable devlopment
Plant trees and afforestation, and adopt an improved free-range model to raise shrimp and crabs.In terms of pure marine conservation, coastal and island landscapes of mangroves, coral reefs, seagrasses and lagoons are natural ecosystems with high biodiversity. It is a prerequisite for promoting the development of industries such as tourism, fishing and renewable energy.

4.Strengthen Protection
Encourage local workshops on the management, development, and use of marine resources and the protection of the marine and island environment. Promote active adaptation to climate change, prevention of pollution and decline of the marine environment, restoration and protection of important marine ecosystems, etc.

IV SYSTEMIC ANALYSIS

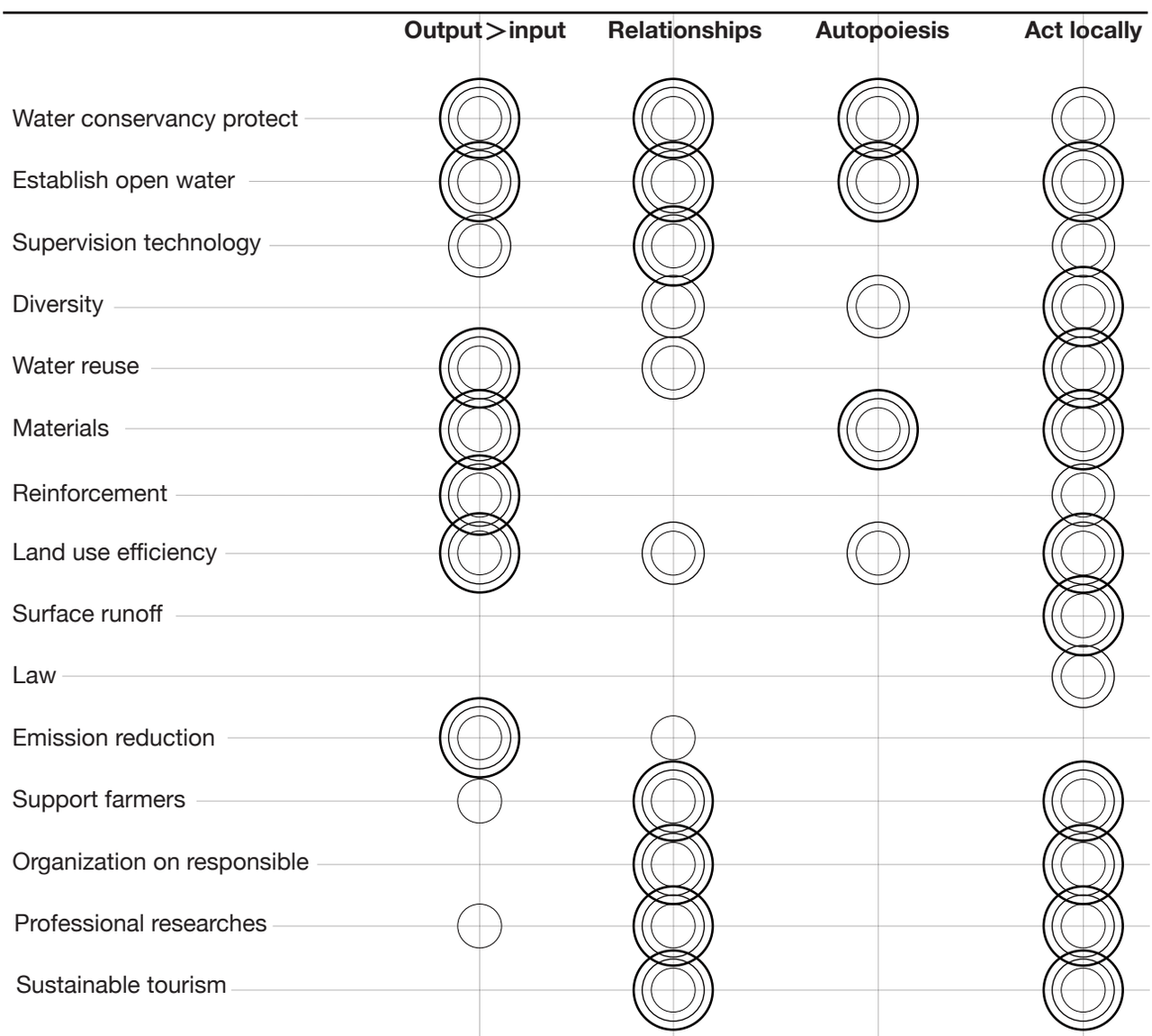
4.1 THE NETHERLANDS ○

COMPLEXITY ANALYSIS .

Systemic analysis
Multicriteria analysis.

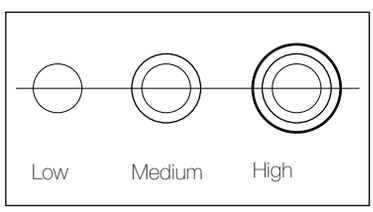
We took into account the influence of parameters for comprehensive scoring and selection. The assessment refers to whether the impact therein is positive or neutral or negative, and how much of an impact he has on the opportunity.

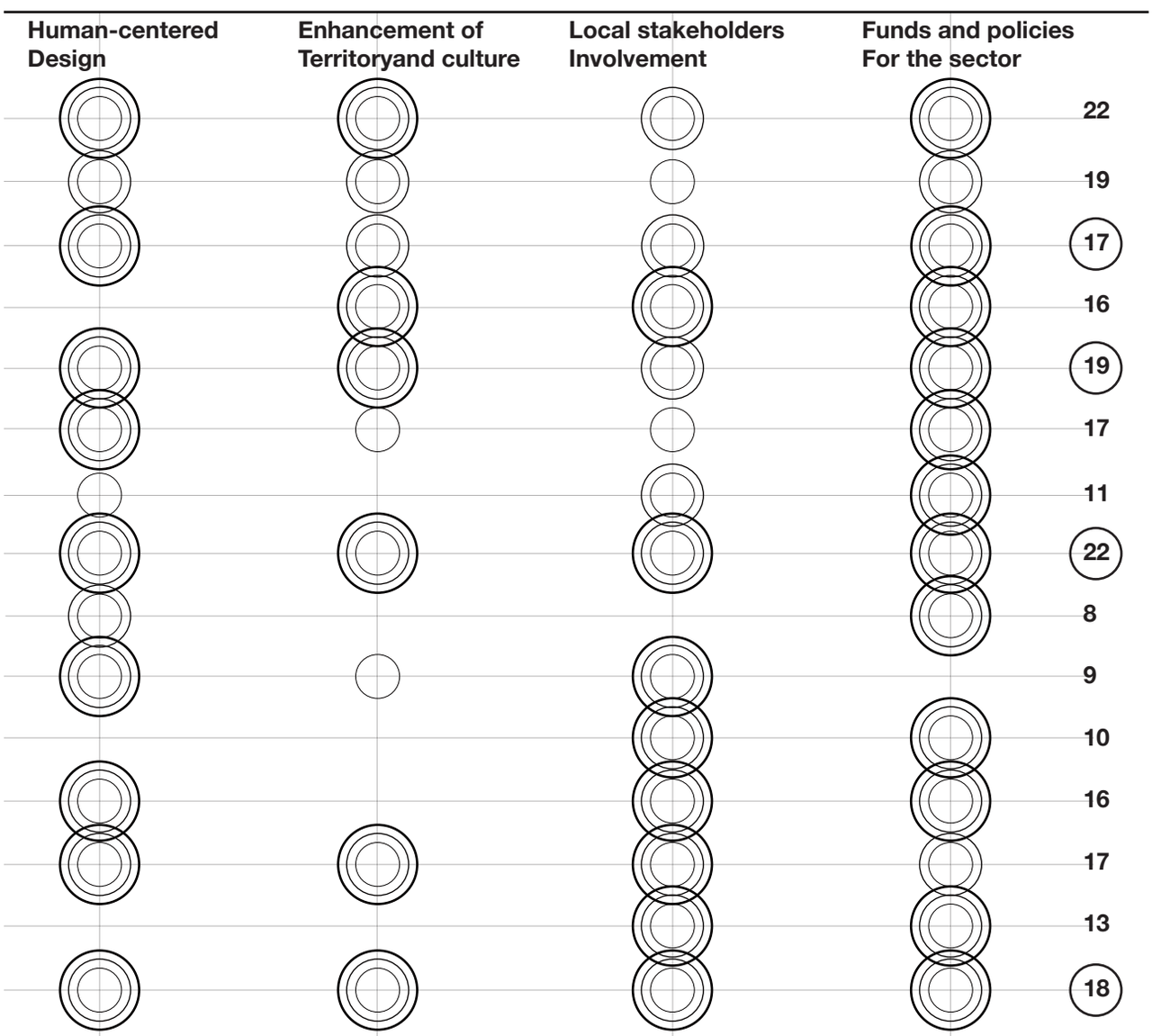
The opportunities that can be identified for the area will need to be assessed and selected in order to achieve immediate and specific solutions that are interlinked and will constitute system engineering. Their evaluation is carried out through a multi-criteria approach and a co-design phase.



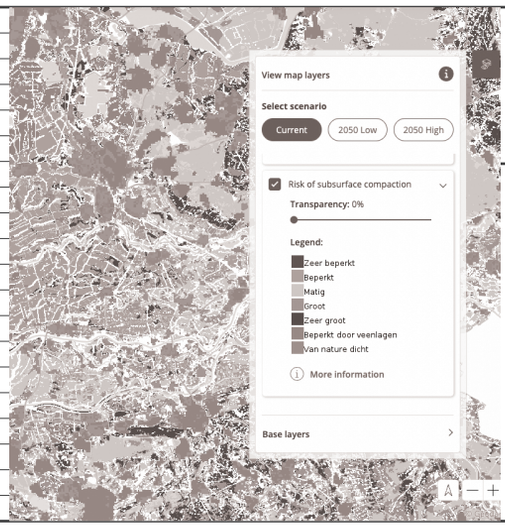
At this stage we selected the most suitable opportunities and eliminated some of the unlikely or low scoring ones.The following aspects were selected:

- Supervision Technology
- Land Use Efficiency
- Water Reuse
- Sustainable Tourism





Supervision
Technology



Thành phố Cà Mau, Vietnam

Delta Plan on Spatial Adaptation 2018

IUCN and the Dutch NGO SNV, implemented a mangrove and market project in Ca Mau (funded by the International Climate Initiative) to help shrimp farmers obtain Naturland, EU Organic and other organic labels.The new Vietnamese model of shrimp farming sets a good precedent for the promising and successful transformation of the economy and agricul ture with organisational and governmental support.

Supervision
Technology

Land Use
Efficiency

Water Reuse

The Netherlands

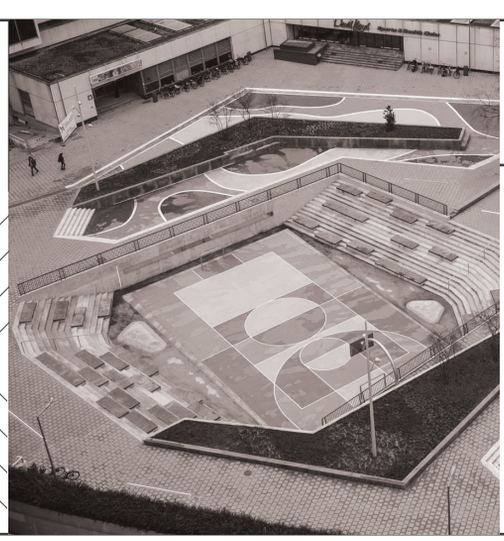
Floating Farm

The project is designed for a future where rising sea levels mean that farmland is increasingly out of action due to flooding.It aims to show a new way of bringing farming back into the city, with minimal impact on resources and the environment.

Land Use
Efficiency

Water Reuse

Sustainable
Tourism



The Netherlands

Water Square

The water square Benthemplein holds a twofold strategy: it is public space and storm water storage combined in one space. The square is part of a strategy to increase climate resilience by adaptive measures. A new way of creating extra funding for high-quality public space is applied here: this square has been largely financed by water management departments and innovation subsidies.

STRATEGIES

Strategy
Agriculture Development

Criticalities	Proposals
Land Subsidence ○ *River sediments are reduced and land uplift rates are reduced.* ○ *Groundwater harvesting causes aquifer hollowing*	**Supervision** — *Data Visualization* ○ *Unmanned Aerial Vehicle* ○ *Real-time Kinematic Positioning (RTK)* ○ *Global navigation satellite system (GNSS)*
Saltwater Intrusion ○ *Land subsidence and groundwater harvesting accelerate saltwater intrusion*	**Increasing Sources** — *Rainwater Collection System, Solar Energy System* ○ *Water Tank* ○ *Water Ttransport* ○ *Solar Panel*
Water Management ○ *Dry season reliance on groundwater exacerbates Dutch problems*	**Reducing Consumption** — *Irrigation System* ○ *Irrigation Nozzle*
Green Energy ○ *Stay cool while reducing energy consumption in hot weather*	

Feasibility


Improve residents' satisfaction


Social benefit goal


Environmental protection

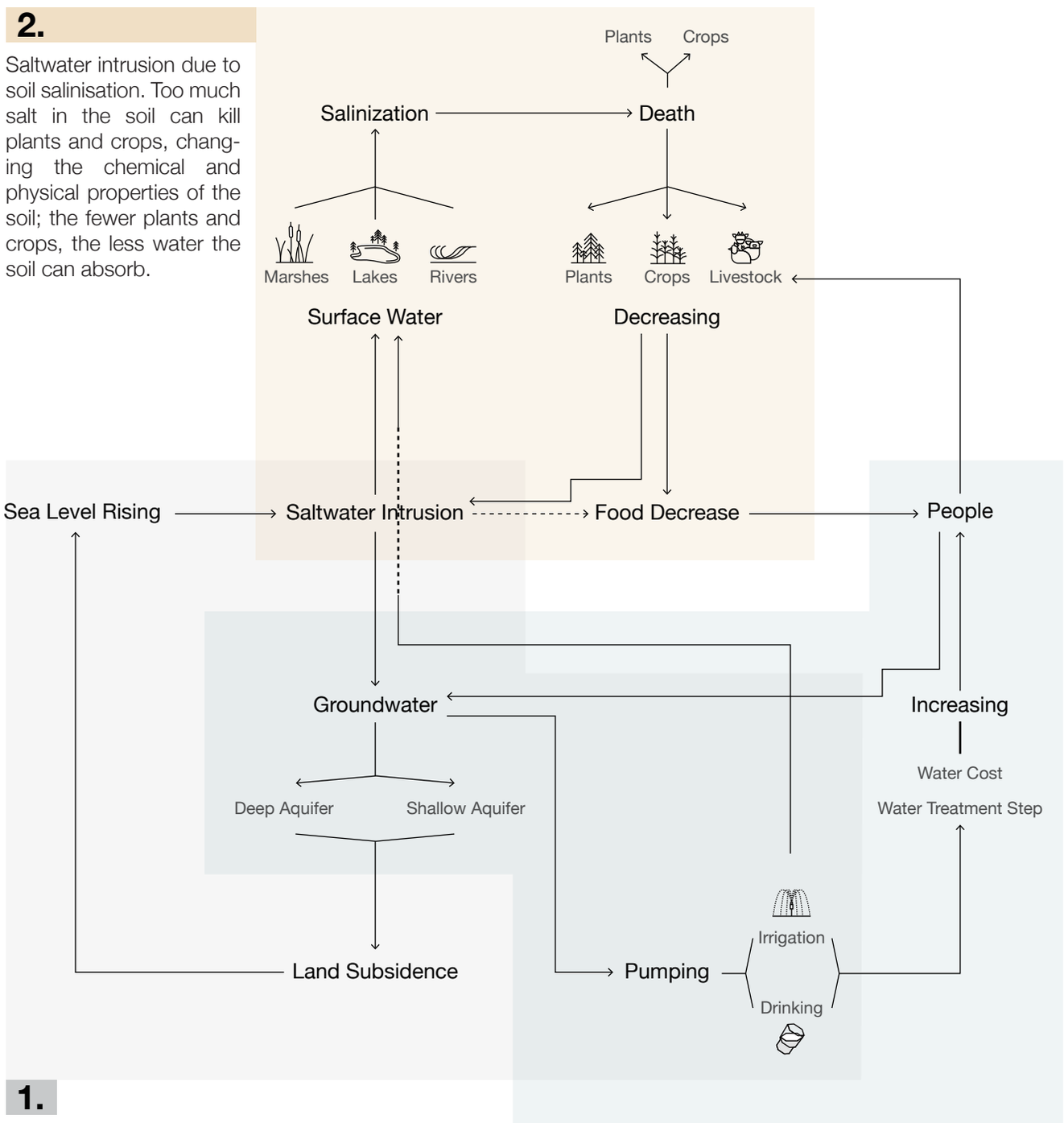

Network creation


Funding Guarantee

Criticalities

2.

Saltwater intrusion due to soil salinisation. Too much salt in the soil can kill plants and crops, changing the chemical and physical properties of the soil; the fewer plants and crops, the less water the soil can absorb.



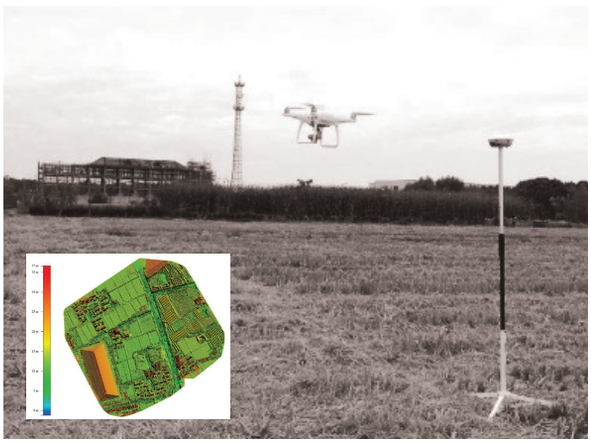
1.

Excessive human use of groundwater leads to hollowing of the aquifer, accelerated land subsidence, increased relative sea level elevation, and heightened salt water intrusion.

3.

Saltwater intrusion makes groundwater more saline, which also increases the cost of water treatment and steps. People want cheaper water, so they dig more wells. The more wells, the more intrusion.

Proposals

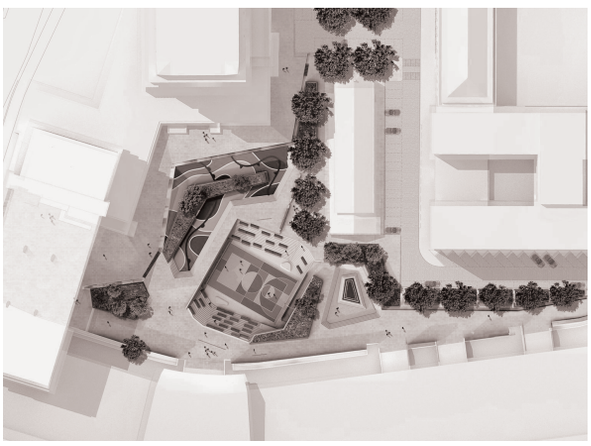


RTK UAV Mapping Project

Shanghai, China

A rural residential area in Shanghai covering 250000m2 (as shown in Fig. 1) needs to be measured and mapped to obtain a high-accurate map. Featuring large area, time pressured and inadequate staffing, using traditional surveying methods is challenging to complete the project.Thus, an excellent solution combining of Phantom 4 RTK (hereinafter referred to as P4R) and T300 Plus GNSS receiver is proposed with no image control points, short-time field work and labor-saving.

By using DJI equipped with RTK under GNSS positioning, and by using Pix4Dmapper and "Survey Master" software, the scanning of farmland is realized.



Water Square

Rotterdam, The Netherlands

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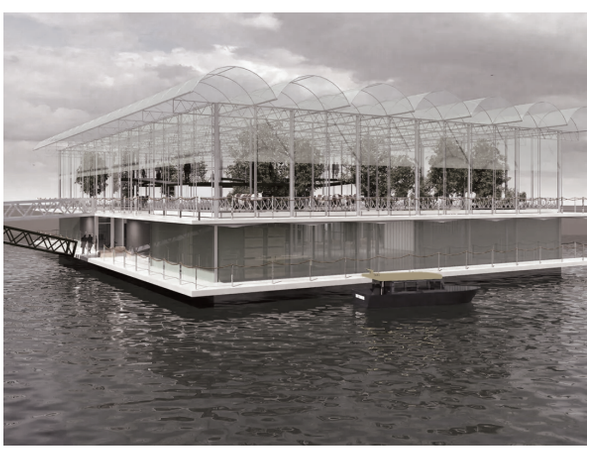
Through municipal planning, rainwater collection is combined with public entertainment venues to realize the reuse of water resources while ensuring efficient use of land.



Floating Farm

Rotterdam, The Netherlands

Rotterdam's floating farm not only enables dairy farming independent of the soil system, but also strengthens the city's food supply chain.

Floating farms support dairy farming through the use of sensors, automated machines. The structure was developed to follow circular design principles. It generates all of its own electricity from floating solar panels and provides fresh water through an integrated rainwater collection and purification system.

Dutch Diamond Approach

“Polderen”

The Netherlands

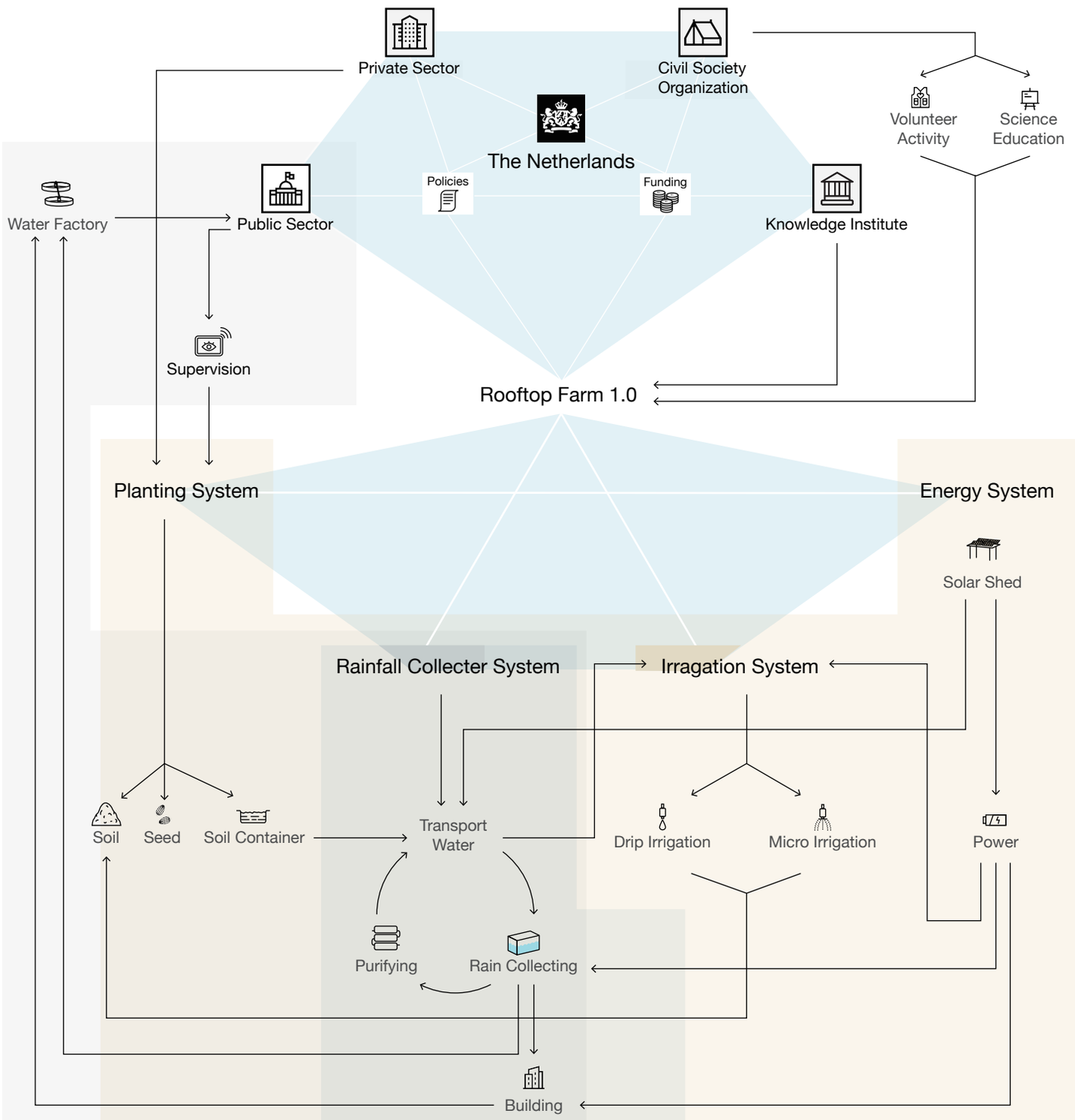
The Dutch like to use the term "Dutch diamonds". The "Dutch Diamond" has four corners: the public sector, the private sector, civil society and knowledge institutions. Between these four, a lot of good things come out, and it's important to use all of these perspectives on the topic of climate action, because you can't address it from a single perspective. We have to do things differently, but we also have to do different things, and these different things, many of which have not yet been invented. So we have to talk to each other and see what we can do differently and it's important to be creative and think outside the box and find new solutions.

For companies, this can mean a complete rethinking of what you're doing, sometimes a new product, sometimes a new way of doing business. The same is true for academia, who may have to do research entirely differently because it has to be more relevant to the changing society in which they work. The public sector may have to come up with different approaches to regulation or create new laws.

Creating Diamonds by Using the Diamond Approach

SYSTEMIC PROJECT .

Urban Sustainable Agriculture



1.

Reduce reliance on groundwater and mitigate land subsidence by increas ing rainwater harvesting facilities.

2.

Rooftop Farm 1.0 provides a new way for agricultural produc tion to avoid the loss of agricul tural production caused by salt water intrusion.

3.

Introduce rainwater collection into domes tic water, increase access to water, and reduce people's cost on water.

1.

Supervison

Unmanned Aerial Vehicel
(UAV)

Real-time Kinematic Positioning
(RTK)

Global Navigation Satellite System
(GNSS)

The single flight distance of military drones can reach tens or even hundreds of kilometers. Although civilian drones cannot reach the same size as military drones, as specialized agricultural drones, they can reach For the purpose of long battery life and data monitoring, this technology is not impossible.

The UAV combines RTK and GNSS to build a UAV monitoring system through preset routes and autonomous flight technology, which ensures data monitoring and saves manpower and material resources.

2.

Agriculture System

Planting

Irrigation

Energy

Agriculture system mainly have two parts: Planting and Irrigation. In the planting part, soil and container are necessary. For soil, due to the limitation of the rooftop, the system need to use lighter marterials, and physical and chemical properties of the soil have to be considered. The water is used in the irrigation comes from the rainfall. Before the irrigation, rainwater should be purified. When the soil moisture sensor detect the moisture low of the set value, the system will transport the water to the soil by drop or micro irrigation.

Normally the wind in the rooftop blow stronger than the street, so a protect shed also should be prepared. Thus solar panel can be used at the top of the shed, and be controled with the electric sensor. On the one hand, shed protect the crops, solar panel transform the solar energy to the electricity.

3.

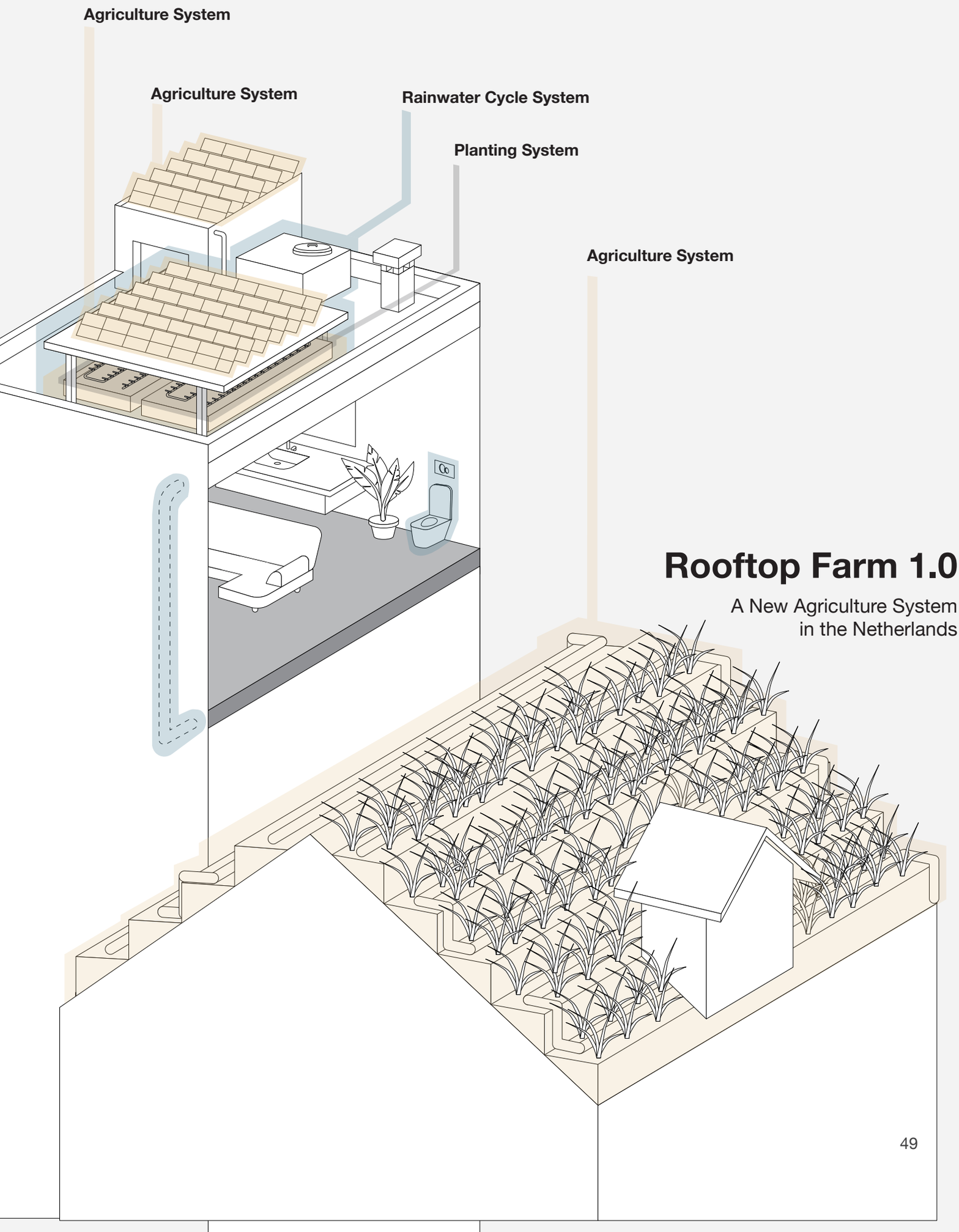
Rainwater Cycle

Rainwater Collect

Rainwater cycle system is the third system in the whole rooftop farm, and plays a important role in the farm.

Decreasing the use of groundwater is the aim of the rooftop farm system, so the rainwater is the important rescourse of the water. According the researches, the netherlands will have sufficient rainfall. Using this part of water efficiently is the duty to the Rainwater cycle system.

When the sensor detect the moisture of the air is surge, the system empty the water tank immediatel. The water flows down the municipal pipe to the water treatment factory.



Rooftop Farm 1.0

A New Agriculture System
in the Netherlands

Study of the outcomes .

We evaluated the project from four aspects: economy, flow, social culture, and scalability, and made an expected timetable for the completion time.

Combined with the Dutch local diamond method, while maximizing the interests of all parties involved, it brings new solutions to the impact of sea level rise on agriculture.

SCALE OF THE OUTCOMES .

MACRO

Territory Protection
By using types of methods avoid territory issues

Agriculture Development
Urban agriculture development

MESO

Supervision
By building a drone monitoring system, the efficiency of data can be improved, and when the situation deteriorates, actions can be taken quickly

Urban rooftop rainwater collecting
Increasing rainwater' scale, reducing pumping groundwater excessively

Enhance city food chain
Develop special features by taking local materials

MICRO

Data Base

Improve the operational efficiency of the public sector and strengthen cooperation with the private sector and knowledge institutions

UAV System
Data System
Data Visualization

Cooperation

Public Sector
Private Sector
Knowledge Institute

Rooftop farm

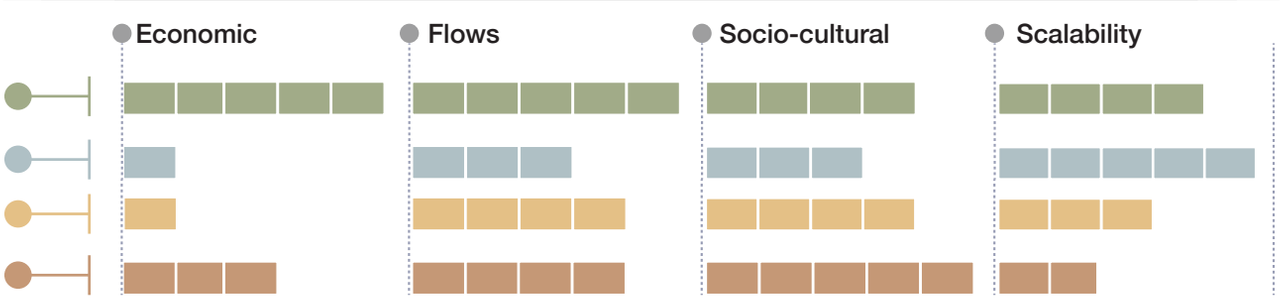
Shorten the transportation distance of urban food and provide the community with convenient and fast fresh food places

Planting System
Irrigation System
Rainwater Circle System
Energy System

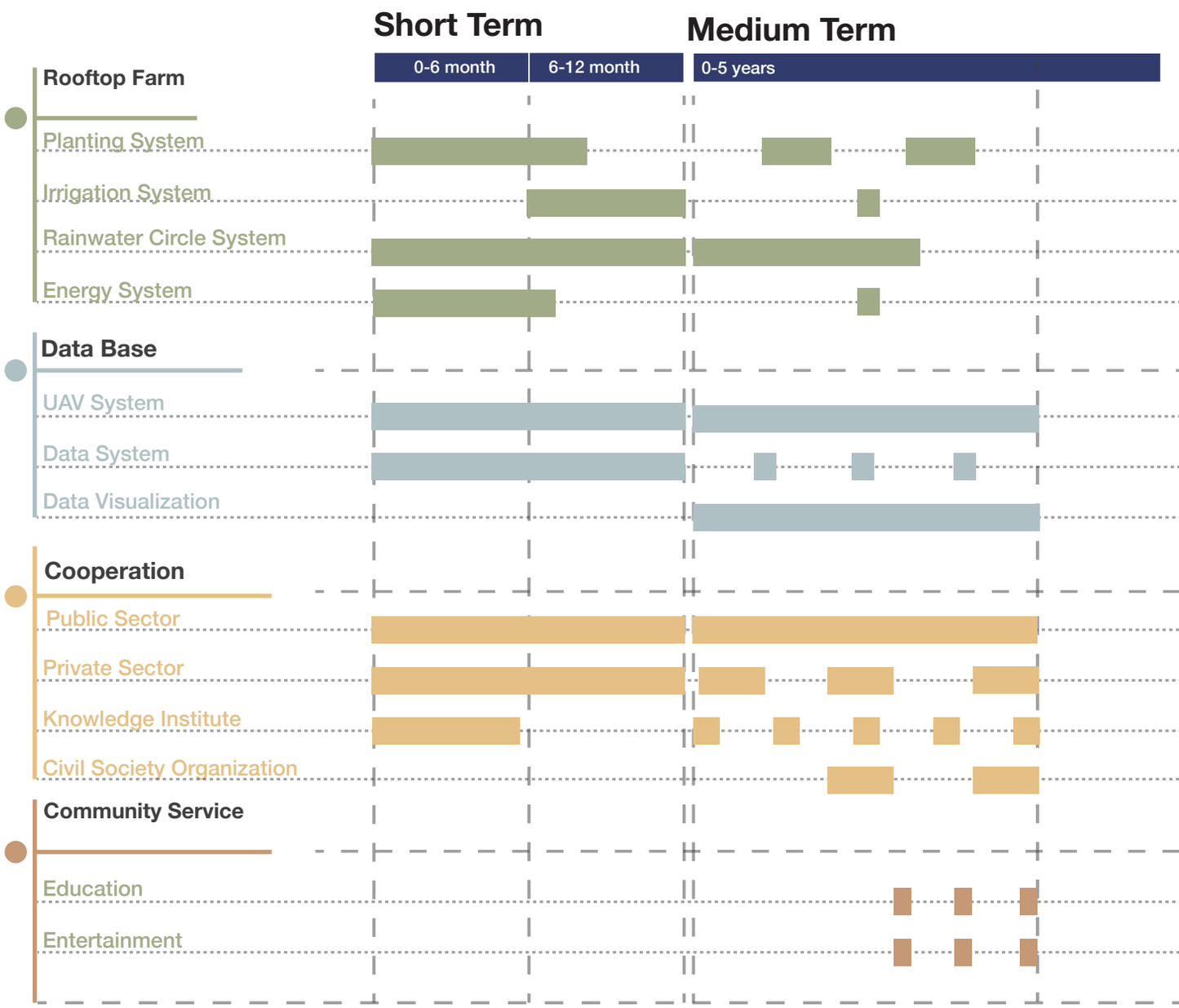
Community Service

While providing fresh food, it also provides knowledge of crop growth to residents in the community

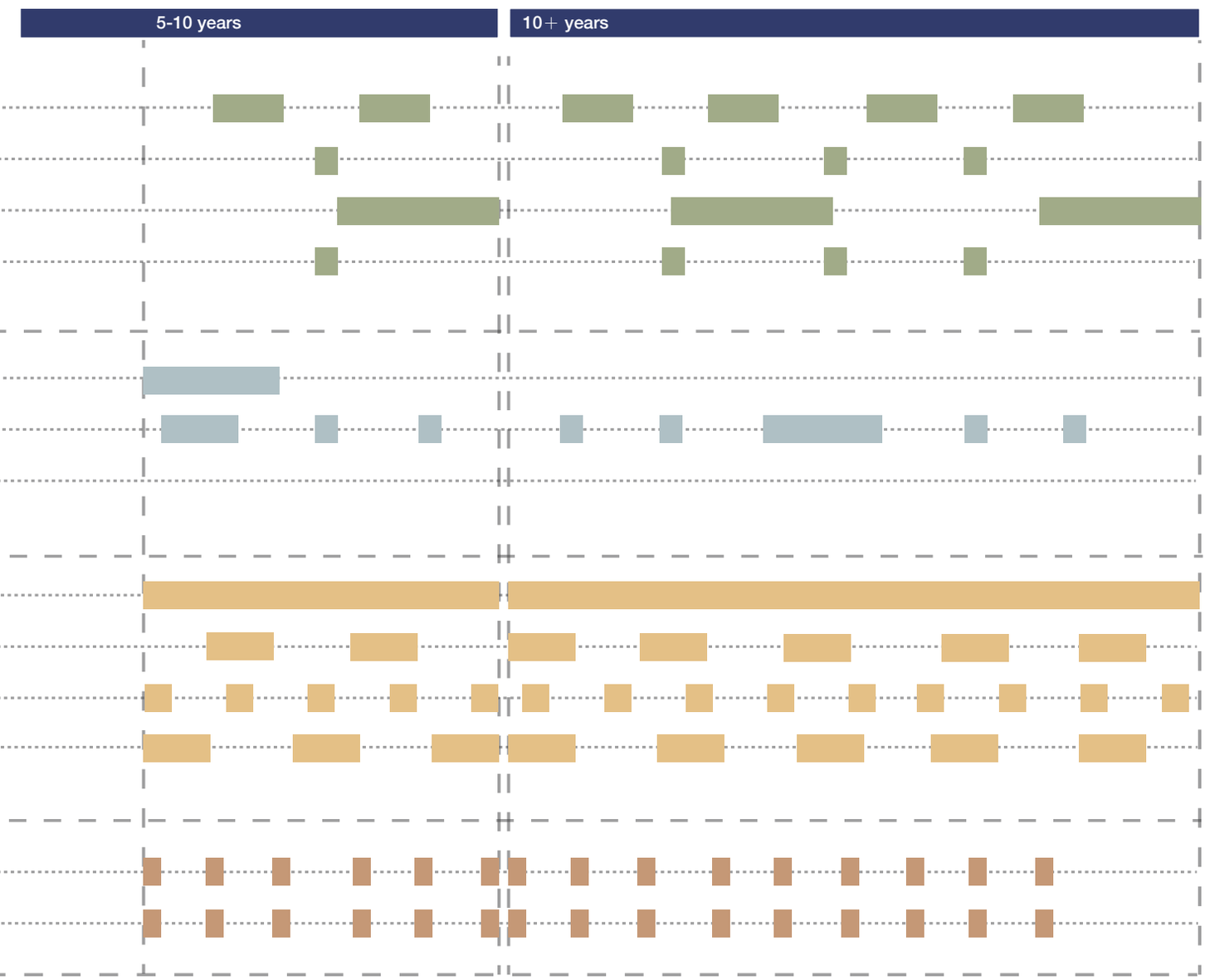
Education
Entertainment



IMPLEMENTATION PLAN .



Long Terrn



4.2 VIETNAM (CAN GIO) ○

COMPLEXITY ANALYSIS .

Systemic analysis
Multicriteria analysis.

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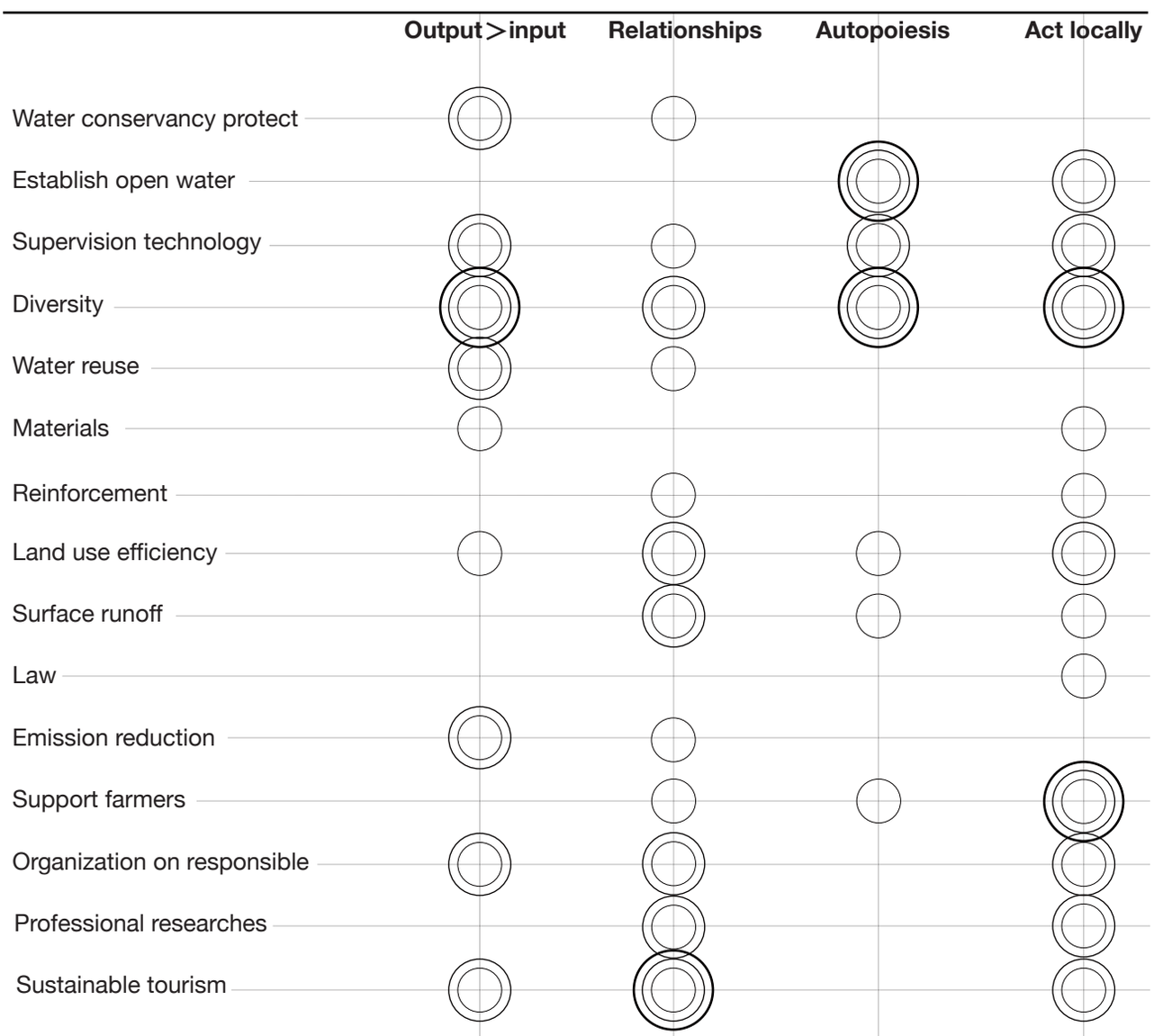
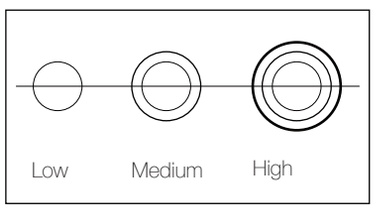
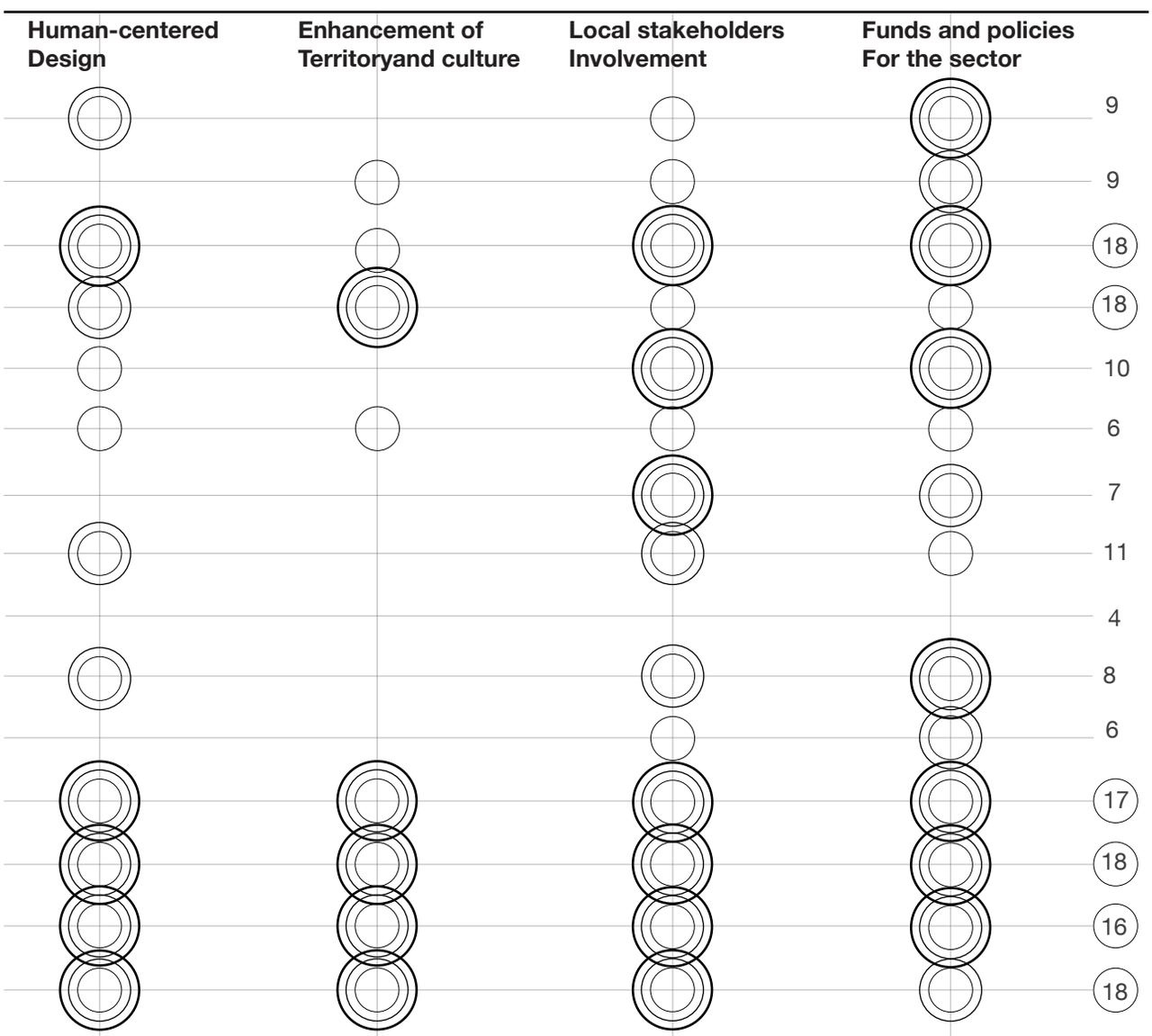


At this stage we selected the most suitable opportunities and eliminated some of the unlikely or low scoring ones.The following aspects were selected:

- Detection technology
- Diversity
- Support farmers
- Organization on responsible
- Professional researches
- Sustainable Tourism





Support farmers

Organization on responsible

Thành phố Cà Mau, Vietnam

Mangrove and market project

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Diversity

Sustainable Tourism

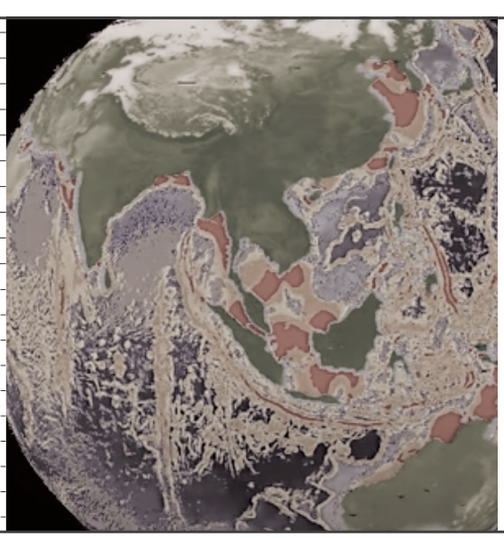
The Netherlands

The National Park De Alde Feanen

The long-term goal of implementing a nature park in Vietnam is achieved by combining the inspiration of the National Park De Alde Feanen, a characteristic nature park in the Netherlands. The old Finen National Park has a landscape of swamps, lakes, forests, peat and meadows. At least 450 species of plants and 100 species of birds can be found in the area. Take advantage of the characteristic horse racing and windmill, which attracts many visitors.

Detection technology

Professional researches



The Netherlands

TELEMAC 2D model

It effectively detects variations in the spatial resolution of the riverbed grid between 50 and 100 m and the topographic grid between 100 and 500 m, including different types of land cover (urban, riverine and agricultural) (Hervouet, 2000), as a way of monitoring the daily general variability data, drawing on the analysis techniques in Model Projections for Pohnpei.

North Carolina

Living Shorelines

Living shoreline is not usually used for open sea beaches, which incorporate natural vegetation or other living, natural "soft elements", alone or in combination with some type of harder shoreline structure such as oyster reefs, rock foundations or anchored Large logs for added stability. Living coastlines connect land and water to stabilize coastlines, reduce erosion and provide ecosystem services, such as valuable habitat, that enhance coastal resilience.

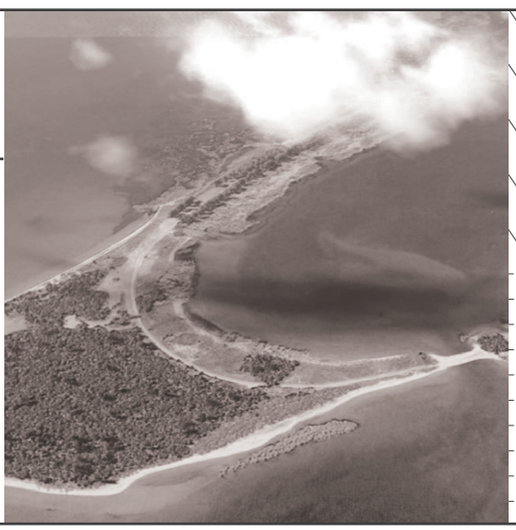
Diversity

Professional researches

New york and new jersey

Gateway national recreation area

The team assessed existing maintenance facilities and reviewed damage. Disturbed and damaged open space areas will be restored with a combination of native seeds, trees and shrubs, while protecting, restoring, enhancing and creating natural habitats for fish, aquatic plants and wildlife.



Sustainable tourism

Professional researches

Ems-Dollard estuary, Netherland

Marconi Salt Marsh Development

The pilot salt marsh consists of six compartments with different percentages of mud (a mixture of clay and silt with a grain size smaller than 63 µm) in the upper meter of the subsurface. Some of the compartments were seeded with Salicornia procumbens (Long-spiked Glasswort).Constructing a salt marsh area creates a gradual land-water boundary with space for flora and fauna, beneficially re-uses dredged sediment and provides a sustainable form of coastal protection as the marsh catches fine sediment and grows with sea level rise.

Support farmers

Detection technology

Vietnam's agriculture is moving towards higher value-added sectors with the help of technological innovation and investment in renewable energy and smart technologies, while the impact of sea level rise on agriculture is gradually increasing. Vietnam has a large area of agricultural land and low labour costs, but the constraints of the terrain make it difficult to mechanize production on a large scale.

The area is own land		The area is state forest land
40%		60%
Hrimp & fish farmers	Clam collectors salt farmers services	
25%	15%	

Vietnam's agriculture is moving towards higher value-added sectors with the help of technological innovation and investment in renewable energy and smart technologies, while the impact of sea level rise on agriculture is gradually increasing. Vietnam has a large area of agricultural land and low labour costs, but the constraints of the terrain make it difficult to mechanize production on a large scale.

In our selection of Can Gio there are challenges that cannot be met by the general opportunities described above, so for this reason we will present a comprehensive analysis here:

In Viet Nam, there is currently a law on natural disaster prevention and control to clarify the obligations of organisations, families and individuals in natural disaster prevention and control activities, and to refine the state management and resource security situation in natural disaster prevention and control. In this law it is clearly stated that natural disaster prevention and control activities must be based on science, protect the environment and recognise the importance of adaptation to climate change. It requires the development of a national strategy for natural disaster prevention and control every 10 years, which must include the results of any risks associated with climate change. District and provincial natural disaster prevention and control plans must identify the potential impact of climate change on socio-economic activities (Government of Vietnam, 2019). As a result of this law, the Vietnamese government and the public have increased their awareness and action to protect nature. It is obvious that the law is an indispensable step to protect the environment and we can conclude that the government is supporting organisations and individuals to promote and take action to protect the environment. Thanks to the mangrove forests, Vietnam has had a very good ecological basis since ancient times, with villages built within mangrove forests and dependent on them for their livelihoods, gradually forming a distinctive village lifestyle. The long-term goal of implementing a nature park in Vietnam is achieved by combining the inspiration of the National Park De Alde Feanen, a characteristic nature park in the Netherlands.

As we have seen in previous cases (PANORAMA, 2019), to help the Vietnamese government address this issue, IUCN and the Dutch NGO SNV, implemented a mangrove and market project in Ca Mau (funded by the International Climate Initiative) to help shrimp farmers obtain Naturland, EU Organic and other organic labels.The new Vietnamese model of shrimp farming sets a good precedent for the promising and successful transformation of the economy and agriculture with organisational and governmental support. However, as the experiment was only implemented in the Ca Mau district, and the ecological cooperation chain was not well developed, we can realise that through the use of the Cà Mau district, we can make a difference. However, we can see that by combining ecological sustainability and strong marketing activities in important markets with high quality products, higher revenues can be achieved while protecting the local ecological environment, making it possible to protect the ecology and bring economic value to the area at the same time.

STRATEGIES

Strategy
Agriculture Development

Criticalities	Proposals
60% of the land is state-owned ○ *Low pay for forest rangers* ○ *Private instability*	Research & Professionalization *Efficient & Accurate* ○ *Talent Training* *Training for farmers/rangers* ○ *Data* *Water logger*
Reliant on mangroves ○ *Obtain food such as fish and shrimp from the forest, building materials, firewood, etc.*	Cultivation of new trees *Sonneratia apetala* ○ *Fast growth* ○ *Quick to adapt* ○ *New Economy*
Agricultural backwardness ○ *Farmers rely on experience to breed*	Increased income sources *Thành Trà Vinh* ○ *Beekeeping* ○ *Herbal Medicine Development* ○ *Wood*
Urbanization ○ *Increased waste accumulation and pollution*	
Loss of young people	Divided area protection ○ *Farming area* ○ *Nature Reserves*

Feasibility


Customers knowledge


Long term approach

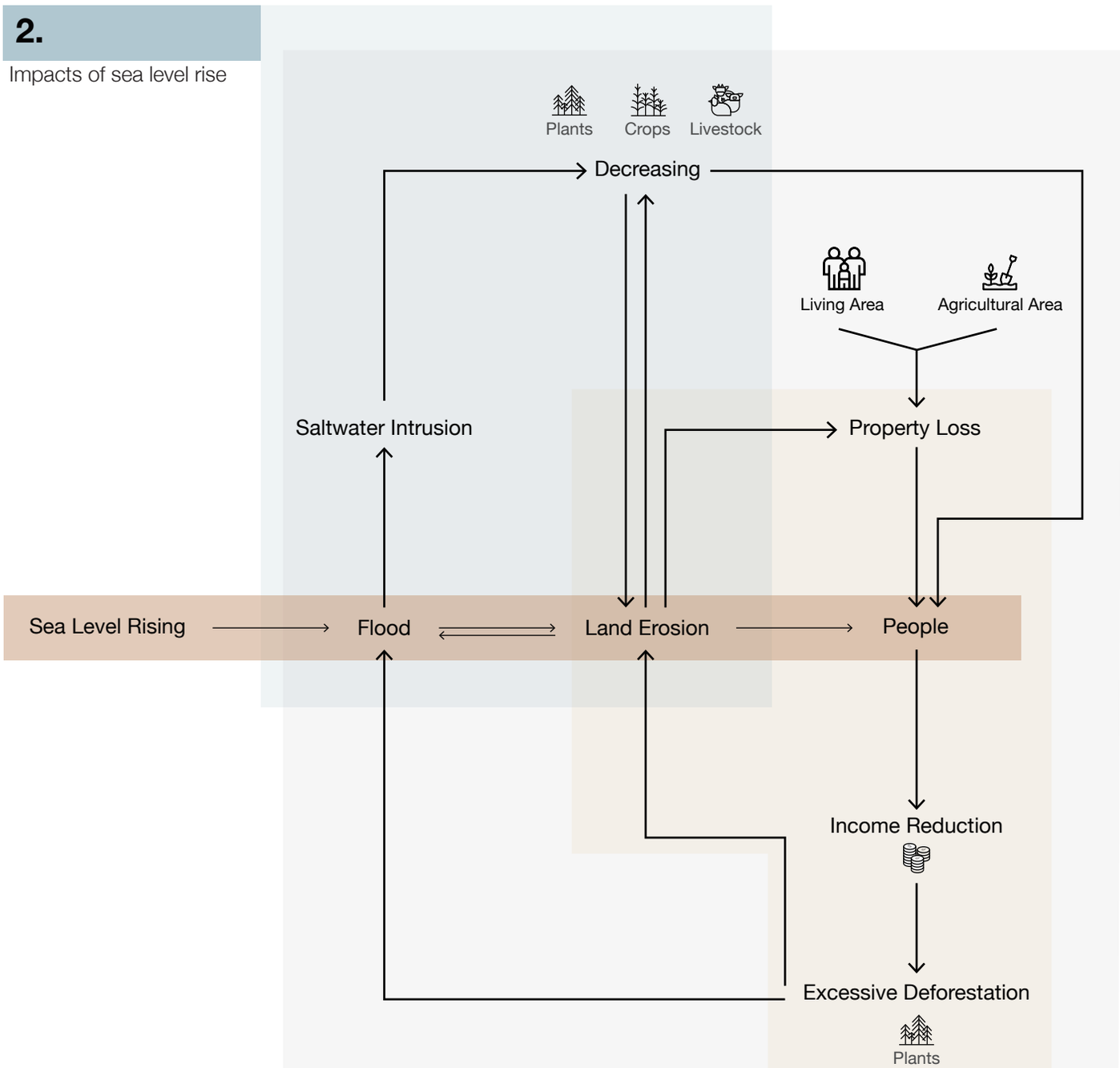

Improve residents' happiness


Data visualization

Criticalities

2.

Impacts of sea level rise



3.

The undesirable cycle caused by the backwardness of human activities and consciousness.

Poorer people tend to take advantage of the direct value of mangroves (mainly resulting in heavy timber harvesting rather than long-term income from mangrove conservation), so improving local livelihoods is an important prerequisite for reducing pressure on mangroves.

1.

Problems caused by SRL

Proposals

Tuan and Kuenzer (2012) sampled over 300 households in Can Gio district, of which 289 were valid for analysis.

Man	Woman
80%	20%

Forest manager	Fisheman	Shrimp farming	Other farming
50%	25%	20%	5%

No experience	1-10 years experience	1-30 years experience	No experience
60%	40%	60%	40%

The modernisation of agriculture and sustainability wi require a greater degree of refinement in environmental management, differentiated management and precise management within sustainable parks.

Modernisation of agriculture requires increased mechanisation, but due to the topography of the land in Can Gio and Vietnam's national context, the most effective strategy at present is to gradually replace the empirical, predictive, decision-oriented, crude management mentality of traditional agriculture with a level of mechanised testing.

Big data, as a new technological tool and way of thinking, breaks the traditional way of collecting, integrating, storing, processing, analysing and visualising data and information. The quantitative level of management and the scientific nature of decision making are improved, bringing new opportunities for a gradual shift towards networked and intelligent environmental management.

Water loggers, monitoring systems

Pohnpei, US

The US has placed water loggers in the Pohnpei area to monitor the health of these important coastal forest resources. At the same time, the team developed a mathematical model to predict the future of mangroves under different sea level rise scenarios to inform local planning and decision-making. The model combines the relationships between the ocean, mangroves and soils to show how changes in sea level translate into changes in the ecosystem as a whole. Elevation relative to sea level determines which tree species will thrive in a given location and influences periodic modifications to the forest's biomass (Kevin J. Buffington, 2021). This programme could continue to be used for mangrove monitoring in Vietnam(Western Ecological Research Center [WERC], 2020).

This programme could continue to be used for mangrove monitoring in Vietnam(Western Ecological Research Center [WERC], 2020).Sea level trends can be calculated from near-global coverage of TOPEX/Poseidon satellite altimetry data combined with historical global tide gauge records(Hunter, 2002, Church et al, 2004a).

This programme could continue to be used for mangrove monitoring in Vietnam(Western Ecological Research Center [WERC], 2020).

Organisations and research institutes have initiated studies and trainings for local farmers on a continuous basis, in order to modernise agriculture and make the plan transparent.The region needs the technical capacity to analyse available tide gauge data to determine predicted trends in mean sea level and extreme high water events, and to incorpo rate this information into land use planning.

Types of mangrove trees

Can Gio, Vietnam

Between 1978 and 1999, 35,000 hectares of the original 40,000 hectares of mangrove forest in Can Gio were restored, ,although progress has been slow (Marchand, 2008).Now more common in the area are Rhizophora apiculata, avicennia alba, and mixed communities between nypa fruticans and acrostitum (Hirose, 2011). Avicennia alba is a pioneering species with a high degree of salt tolerance and the ability to grow on loose sediments, but it is not suitable for firewood or timber, and although extracts of the heartwood can be used as a tonic and the seeds can be used.

Sonneratia apetala is found in medium high tidal areas, but no attention has been paid to this tree. However, it has the growth properties to allow for large scale planting and to achieve a barrier effect more quickly. This tree grows relatively quickly and is a better grower than other species. This species is very fond of mud flats in moderate or high-intensity saline conditions (Useful Tropical Plants, 2023). The species is long eaten by the people of the region along the coast of Bangladesh and the fruit is used as a pickle or vinegar, or as a vegetable. The seeds and bark contain anthocyanins, and bark extracts also have anti-inflammatory activity. In agroforestry it helps to protect the soil from erosion and provides important habitat for wildlife(Useful Tropical Plants, 2023).

Mangrove Environmental Mechanism

Can Gio, Vietnam

There are three main reasons for this:

(1) mangroves are more productive and provide more food than other adjacent inshore habitats;
(2) the complex structure, high oil content and soft substrate of mangrove trunks, roots and debris provide greater protection for animals from predators;
(3) mangroves produce a larval retention mechanism that prevents increased dispersal of planktonic juvenile shrimp by tidal currents.

Many mangroves have shallow water depths at the mouths of tidal channels and are mostly mudflats. The high friction between the water and the mudflats does not create a tidal jet, and at low tide the water fans out at the mouth of the tidal trench, and as there is little or no littoral flow during the period, the water from the marshes is sent back into the mangrove at the next high tide. This lateral movement of the mangroves, which impedes littoral flow, can last from 2 to 8 weeks, and even during the rainy season the water can remain in the mangroves and tidal gullies for several weeks(Yanez-Arancibia et al., 1994).

The area is suitable for fish and shrimp and crab farming.Farmers need to treat the wastewater produced by farming in order to balance the ecology of the area.

Establishment of sea level rise data detection and scientific cultivation of agricultural products. From the transparency and accuracy of data as a basis for ensuring a traceable supply chain for agricultural products, most of the products produced in the region can be certified as organic, thus increasing the selling price.

The National Park De Alde Feanen

The Netherlands

National parks are unique natural areas; this area is a protected place that tells the story of Dutch nature. The national park is also an ideal starting point for hiking. The places are easily accessible by car and there is ample parking.

It expansion of the connotations of agriculture can lay the foundation for the future spatial development of the countryside and the diversification of economic activities, and promote the development of agricultural functions from single food agriculture to health, speciality, ecology, leisure, culture, history and education, and become multifunctional and complex agriculture.The mangroves in some of the protected areas can be used as ecotourism circles for external promotion of sea-level rise protection.

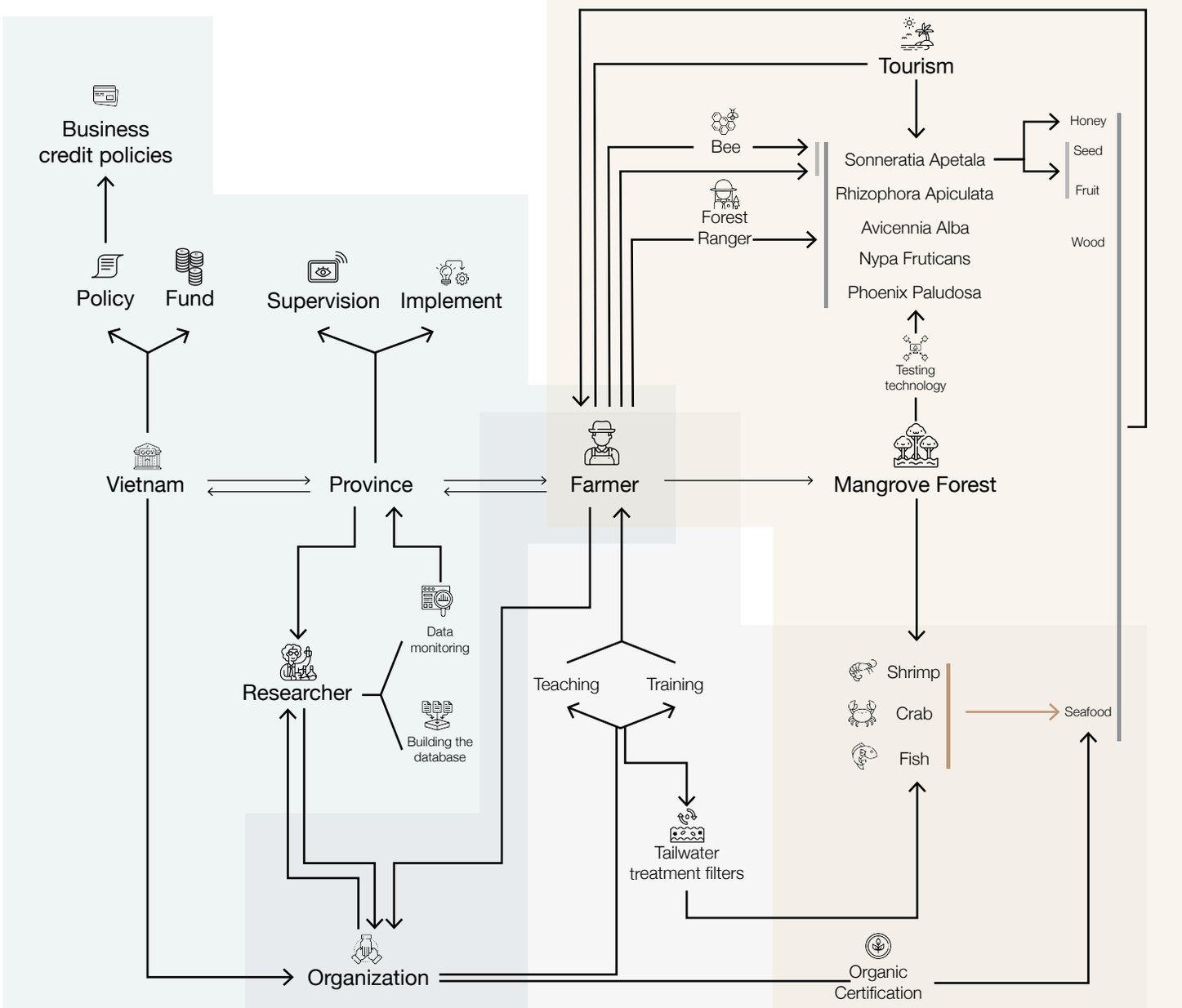
The visitor data and sea level rise data can be used as research data and so on, with the final aim of improving the standard of living of the local people while maintaining harmony with nature. The area will be integrated with the mangrove ecosphere, developing tourism and agriculture to create a mangrove ecological and educational area with a mix of agricultural production and local characteristics.

SYSTEMIC PROJECT .

Original ecological and agricultural .

Rational use of mangrove resources to improve the income of people in the area.

1.



2.

On the territorial side, the government collaborates with organizations and research institutions. Real-time monitoring of sea level rise provides data and talent to support subsequent updates and iterations of conservation programs.

Increase the involvement of organizations in order to protect mangroves. Integrate conservation awareness into farming practices and involve local people in conservation practices to raise awareness.

3.

Sonneratia apetala


Vegetables


Timber


Honey


Anthocyanins

Scientific feeding

Box-net farming


Lates calcarifer
Grass shrimp


Callinectes sapidus

Captive breeding


Penaeus monodon

Organic detection


IUCN
Dutch NGO SNV

Tailwater treatment filters


Modern septic tanks
Domestic waste management

There is a need to continue planting **Rhizophora apiculata, Avicennia alba, and Nypa fruticans and Acrostitum** while adding **sonneratia apetala** species to agricultural areas in the **low and medium tidal zones** in order to **protect the soil from erosion**, provide habitat for bees and wildlife and construction of new mudflats. **The fruit** of the Sonneratia apetala tree can be eaten as a vegetable; **its seeds** and **peel** can be used to extract anthocyanins; they can be supplied to raw material companies to make medicines; and its **flowers** can be supplied to bees to make sweet nectar. The **flowers** are used by bees to make sweet nectar.

Mangrove ecosystems are rich in species diversity, but most species are vulnerable to attack by enemies or threatened by human activities in coastal areas (Xu & Li, 2010). So in this area we intend to maintain the farming industry and add a part of the side industry, helping local people to raise crabs in river net boxes, so that the quality of the crabs can be checked and the area where they grow can be controlled, while reducing the use of antibiotics and pesticides in the ponds. Of course, not only can shrimp and crab farming be developed in this section, but also saline fish farming, i.e. fish that can adapt to changes in salinity from near freshwater (<1) to heavy rainfall 35 (Yanez-Arancibia et al., 1994).

Drawing on the previous case of Thành phố Cà Mau, when the quality of the shrimp and crab in the area is up to standard, it can be derived to expand to provide organic certification for the shrimp and crab in the area, thus increasing the local income level.

Sideline development: tourism


Ticket commission
Rangers become tour guides

Differentiate and specialise the area by following locally minded operational guidelines to form a special economic zone and avoid convergence. The development of ecotourism is in line with the modern development concept of green development, while cultural tourism can increase people's sense of cultural identity and pride in their hometown, as well as drawing residents' attention to rising sea levels.

Visitors can enter the eco-zone as "rangers" and experience a day in the life of a ranger under the guidance of a professional ranger, allowing them to experience the real work of a ranger in a more educational way while safely viewing the amazing wildlife and informing the public about the protection of mangroves against sea level rise.It will enable visitors to experience the local customs and better inspire them to protect the mangroves. It is also planned that 1% of the entrance fee will be taken as a percentage and saved as a mangrove conservation fund.Visitors will also be able to taste shrimps and crabs in the eco-agricultural area after their visit.

Visitor data and sea level rise data will be used as research data, among other things, with the ultimate aim of improving the standard of living of local people while maintaining harmony with nature.

Business credit policies

Business credit policies

Preferential credit

Municipalities need to provide preferential credit and business credit policies for local people to help them establish agroforestry enterprises, as well as aquaculture, salt production and other livelihood opportunities.

Testing technology

Water loggers

TNHY-6 Handheld Agricultural Environmental Detector

Data monitoring

TELEMAC modelling system

Building the database

Sea Level Database

Agricultural database

Future research on the relationship between mangrove wetlands and fisheries should be based on a clear understanding of the connectivity between the various habitats and the use of standardized data collection models.

We can use the **TELEMAC 2D model technology**,Further scenarios of its application in agricultural production management are envisaged and found to play an important role in agricultural planning, environmental quality management, life cycle management of agricultural products, environmental emergency response and public participation, in order to facilitate the transformation of environmental management into digitalization, networking and refinement.The paper suggests possible solutions to the problems of environmental big data in terms of data processing, data management and data application.

For the government, big data can help it grasp comprehensive data information and provide more scientific and solid data and technical support for the formulation of various environmental policies.

For the Institute, real-time monitoring and analysis can improve environmental regulation, early warning and emergency response capabilities; the dramatic increase in data volume and interconnection sharing can enhance inter-departmental collaboration and improve management efficiency.

For shrimp enterprises and farmers, big data can provide real-time information on energy consumption and pollution emissions in all aspects of production, as well as on the operation of production and environmental facilities, helping them to reduce production and pollution control costs and reflecting corporate social responsibility.

In addition, the presentation of big data can also help the public and tourists to understand the environmental situation of the rising sea level accurately and to get timely information on the precautions to be taken in life.

Tailwater treatment filters

Modern septic tanks

Domestic waste management

To improve the chances of obtaining organic certification, farmers need to be trained in the installation and use of modern cesspools, domestic waste management, as well as in mangrove planting and scientific production of shrimp and crabs.

Education and training

MARD

Ho Chi Minh City University

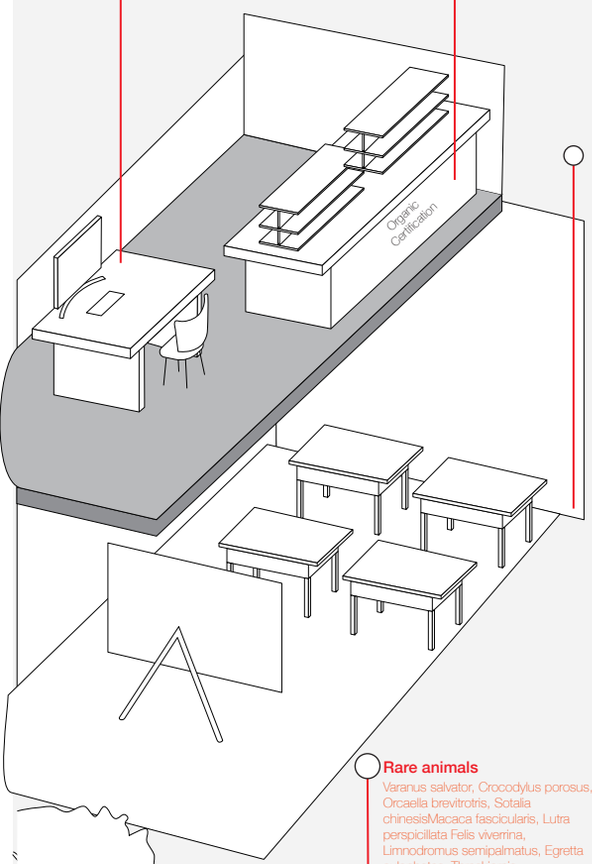
We advocate for governments and institutions to provide education and training to enable local people to establish new industries without affecting the mangrove environment. The government needs to support a simultaneous economic and natural development approach. Co-organized by the Ministry of Agriculture and Rural Development (MARD), the Center for International Forestry Research (CIFOR) and Nong Lam University committee needs to lead studies for locals and rangers, organize workshops, and emphasize the importance of the ecosystem. Rangers need to be trained in new techniques of mangrove management to monitor mangrove cover. In cooperation with Ho Chi Minh City University of Agriculture and Forestry, experienced farmers are invited to share their knowledge and professionals can give scientific explanations and feedback. Students have the opportunity to conduct field trips and practice to make in-class experiments more localized.

Can Gio Mangrove Ecological Agriculture Area

Vietnam' Agricultural Recycling Ecosystem Services System

Data Monitoring
The goal is to understand the overall picture of the data and detect anomalies. **Analysts** can do visual analysis of the data created through charts and dashboards, so that they can more accurately **understand** the local **production conditions, pollution** conditions, agricultural product **quality and other indicators**.

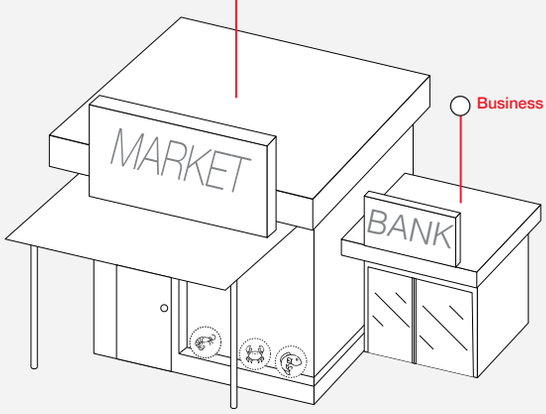
Organic certification



Education of Farmers & Rangers
Farmers: In order to obtain organic certification for agricultural products, farmers need to receive training on the installation and use of septic tanks, domestic waste management, and how to replant mangroves, reasonable and scientific production of shrimp and crab.

Rangers: Need to be trained in new techniques of mangrove management to monitor and audit contracted mangrove cover.

Export overseas / Market
After visiting the mangrove swamp, visitors can also go to the eco-agriculture area to taste prawns and crabs.



Business credit policies

Rare animals
Varanus salvator, Crocodylus porosus, Orcaella brevitrotris, Sotalia chinesisMacaca fascicularis, Lutra perspicillata Felis viverrina, Limnodromus semipalmatus, Egretta eulophotes, Threskiornis melanocephalus, Pelecanus philippensis, Mycteria leucocephala,,etc.

Sonneratia apetala

Testing technology
Water loggers

Promotional Boards

Box - net boxes

Honey farming
The flowers of sonneratia apetala make the best fodder for beekeeping

Sideline development:·tourism
Natural areas can be divided into parts and developed as tourist attractions.A day in the life of a ranger, led by a professional ranger, allows for safe viewing of the amazing wildlife, with the ranger taking shifts and earning a commission for each day's work.

Mangrove Farming Area
Planting of ***Rhizophora apiculata, avicennia alba,*** and **Nypa fruticans** and ***Acrostitum*** along with the addition of ***Sonneratia apetala*** species in agricultural areas in the low and medium tidal zones in order to protect the soil from attack.

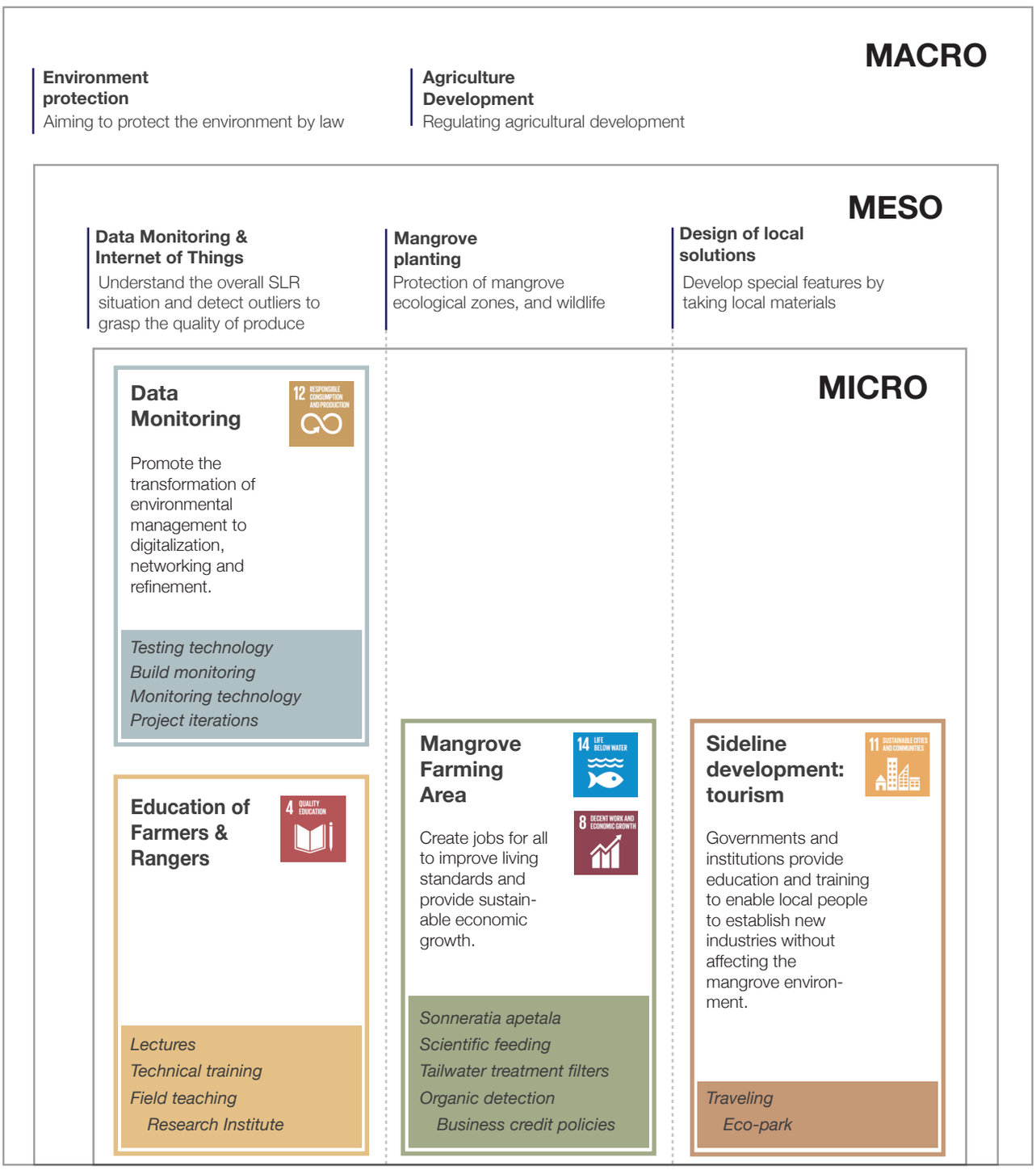
Study of the outcomes .

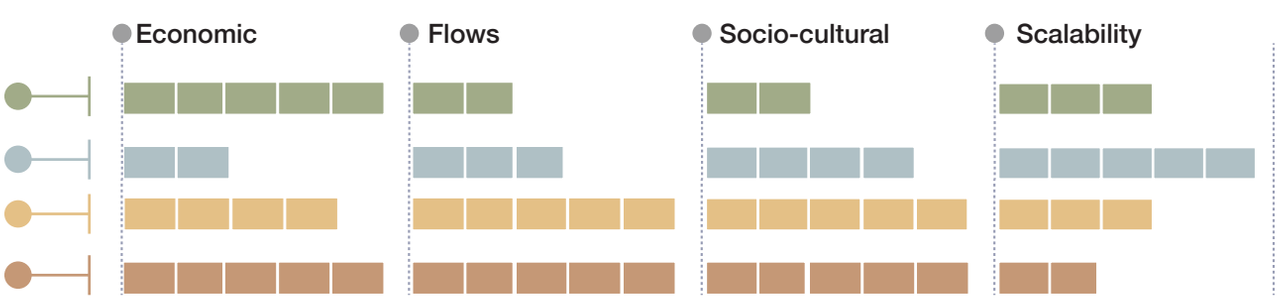
The proposed project will have :

Positive impact on the Can Gio region of Vietnam, both tangible and intangible, which in general will be reflected in socio-cultural, flows, economic, scalability aspects.

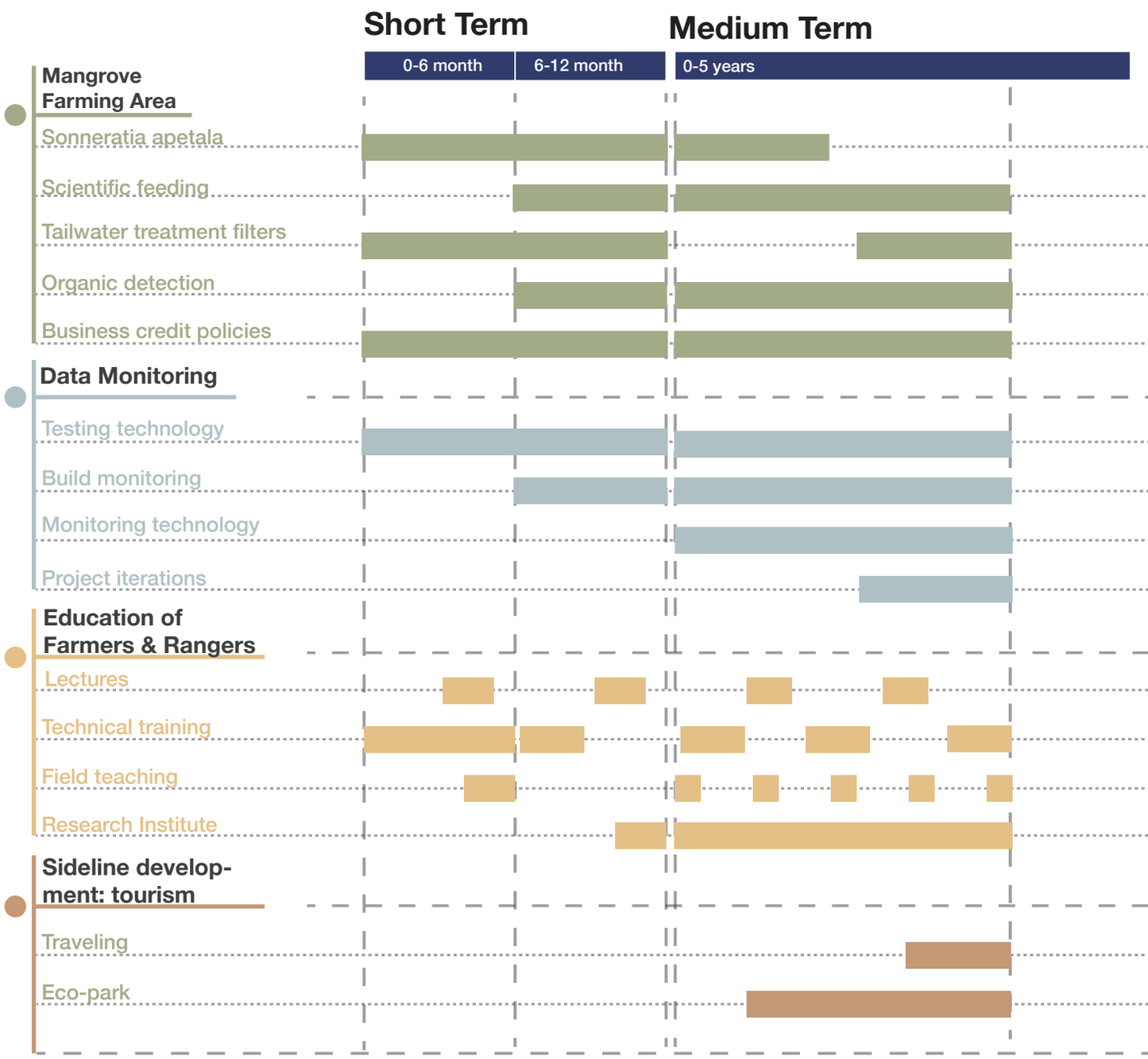
The creation of new networks and the strengthening of different relationships will make this broad positive impact possible.

SCALE OF THE OUTCOMES .

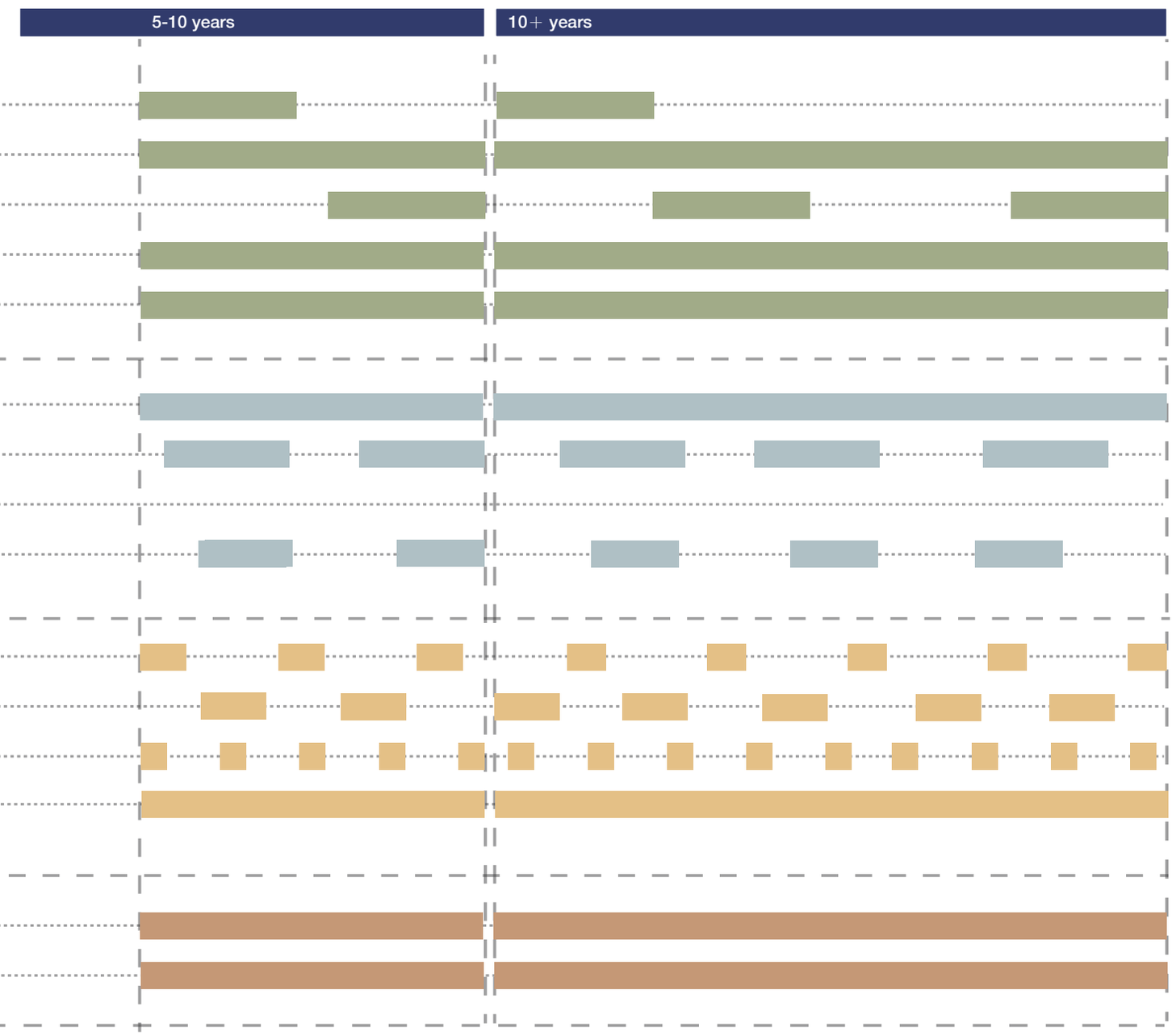




IMPLEMENTATION PLAN .



Long Terrn



V CONCLUSION

5.2 VIETNAM (CAN GIO)

Rising sea levels bring more than just inundation and erosion. For us designers, we need to calmly analyse the patterns and characteristics of rising seas and guide and plan in a scientific and rational way in order to discover new opportunities in this seemingly dangerous tide. We are in an increasingly interconnected society and systems design is increasingly able to use the methodologies within that system to solve problems for humanity. The analysis of certain situations in their own context is critical, where the whole is greater than the sum of its parts. Nature is a self-perpetuating circle, and the question of how to use it in a rational way to cope with human-induced damage is central to our discussion.

Based on the realities of Vietnam, the proposed concept of sustainability through 'agricultural development' focuses on transforming the region's living conditions and education levels, thereby increasing the region's income, in order to protect mangroves and stop the rise in sea level. This analysis was carried out through a systems design lens, which provides a different perspective on a region that is slowly transforming towards a more sustainable and nature-respecting region.

Due to the complexity of the scenario and the number of issues to be designed, this thesis defines three separate areas of analysis from large to small: the geographical context of Vietnam, the circular economy as a resilience tool and the framework of current policies. From these, an overall survey was generated separately. Which integrates data from the region, generates a framework of good practice, understands the overall issues currently at play in Vietnam and furthermore selects one of the representative cities as an example to develop a follow-up scenario.

5.2 VIETNAM (CAN GIO)

Specific interventions and areas were identified by incorporating key issues/opportunities in the three survey areas into one system. However, the study faced some limitations, mainly the low level of digitisation and modernisation in the area, some of the proposed farm strategic plans were to require participants to have fixed and accessible watersheds or farms and to agree to install uniform detection tools for data collection and efficient handling of farm waste, areas that are part of the certification of organicisation in the sustainability of this system. Fortunately, in 2016 the People's Committee of Cam Ou Province in Vietnam piloted Decision No. 111 to regulate the province's organic shrimp project as a pilot model for direct payments for aquaculture ecosystem services. The programme was assisted by the International Union for Conservation of Nature (UCN) and, in line with its success, is something that can gradually move to other towns. The addition of the Vietnamese government and professional staff has given the partners in the region clearer objectives and is now being gradually consolidated and improved. The ecological service system for aquaculture is only partly complete and the aim is to involve these participants in long-term changes, following digital and modern good practices. From the ground up, the area's per capita income is guaranteed, followed by a solution to the ecological problems of the woods, using natural forests to reduce the impact of sea level on the local area.

This study attempts to weave together the links between farmers, organisations and government. These farmers, organisations and the government can work together in a gradual and slow manner. While the strategy is analysed and articulated with one region of Can Gio in mind, the considerations presented are applicable to many local delta areas in Vietnam. The proposals are highly scalable and their application is in fact then based on the further development and definition of a territorial system to stop sea level rise. It is also hoped that their territory will become a representative of good practice and a source of inspiration.

5. REFERENCE

Netherlands - Country Commercial Guide. (n.d.). Netherlands—Agriculture. Retrieved 30 January 2023, from *https://www.trade.gov/country-commercial-guides/netherlands-agriculture*

2022 Sea Level Rise Technical Report. (n.d.). Retrieved 30 January 2023, from *https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html*

Ablain, M., Meyssignac, B., Zawadzki, L., Jugier, R., Ribes, A., Spada, G., Benveniste, J., Cazenave, A., & Picot, N. (2019). Uncertainty in satellite estimates of global mean sea-level changes, trend and acceleration. Earth System Science Data, 11(3), 1189–1202. *https://doi.org/10.5194/essd-11-1189-2019*

Ahmad, A., van der Wens, P., Baken, K., de Waal, L., Bhattacharya, P., & Stuyfzand, P. (2020). Arsenic reduction to <1 µg/L in Dutch drinking water. Environment International, 134, 105253. *https://doi.org/10.1016/j.envint.2019.105253*

Báo cáo thống kê. (n.d.). Retrieved 30 January 2023, from *https://www.mard.gov.vn/Pages/bao-cao-thong-ke.aspx*

Barbero, S., & Bicocca, M. (2017). Systemic Design approach in policy-making for sustainable territorial development. The Design Journal, 20, S3496–S3506. *https://doi.org/10.1080/14606925.2017.1352853*

Battistoni, C., Giraldo Nohra, C., & Barbero, S. (2019). A Systemic Design Method to Approach Future Complex Scenarios and Research Towards Sustainability: A Holistic Diagnosis Tool. Sustainability, 11(16), Article 16. *https://doi.org/10.3390/su11164458*

Bedrijfsstructuur: Lichte daling aantal bedrijven in 2021. (n.d.). Retrieved 30 January 2023, from *https://www.agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2286&indicatorID=3049*

Benefits of RTK System – Indian Drone Store. (n.d.). Retrieved 30 January 2023, from http://www.indiandronestore.in/benefits-of-rtk-system/

Bistagnino, L. (2009). Design sistemico: Progettare la sostenibilità produttiva e ambientale / Luigi Bistagnino ; con annotazioni di e commenti di Carlo Petrini ; saggi di Catia Bastioli ... [et al.]. Slow Food.

Boffey, D. (2020, March 27). Utrecht rooftops to be 'greened' with plants and mosses in new plan. The Guardian. https://www.theguardian.com/world/2020/mar/27/utrecht-rooftops-greened-plants-mosses-vertical-forest

Caribbean Islands. (n.d.). Retrieved 30 January 2023, from https://countrystudies.us/caribbean-islands/

Cazenave, A., Dieng, H.-B., Meyssignac, B., von Schuckmann, K., Decharme, B., & Berthier, E. (2014). The rate of sea-level rise. Nature Climate Change, 4(5), 358–361. https://doi.org/10.1038/nclimate2159

Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate. (n.d.). Retrieved 30 January 2023, from https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

Chen, J., Tapley, B., Wilson, C., Cazenave, A., Seo, K., & Kim, J. (2020). Global Ocean Mass Change From GRACE and GRACE Follow-On and Altimeter and Argo Measurements. Geophysical Research Letters, 47(22). https://doi.org/10.1029/2020GL090656

Chen, Y., Shi, H., & Zhao, H. (2021). Summer Phytoplankton Blooms Induced by Upwelling in the Western South China Sea. Frontiers in Marine Science, 8. https://www.frontiersin.org/articles/10.3389/fmars.2021.740130

Coastal floods in Netherlands. (n.d.). Climatechangepost.Com. Retrieved 30 January 2023, from https://www.climatechangepost.com/netherlands/coastal-floods/

CoR - The Netherlands—Water Management. (n.d.). Retrieved 30 January 2023, from https://portal.cor.europa.eu/divisionpowers/Pages/The-Netherlands-Water-Management.aspx

Dame, M. C. W. // U. of N. (n.d.). Rankings // Notre Dame Global Adaptation Initiative // University of Notre Dame. Notre Dame Global Adaptation Initiative. Retrieved 30 January 2023, from https://gain.nd.edu/our-work/country-index/rankings/

Dao, H. T., Masutani, K., & Ishidaira, H. (2017). THE ECONOMIC VALUE OF WATER IN AGRICULTURE AND AQUACULTURE: A CASE STUDY IN SOC TRANG AND BAC LIEU PROVINCE, VIETNAM. Journal of Japan Society of Civil Engineers, Ser. G (Environmental Research), 73(5), I_165-I_172. https://doi.org/10.2208/jscejer.73.I_165

Delta Plan on Spatial Adaptation 2018. (n.d.). [Overzichtspagina]. Spatial Adaptation. Retrieved 30 January 2023, from https://klimaatadaptatienederland.nl/en/policy-programmes/delta-plan-sa/

Delta Works. (2023). In Wikipedia. https://en.wikipedia.org/w/index.php?title=Delta_Works&oldid=1133134352

Desk, H. N. (2022, November 7). Drip irrigation system: All you need to know. Housing News. https://housing.com/news/drip-irrigation-system/

Dieng, H. B., Cazenave, A., Meyssignac, B., & Ablain, M. (2017). New estimate of the current rate of sea level rise from a sea level budget approach. Geophysical Research Letters, 44(8), 3744–3751. https://doi.org/10.1002/2017GL073308

Doorn-Hoekveld, W. van, & Groothuijse, F. (2017). Analysis of the Strengths and Weaknesses of Dutch Water Storage Areas as a Legal Instrument for Flood-risk Prevention. Journal for European Environmental & Planning Law, 14(1), 76–97.
https://doi.org/10.1163/18760104-01401005

Drones in akkerbouw verdubbeld. (2019, May 1). AgriDirect.
https://www.agridirect.nl/blogs/drones-in-akkerbouw-verdubbeld/

Dutch Diamond Approach. (2020, December 6). R2 Wiki.
https://r2.miraheze.org/wiki/Dutch_Diamond_Approach

Dutch farmers flee environmental rules at home to settle in other EU countries. (2021, February 8). POLITICO.
https://www.politico.eu/article/netherlands-farmers-flee-environmental-rules-at-home-settle-other-eu-countries/

Dutch Farmers Protesting Damaging Climate Change Policies. (2022, July 13). John Locke Foundation.
https://www.johnlocke.org/dutch-farmers-protesting-damaging-climate-change-policies%ef%bf%bc/

Dutch Water Facts. (2011, May 31).
https://www.holland.com/global/tourism/information/general/dutch-water-facts.htm

El Niño and La Niña: Frequently asked questions | NOAA Climate.gov. (n.d.). Retrieved 30 January 2023, from https://www.climate.gov/news-features/understanding-climate/el-ni%C3%B1o-and-la-ni%C3%B1a-frequently-asked-questions

Export of key agricultural products of Vietnam: Opportunities and challenges in the coming time. (n.d.). Retrieved 30 January 2023,
from https://vioit.org.vn/en/strategy-policy/export-of-key-agricultural-products-of-vietnam--opportunities-and-challenges-in-the-coming-time-4384.4144.html

File:The Netherlands compared to sealevel.pn—Wikimedia Commons. (n.d.). Retrieved 30 January 2023, from https://commons.wikimedia.org/wiki/File:The_Netherlands_compared_to_sealevel.pn

Firmani, M. (n.d.). PX Web. General Statistics Office of Vietnam. Retrieved 30 January 2023, from https://www.gso.gov.vn/en/px-web/

D. you have a question about breeding climate-friendly dairy cows? A. our expert: Ae. B. Ms. C. (2022, June 3). Breeding climate-friendly dairy cows. WUR.
https://www.wur.nl/en/research-results/research-institutes/livestock-research/show-wlr/breeding-climate-friendly-dairy-cows.htm

Geography | Embassy of the Socialist Republic of Vietnam in the United States. (n.d.). Retrieved 30 January 2023,
from https://vietnamembassy-usa.org/vietnam/geography

Gilliam, F. S. (2016). Forest ecosystems of temperate climatic regions: From ancient use to climate change. New Phytologist, 212(4), 871–887.
https://doi.org/10.1111/nph.14255

Global and European sea level rise. (n.d.). Retrieved 30 January 2023,
from https://www.eea.europa.eu/ims/global-and-european-sea-level-rise

Gomes, A., & Reidsma, P. (2021). Time to Transition: Barriers and Opportunities to Farmer Adoption of Soil GHG Mitigation Practices in Dutch Agriculture. Frontiers in Sustainable Food Systems, 5.
https://www.frontiersin.org/articles/10.3389/fsufs.2021.706113

Greenhouse Tomatoes. (n.d.). Sensoterra. Retrieved 30 January 2023,
from https://www.sensoterra.com/en/cases/agriculture-horticulture/tomatoes/

Haarlem Lake | polder, Netherlands | Britannica. (n.d.). Retrieved 30 January 2023, from https://www.britannica.com/place/Haarlem-Lake

Kaartviewer—Klimaateffectatlas. (n.d.). Retrieved 30 January 2023, from https://www.klimaateffectatlas.nl/nl/

Katsman, C. A., Sterl, A., Beersma, J. J., van den Brink, H. W., Church, J. A., Hazeleger, W., Kopp, R. E., Kroon, D., Kwadijk, J., Lammersen, R., Lowe, J., Oppenheimer, M., Plag, H.-P., Ridley, J., von Storch, H., Vaughan, D. G., Vellinga, P., Vermeersen, L. L. A., van de Wal, R. S. W., & Weisse, R. (2011). Exploring high-end scenarios for local sea level rise to develop flood protection strategies for a low-lying delta—The Netherlands as an example. Climatic Change, 109(3), 617–645. https://doi.org/10.1007/s10584-011-0037-5

KNMI - Hittegolven. (n.d.). Retrieved 30 January 2023, from https://www.knmi.nl/nederland-nu/klimatologie/lijsten/hittegolven

Kuenzer, C., & Vo, T. (2013). Assessing the Ecosystem Services Value of Can Gio Mangrove Biosphere Reserve: Combining Earth-Observation- and Household-Survey-based Analyses. Applied Geography, 45, 167–184. https://doi.org/10.1016/j.apgeog.2013.08.012

Land use in the Netherlands, 2015 | Environmental Data Compendium. (n.d.). Retrieved 30 January 2023, from https://www.clo.nl/en/indicators/en0061-land-use-in-the-netherlands

Le, A. N., Vo, T. N., Nguyen, V. H., & Nguyen, D. M. (2022). Climate trends and climate change scenarios in Ho Chi Minh City. IOP Conference Series: Earth and Environmental Science, 964(1), 012009. https://doi.org/10.1088/1755-1315/964/1/012009

Legeais, J.-F., Meyssignac, B., Faugère, Y., Guerou, A., Ablain, M., Pujol, M.-I., Dufau, C., & Dibarboure, G. (2021). Copernicus Sea Level Space Observations: A Basis for Assessing Mitigation and Developing Adaptation Strategies to Sea Level Rise. Frontiers in Marine Science, 8, 704721. https://doi.org/10.3389/fmars.2021.704721

Lodder, Q., & Slinger, J. (2022). The 'Research for Policy' cycle in Dutch coastal flood risk management: The Coastal Genesis 2 research programme. Ocean & Coastal Management, 219, 106066. https://doi.org/10.1016/j.ocecoaman.2022.106066

Hervouet, J.-M. (2000). TELEMAC modelling system: An overview. Hydrological Processes, 14(13), 2209–2210. https://doi.org/10.1002/1099-1085(200009)14:13<2209::AID-HYP23>3.0.CO;2-6

Hirose, K., Maruyama, Y., Shiokawa, Y., Triet, T., & Hang, H. T. M. (n.d.). A CASE STUDY OF MANGROVE FOREST MONITORING IN CAN GIO DISTRICT, SOUTHERN VIETNAM.

Hofman-Caris, R., Bertelkamp, C., de Waal, L., van den Brand, T., Hofman, J., van der Aa, R., & van der Hoek, J. P. (2019). Rainwater Harvesting for Drinking Water Production: A Sustainable and Cost-Effective Solution in The Netherlands? Water, 11(3), Article 3. https://doi.org/10.3390/w11030511

https://plus.google.com/+UNESCO. (2018, December 17). Can Gio Mangrove Biosphere Reserve, Viet Nam. UNESCO. https://en.unesco.org/biosphere/aspac/can-gio

https://www.jpl.nasa.gov. (n.d.). Sea Level to Rise up to a Foot by 2050, Interagency Report Finds. NASA Jet Propulsion Laboratory (JPL). Retrieved 30 January 2023, from https://www.jpl.nasa.gov/news/sea-level-to-rise-up-to-a-foot-by-2050-interagency-report-finds

Hunter, J. R. (n.d.). A Note on Relative Sea Level Change at Funafuti, Tuvalu.

Hussain, M. S., Abd-Elhamid, H. F., Javadi, A. A., & Sherif, M. M. (2019). Management of Seawater Intrusion in Coastal Aquifers: A Review. Water, 11(12), Article 12. https://doi.org/10.3390/w11122467

IPCC — Intergovernmental Panel on Climate Change. (n.d.). Retrieved 30 January 2023, from https://www.ipcc.ch/

Islands of the Commonwealth Caribbean: A regional study. (n.d.). [Image]. Library of Congress, Washington, D.C. 20540 USA. Retrieved 30 January 2023, from https://www.loc.gov/item/88600483/

Marchand, M. (2008). Mangrove restoration in Vietnam: Key considerations and a practical guide. https://repository.tudelft.nl/islandora/object/uuid%3A98b5ba43-1452-4631-81dc-ad043ef3992c

Ministerie van Economische Zaken, L. en I. (2019a, February 1). Climate policy—Climate change—Government.nl [Onderwerp]. Ministerie van Algemene Zaken. https://www.government.nl/topics/climate-change/climate-policy

Ministerie van Economische Zaken, L. en I. (2019b, February 1). Climate policy—Climate change—Government.nl [Onderwerp]. Ministerie van Algemene Zaken. https://www.government.nl/topics/climate-change/climate-policy

More, C. ing Hb. C. form + S. (2021, March 3). Coping with Dutch droughts: Irrigation in the Netherlands. WUR. https://www.wur.nl/en/project/coping-with-dutch-droughts-irrigation-in-the-netherlands.htm

Nam, V. N., My, T. V., & Jensen, M. (1993). Mangrove for production and protection. A changing resource system: Case study in Can Gio District, Southern Vietnam. https://scholar.google.com/scholar_lookup?title=Mangrove+-for+production+and+protection.+A+changing+resource+system%3A+Case+study+in+Can+Gio+District%2C+Southern+Vietnam&author=Vien+Ngoc+Nam&publication_year=1993

Nasuchon, N. (n.d.). COASTAL MANAGEMENT AND COMMUNITY MANAGEMENT IN MALAYSIA, VIETNAM, CAMBODIA AND THAILAND, WITH A CASE STUDY OF THAI FISHERIES MANAGEMENT.

National Park Lauwersmeer. (n.d.). Visit Groningen. Retrieved 30 January 2023, from https://www.visitgroningen.nl/en/locations/province/nationaal-park-lauwersmeer

OECD. (2015a). Innovation, Agricultural Productivity and Sustainability in the Netherlands. Organisation for Economic Co-operation and Development.
https://www.oecd-ilibrary.org/agriculture-and-food/innovation-agricultural-productivity-and-sustainability-in-the-netherlands_9789264238473-en

OECD. (2015b). OECD Environmental Performance Reviews: The Netherlands 2015. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/environment/oecd-environmental-performance-reviews-the-netherlands-2015_9789264240056-en

Ontdek het Keringhuis. (n.d.). Retrieved 30 January 2023,
from https://www.keringhuis.nl/ontdek-het-keringhuis#luchtfoto

Open-File Report (Open-File Report). (2021). [Open-File Report].
Precipitation increase in the Netherlands in the past century. (n.d.). Climatechangepost.Com. Retrieved 30 January 2023,
from http://www.climatechangepost.com/news/2013/5/21/precipitation-increase-netherlands-past-century/

Provide enough freshwater: WUR and delta management. (2019, February 14). WUR. https://www.wur.nl/en/article/provide-enough-freshwater-wur-and-delta-management.htm

Publication preview page | FAO | Food and Agriculture Organization of the United Nations. (n.d.). FAODocuments. Retrieved 30 January 2023,
from https://www.fao.org/documents/card/en?details=I9540EN/

Risk and coastal zone policy: Example from the Netherlands—Coastal Wiki. (n.d.). Retrieved 30 January 2023,
from http://www.coastalwiki.org/wiki/Risk_and_coastal_zone_policy:_example_from_the_Netherlands#cite_note-CPD2000-7

Rooftop Catalogue. (2021, May 31).
https://www.mvrdv.nl/shop/4081/rooftop-catalogue

Scussolini, P., Tran, T. V. T., Koks, E., Diaz-Loaiza, A., Ho, P. L., & Lasage, R. (2017). Adaptation to Sea Level Rise: A Multidisciplinary Analysis for Ho Chi Minh City, Vietnam. Water Resources Research, 53(12), 10841–10857.
https://doi.org/10.1002/2017WR021344

Sea Level Rise. (n.d.). Retrieved 30 January 2023, from https://meeresspiegel-monitor.de/cuxhaven/sla/index.php.de

Sea-level Rise Vulnerability of Mangrove Forests in Micronesia and the Pacific | U.S. Geological Survey. (n.d.). Retrieved 30 January 2023,
from https://www.usgs.gov/centers/werc/science/sea-level-rise-vulnerability-mangrove-forests-micronesia-and-pacific?qt-science_center_objects=0#qt-science_center_objects

SeaLevelRise.org. (n.d.). Florida's Sea Level Is Rising. Sea Level Rise. Retrieved 30 January 2023,
from https://sealevelrise.org/states/florida/

Shrimping Horizons: How Shrimp Farmers are Saving Thousands of Hectares of Mangroves in Vietnam. (2018, August 20).
https://panorama.solutions/en/solution/shrimping-horizons-how-shrimp-farmers-are-saving-thousands-hectares-mangroves-vietnam

Sonneratia apetala—Useful Tropical Plants. (n.d.). Retrieved 30 January 2023,
from https://tropical.theferns.info/viewtropical.php?id=Sonneratia+apetala

Special Report on the Ocean and Cryosphere in a Changing Climate—. (n.d.). Retrieved 30 January 2023,
from https://www.ipcc.ch/srocc/

Squintani, L., Plambeck, E., & Rijswick, M. van. (2017). Strengths and Weaknesses of the Dutch Implementation of the Water Framework Directive. Journal for European Environmental & Planning Law, 14(3–4), 269–293.
https://doi.org/10.1163/18760104-01403002

Sustainable Land Use and Rural Development in Southeast Asia: Innovations and Policies for Mountainous Areas. (n.d.). Retrieved 30 January 2023,
from https://link.springer.com/book/10.1007/978-3-642-33377-4

System of Environmental-Economic Accounting for Water Resources—EconStatKB - UN Statistics Wiki. (n.d.). Retrieved 30 January 2023,
from https://unstats.un.org/wiki/display/EC/System+of+Environmental-Economic+Accounting+for+Water+Resources?preview=%2F101353910%2F106496542%2FSEEA-Water.pdf

The U.S. Military and the Herbicide Program in Vietnam—Veterans and Agent Orange—NCBI Bookshelf. (n.d.). Retrieved 30 January 2023, from https://www.ncbi.nlm.nih.gov/books/NBK236347/

thuyduong. (n.d.). Action plan on Central Highlands development issued. General Statistics Office of Vietnam. Retrieved 30 January 2023, from https://www.gso.gov.vn/en/other-news/2022/11/action-plan-on-central-highlands-development-issued/

Tuan, V. Q., & Kuenzer, D. C. (n.d.-a). Can Gio Mangrove Biosphere Reserve Evaluation 2012.

Tuan, V. Q., & Kuenzer, D. C. (n.d.-b). Can Gio Mangrove Biosphere Reserve Evaluation 2012.

Tuan, V. Q., & Kuenzer, D. C. (n.d.-c). Can Gio Mangrove Biosphere Reserve Evaluation 2012.

Vereinte Nationen (Ed.). (2012a). System of environmental-economic accounting for water. United Nations.Vereinte Nationen (Ed.). (2012b). System of environmental-economic accounting for water. United Nations.

Vizzuality. (n.d.). Law on Natural Disaster Prevention and Control No. 33/2013/QH13 and Decree No. 66/2021/ND-CP - Vietnam—Climate Change Laws of the World. Retrieved 30 January 2023, from https://climate-laws.org/geographies/vietnam/laws/law-on-natural-disaster-prevention-and-control-no-33-2013-qh13-and-decree-no-66-2021-nd-cp

von Schuckmann, K., Le Traon, P.-Y., Smith, N., Pascual, A., Brasseur, P., Fennel, K., Djavidnia, S., Aaboe, S., Fanjul, E. A., Autret, E., Axell, L., Aznar, R., Benincasa, M., Bentamy, A., Boberg, F., Bourdallé-Badie, R., Nardelli, B. B., Brando, V. E., Bricaud, C., … Zuo, H. (2018). Copernicus Marine Service Ocean State Report. Journal of Operational Oceanography, 11(sup1), S1–S142. https://doi.org/10.1080/1755876X.2018.1489208

Watersquare Benthemplein, Rotterdam. (n.d.). DE URBANISTEN. Retrieved 30 January 2023, from https://www.urbanisten.nl/work/benthemplein

Waterstaat, M. van I. en. (n.d.). Oosterscheldekering [Webpagina]. Retrieved 30 January 2023, from http://www.rijkswaterstaat.nl/water/waterbeheer/bescherming-tegen-het-water/waterkeringen/deltawerken/oosterscheldekering

WCRP Global Sea Level Budget Group. (2018). Global sea-level budget 1993–present. Earth System Science Data, 10(3), 1551–1590. https://doi.org/10.5194/essd-10-1551-2018

What is “Precision Farming”? | The Quest for Precision Farming | Kubota Global Site. (n.d.). Retrieved 30 January 2023, from https://www.kubota.com/global-index/precision-farming/01.html

WIPO. (n.d.). Global Innovation Index 2022, 15th Edition. https://doi.org/10.34667/tind.46596

World Bank Climate Change Knowledge Portal. (n.d.-a). Retrieved 30 January 2023, from https://climateknowledgeportal.worldbank.org/

World Bank Climate Change Knowledge Portal. (n.d.-b). Retrieved 30 January 2023, from https://climateknowledgeportal.worldbank.org/

World Bank Climate Change Knowledge Portal. (n.d.-c). Retrieved 30 January 2023, from https://climateknowledgeportal.worldbank.org/