The Path towards Modern Urban Renewal

Adaptive reconstruction process after tsunami disaster in coastal cities of Japan

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DIMI Delft Infrastructures & Mobility Initiative

TOHOKU UNIVERSITY

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Summary

Japan has a vast history of earthquake and tsunami disasters that Japan had to cope with, the country can be defined as a disaster society. The most recent disaster, The Great East Japan Earthquake with a magnitude of 9.0, resulted in a tsunami which had a devastating effect on the coastal regions of Tohoku. However, these crisis situations also offer a potential for implementing innovative concepts and strategies regarding disaster recovery.

Japan copes with high volumes of precipitation and a rapid aging and declining population. Furthermore, as a result of the shutdown of almost all the nuclear energy plants after the tsunami there is a need for other (renewable) energy sources. It is important to take this trauma into account where most of the people want to recover what was lost. This causes a friction between the urge to develop new areas and recover what was there before, which results in defining the concept of Traditional Urban Recovery (TUR).

There is a need for change from Traditional Urban Recovery to a new concept, Modern Urban Renewal (MUR). MUR in the context of Japan is defined as a combination of multiple concepts and topics that are systematically integrated together and strengthened by the community providing balance between water and land. These include four topics: physical living quality, environment, energy, and tsunami resilience. This research project is using the Dynamic Adaptation Policy Pathway (DAPP) approach as guiding method in order to shift from TUR towards MUR or learn how to directly implement MUR after a disaster. In order to strengthen this approach a set of supplementing methods is chosen. One of the supplementing methods used is the multidisciplinary approach. There are many problems in a disaster society such as in Japan which cannot be fully addressed by one scientific discipline. To resolve problems of a disaster society, contributions from many disciplines are needed, with inputs that should preferably be balanced and integrated.

Actions that are developed to generate pathways and strategies are derived from the process analysis and spatial analysis. After defining the current situation of Yuriage the developed actions can be added to the pathway map. There are two phases that the strategy will go through: adaptation and resilience. The first phase starts from the current situation of Yuriage where some hard engineered solutions have been applied. the adaptation phase provides a foundation for the shift towards more resilient solutions. In phase two the transition from adaptive solutions towards resilient solutions is supported. Most of the hard engineered solutions are replaced by natural processes. However, in some cases the civil constructions and nature based solutions strengthened each other and were therefore combined to increase resilience.

The hypothesis is that following a pathway for each of the four themes from adaptive actions to resilient actions Modern Urban Renewal is reached. The strategy is tested on its performance by translating the pathways in a design proposal for the coastal village Yuriage. The design can be divided into four sections: the coast, the harbor, the housing area, and the energy hub. By using the DAPP approach a set of steps is developed that can be followed in order to reach MUR faster in case of a new disaster situation.

Table of Contents

Acronyms

BBB	Build Back Better
BFE	Base Flood Elevation
DAPP	Dynamic Adaptive Policy Pathway
GEJE	Great East Japan Earthquake
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JSMCWM	Japan Society of Material Cycles and Waste Management
METI	Ministry of Economy, Trade and Industry
MUR	Moder Urban Renewal
TUR	Traditional Urban Recovery
UNISDR	The United Nations Office for Disaster Risk Reduction

List of Figures

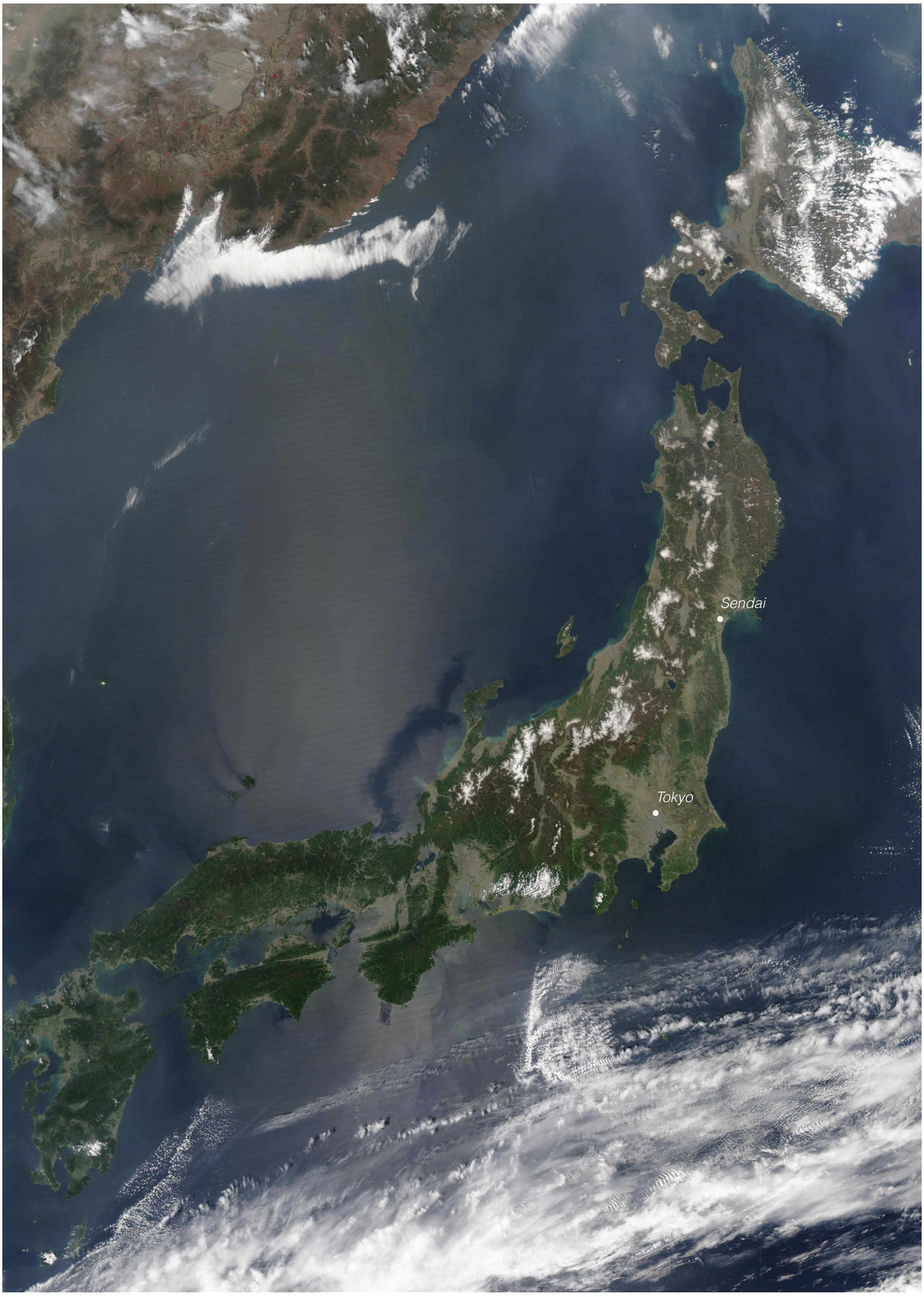

figure 1. Satellite image of Japan. NASA

Introduction

Throughout human history, most of the major settlements were developed along coastal areas or rivers, which provided trading routes or fertile lands. These lands were either low-lying coastal zones or river deltas. As a result, this process led to a large part of the world's population living in low elevation urbanized areas which are, almost always, vulnerable to flooding due to a combination of storm surges, high tides, river discharges and human induced stresses such as urbanization and subsidence (P. van Veelen, Voorendt, & Zwet, 2015). Studies have indicated that losses from flood hazards are expected to increase in the coming years (Kellens, Terpstra, & De Maeyer, 2013). Due to the effects of global warming, such as an increased amount of heavy storms and the rising sea level, many of these coastal cities face increasing risk of flooding.

In Japan, about 49% of the population lives and 75% of real estate is built in these low-lying coastal zones (Zhai & Ikeda, 2008). This is due to the topographical lay-out of Japan which consists 61% out of steep mountainous areas that are mainly inhabitable (Graaf & Hooimeijer, 2008). Recent events have shown the vulnerability of urban settlements in delta regions and the devastating force of natural events. On March 2011, the most powerful earthquake in Japanese history was recorded with a magnitude of 9.0. As the 3/11 earthquake originated from a depth of only 32 km, the seafloor was uplifted (approx. 30-40 m; USGS, 2011a) and caused a major tsunami, inundating 516 km^2 of the eastern coastline of Japan (GSI, 2012). The tsunami reached waves with heights up to 15 meters destroying almost all coastal villages completely of the Tohoku region in the north-eastern part of Japan. This resulted in 16.000 deaths, 2.000 still missing, and damages estimated around 122 billion dollar (Arm, Vervaeck, & Daniell, 2012). In addition, the tsunami destroyed the Fukushima Daiichi Nuclear Power Plant, resulting in a nuclear disaster and heavy power shortages. The release of radioactive substances into air and sea had devastating effects on the environment and has made it impossible for residents to return to their former homes. In fact, residents and local governments are still recovering from the tsunami disaster. Until February 2017 there were still around 150,000 evacuees without homes, of which 50,000 were still living in temporary housing, stated by Japan's Reconstruction Agency.

Although there is no doubt that such a disaster is a horrific event, one could say that it also offers new possibilities. Because everything is washed away, a tabula rasa is created. This offers room to implement new innovative building concepts and tsunami mitigation techniques. Despite the fact that government and municipalities has already started performing a more traditional urban recovery with mainly hard engineered solutions, the question that arises is if this is the right direction of recovery and whether it effects the relationship between the people and the water.

The 2011 tsunami proves that hard engineered structures alone is not enough for successful tsunami mitigation. Uncertainty and natural dynamics challenge the engineered approach. Therefore one of the biggest challenges of adapting existing urban environments is that it requires long-term thinking and the ability to anticipate on trends that can easily exceed periods of 50 to 100 years (P. C. van Veelen, 2016). This forms a challenge for the design and planning process as it brings many uncertainties.

This leads to the aim of this research project, which is, to explore and understand the reconstruction process after a tsunami disaster and develop a method which helps shifting from traditional urban recovery towards a more modern urban renewal approach.

Prologue

When walking around in Japanese cities there are two elements that keep returning: Water and land. Everywhere you look water is integrated in the public spaces, connecting the water to the land. Each system, function, human or natural process is being reflected in the water. The picture below represents this reflection where you see nature and the built environment reflecting in the water. It is as if the water tells what happens on the land. This phenomena is a returning concept in the cities of Japan. Lakes and canals are designed in a way that the observer experiences this connection between land and water. It emphasizes the fact that water is part of the land and vice versa. However, it is not only about the visual reflection, the water also reflects the daily lives of people and industries and how it is being used for activities such as generating energy, leisure, waste treatment or purely visual esthetics. These functions influence the quality of the water and therefore the quality of the land around it, especially at the estuary of a river. Normally the transition between water and land is done in a natural way, for example through natural infiltration. However, to increase safety and quality of the water and land the transition can be helped or even directed through hydrological engineering. It forms the bridge, or actually the pipe, between water and land. This transition is a very delicate process and with the slightest mistakes it can completely distort environments. Therefore, it is important to understand these natural processes and the balance between land and water in order to successfully guide these processes.

figure 2. Reflection of the city and natural systems. Author

CONTEXT

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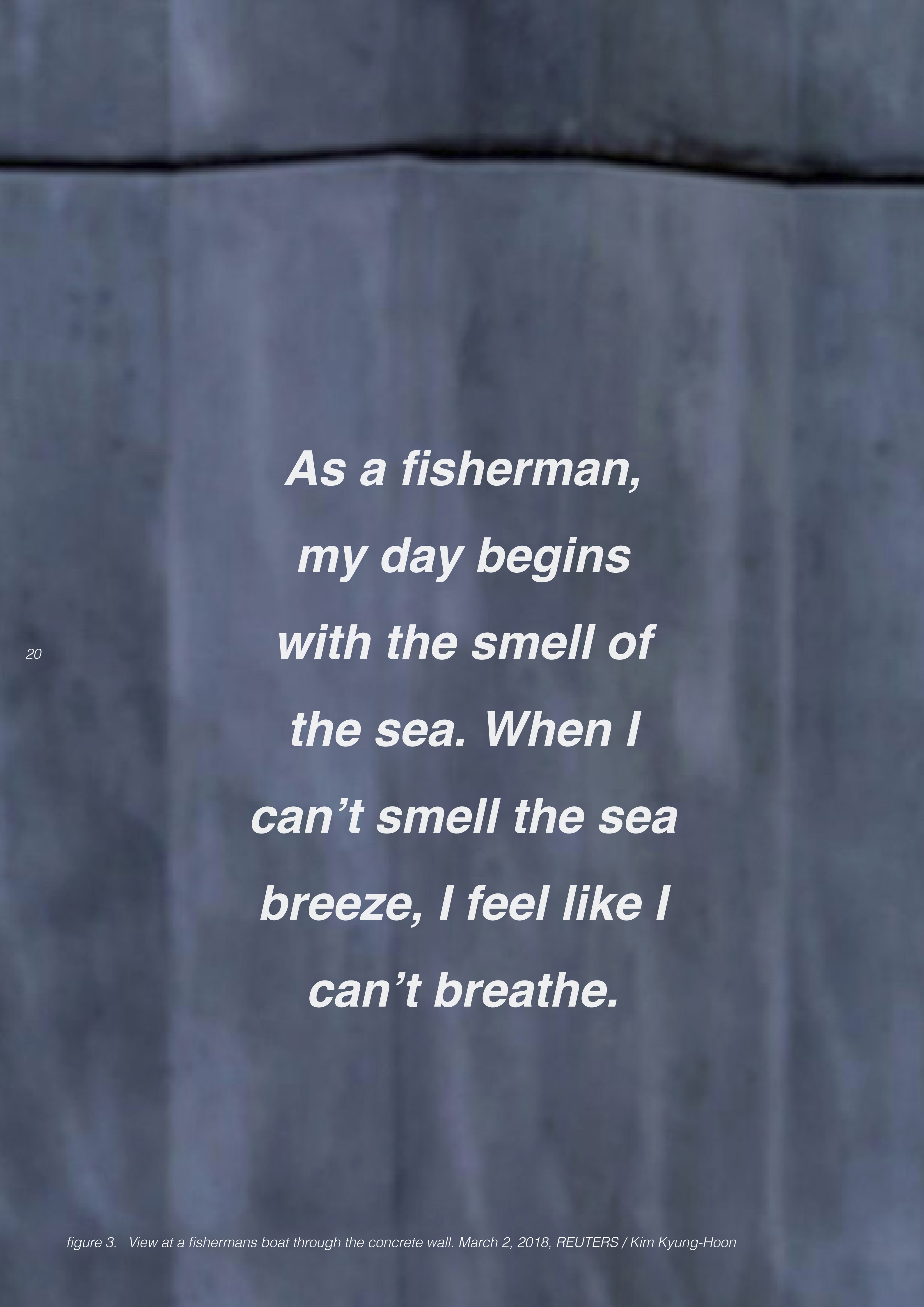


As a fisherman, my day begins with the smell of the sea. When I can't smell the sea breeze, I feel like I can't breathe.

figure 3. View at a fishermans boat through the concrete wall. March 2, 2018, REUTERS / Kim Kyung-Hoon

Dynamic systems of Japan

Many different dynamic systems shape Japan as it is today. As explained in the prologue land and water play an important role on how spaces are used by the people living and working in Japan. This section illustrates the four main dynamic systems that take place on land and water: heights, soil, climate and industry. Although the systems are analyzed for the national scale, a focus lies on the prefecture Miyagi North-East of Japan. The goal of this study is to get an understanding of processes taking place that influence the redevelopment of cities or villages flushed away by a tsunami disaster. On the left page the dynamic systems of the land are illustrated, whereas on the right page the systems of the water are shown.

LAND

Topography
Industry + economy

WATER

Bathymetry
Industry + Economy

figure 4. Topography of Japan

Topography

Japan has a very characteristic topographic layout. Almost 65% of the country has slopes steeper that 14% which are not fit for habitation. The remaining 39% consists of hills (12%) terraces (11%) and plains (16%). The transition from plains or terraces to the steep slopes is done in a very rapid way over a short distance.

Relief

Flat Steep

100 KM

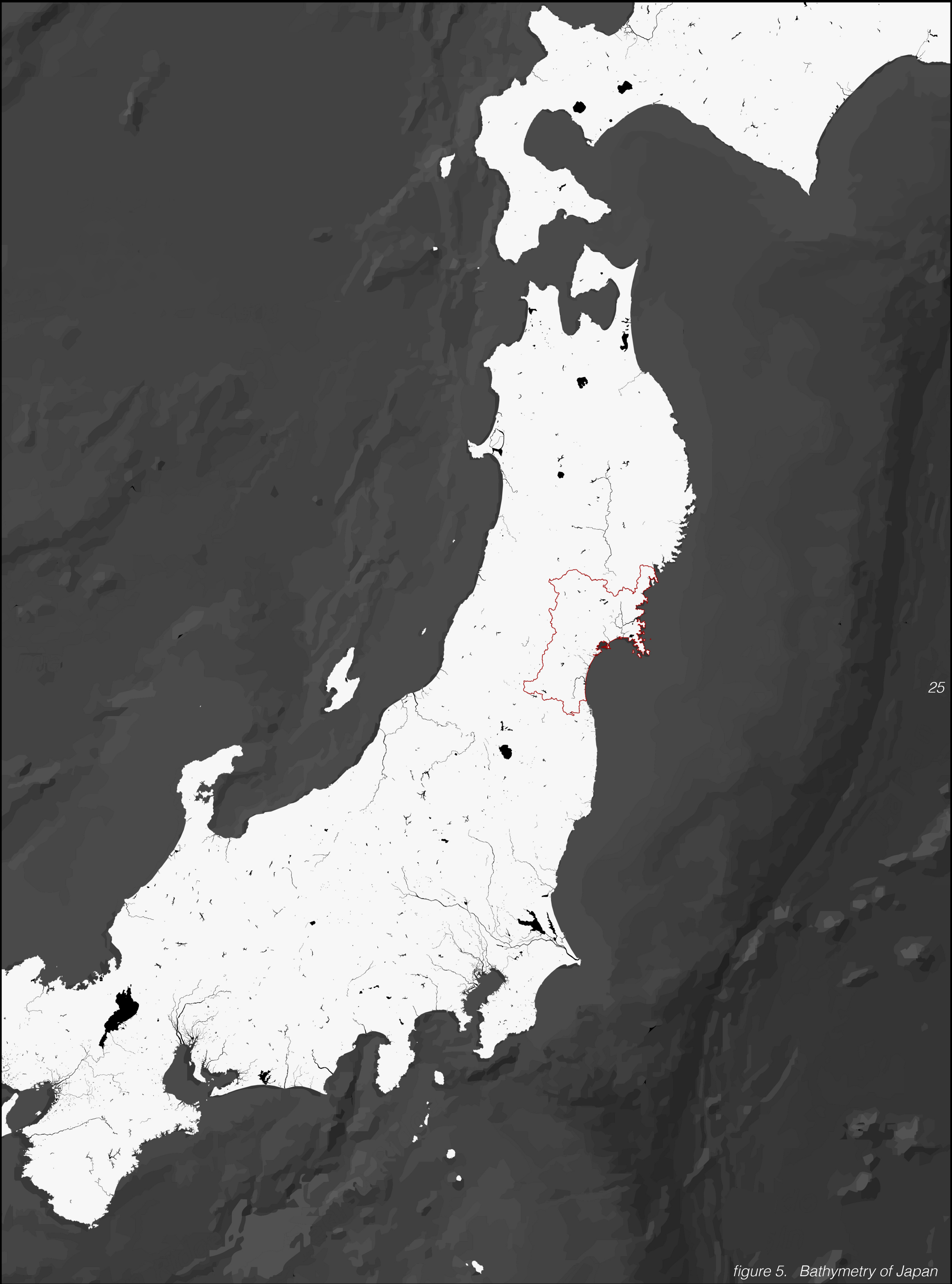


figure 5. Bathymetry of Japan

BATHYMETRY

The upper continental slope off Northwest Japan descends very gradually, forming a broad, gently sloping deep-sea terrace between depth of about 1,000-3,500 m before descending more steeply into the Japan Trench which reaches a depth of almost 7700 meters.

Depth

-20 -2000 -7500

100 KM

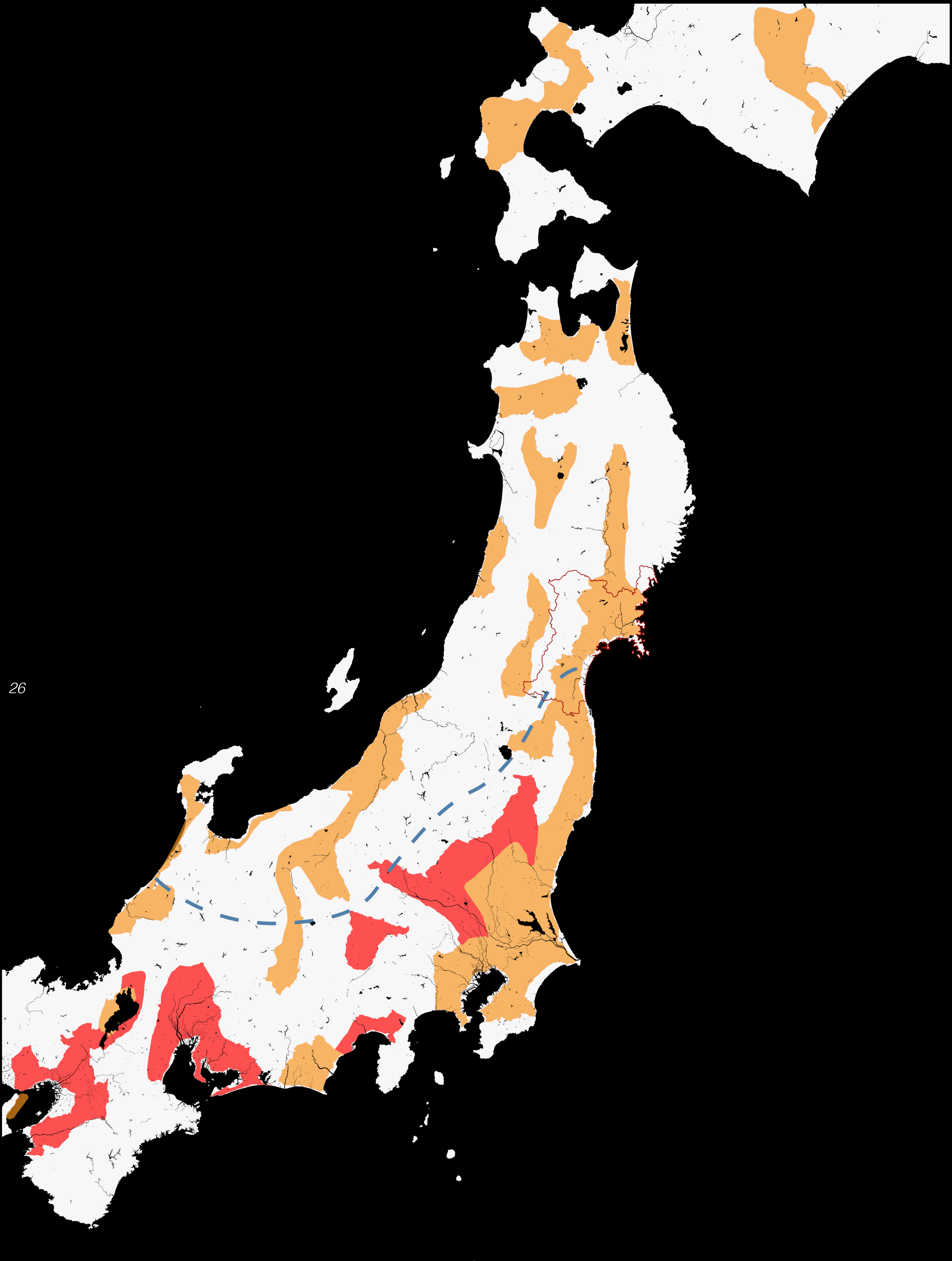


figure 6. Rice industry of Japan

INDUSTRY

One of the main industries of Japan that occur on the land is the production of Rice, especially in the southern parts of Japan. The reason for this is the climate difference between the north and the south.

Rice production

- Double cropping; Paddy rice dominant with wheat and barley and dry crops
- Single cropping; Paddy rice
- Northern limit of winter crops in paddy fields

100 KM

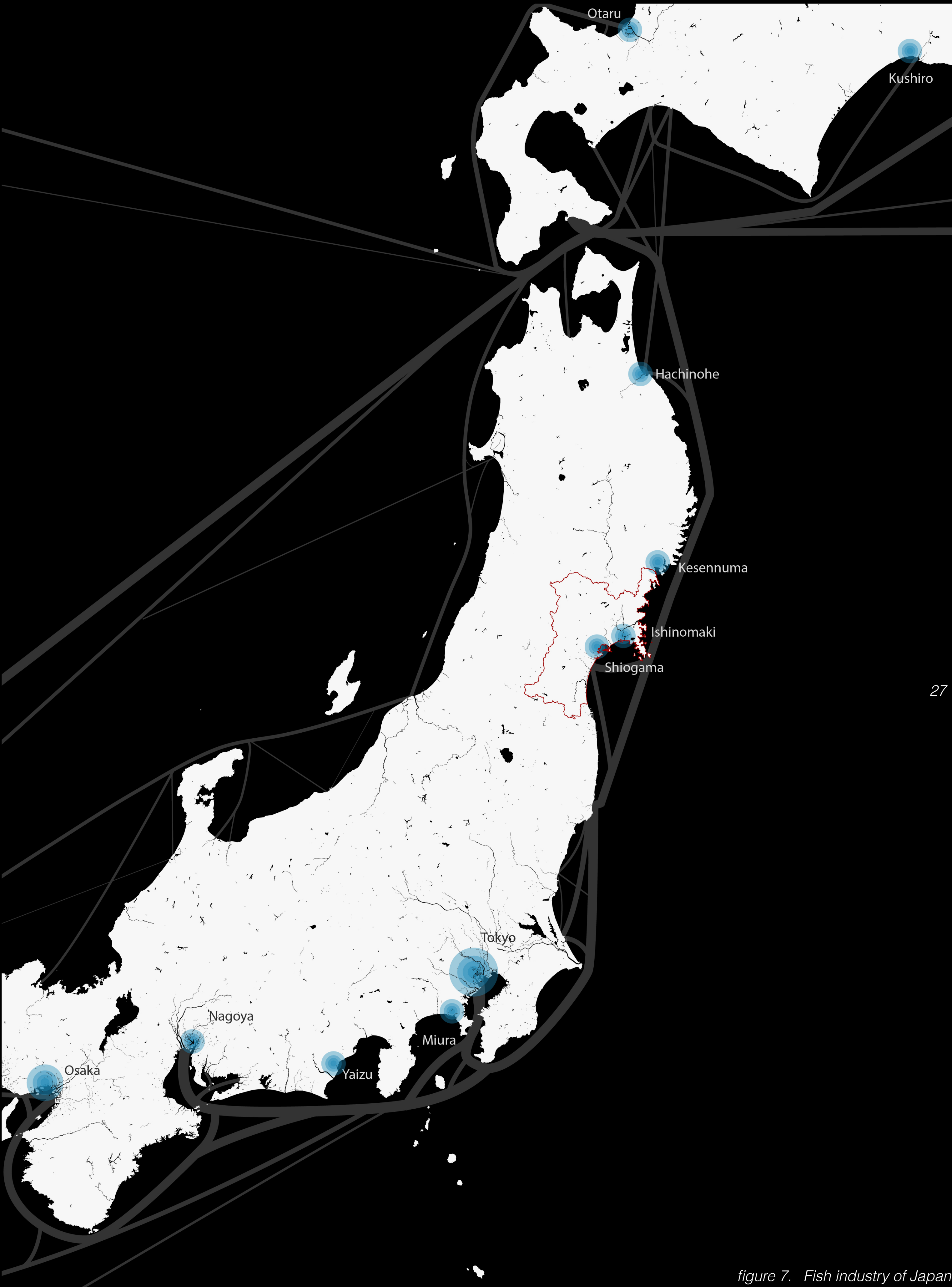


figure 7. Fish industry of Japan

INDUSTRY

The main industry in the sea-domain is the fishing industry. Noticeable is that around Ishinomaki multiple major fishing ports are located. Because of the rich fishing grounds most of the fish is caught in these waters. Tokyo, Nagoya and Osaka are three of the major trading ports in Japan because of their important status.

Industries
- Shipping routes
- Main fishing ports

100 KM

Conclusions

Heights

The largest part of Japan consists of steep hills which are not fit for habitation. Therefore most cities and villages are located at the plains close to the sea. Interesting to see is the short transition distance between the plains and steep slopes. This causes high runoff during periods of precipitation increasing the water volume to the plains. The plains themselves have a high risk of flooding due to their low-lying and flat character.

In the bathymetry we can see that the relief is almost a mirrored projection of the topography on land. From the coast a long shallow sea floor stretches out until it reaches the Japan ridge that descends to almost 7700 meters. Similar as the land, the transition between the shallow and deep sea happens in a rapid way. This bathymetry causes the water volume from the deep sea to compress at the shallow sea, causing higher waves when reaching shore.

Soil

The main soil type in the Miyagi prefecture are fluvic soils which received fresh material from the sea over time. Resulting in fertile soft ground along the coast. The mountainous parts of Miyagi mainly consist of brown forest soil. The overall temperature of the soil in Japan is around 8 - 15 degrees. However, the North parts have temperatures of less than 8 degrees and in the South reaching temperatures of around 15 - 22 degrees Celsius. These soil temperatures can influence the way the soil can be used. For example, when using geothermal heating.

Climate

There is a clear distinction between the East and West side of Japan. Because of the mountain ridge splitting the country in two, the climate differs on each side. This is especially noticeable in the amount of precipitation. The East side receives the most precipitation with at some points even 4000 ml a year which is almost double the world average. This has a major impact on volume of the water runoff in the river basins. The West side of Japan has the highest temperatures and amount of sun hours.

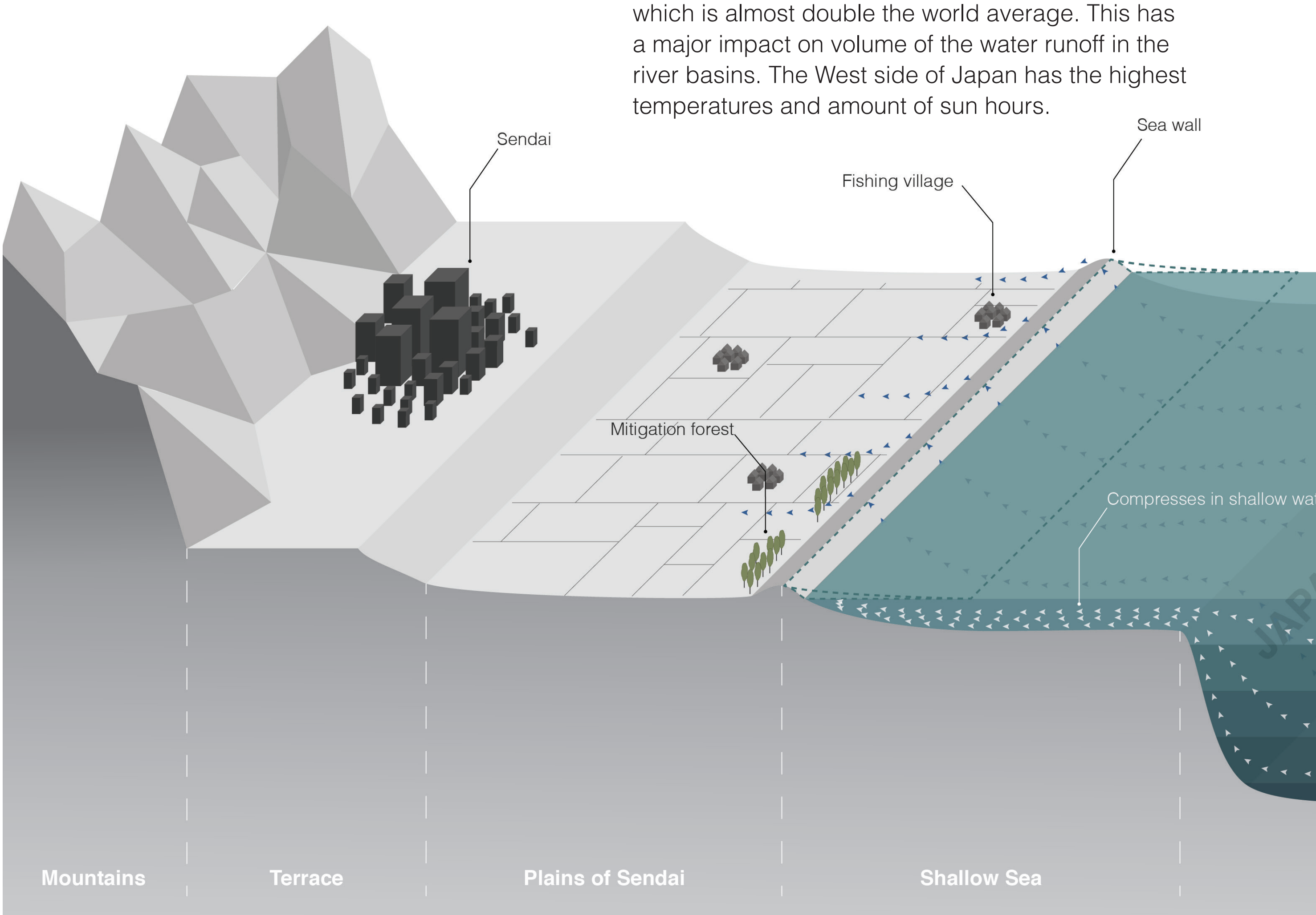


figure 8. Conceptional representation of the dynamics in the Sendai Bay. Author

Interesting to see are the two main currents colliding at the coast of japan. Warm and cold ocean currents cause a wide variety of temperatures that result in many different marine communities and creating a rich biodiversity in the ocean.

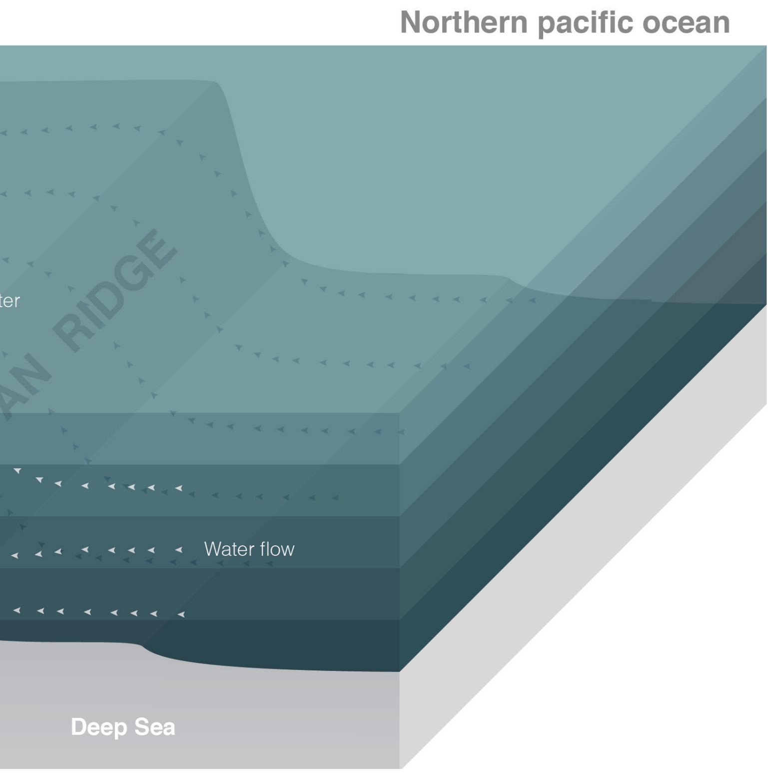
Industry

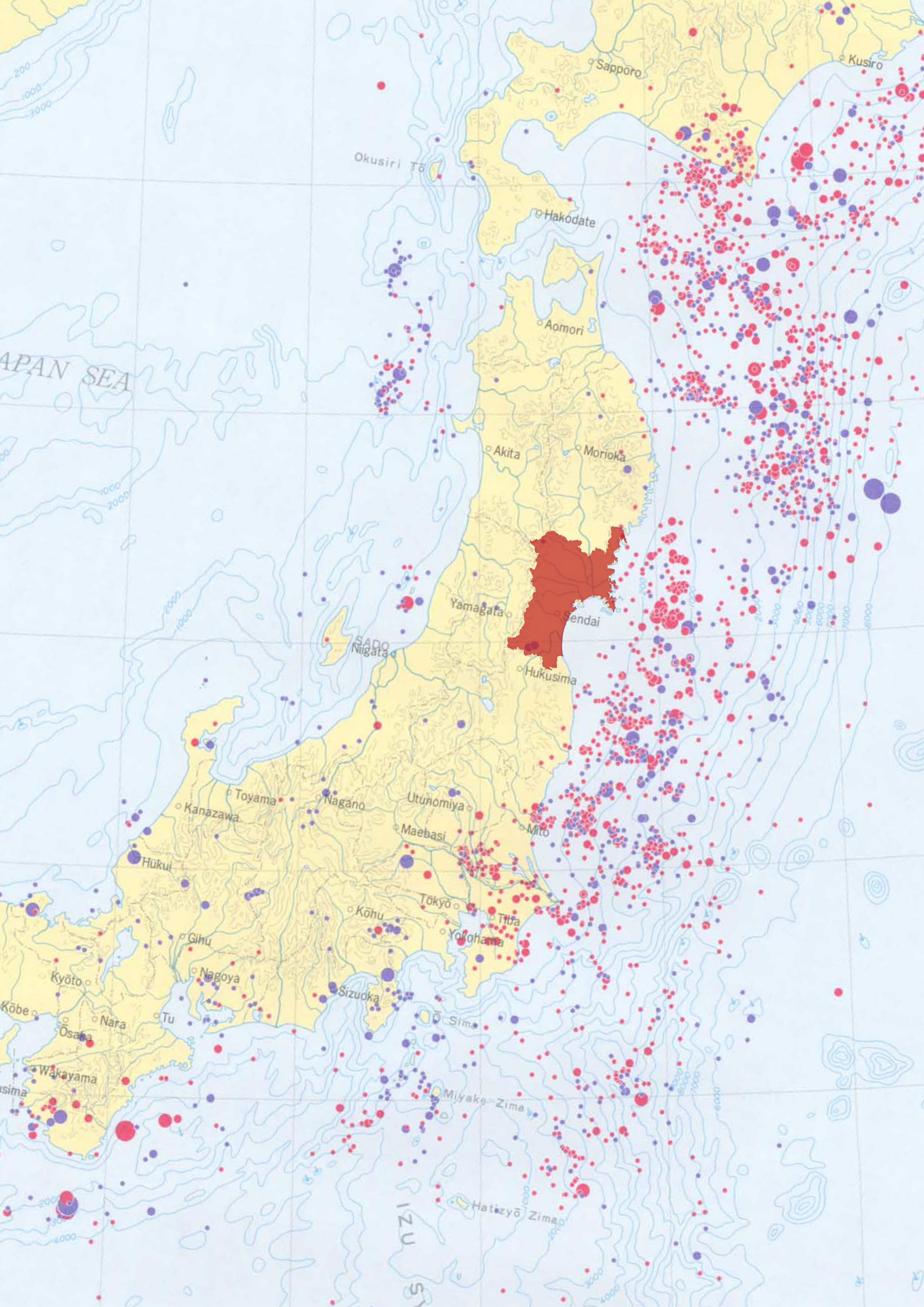
Japan is world famous for their rice production, and the Miyagi prefecture is no exception in that. From the 47 prefectures, Miyagi positions itself on the sixth place in amount of annual rice production. Because of the wet grounds and large amount of sun hours this location is ideal to grow crops. Therefore, rice production is one of the main industries of Miyagi.

When looking at the sea-domain it is clear that the fishing industry is very dominant throughout the whole of Japan. Because of rich eutrophic body of water North-West of Japan that attracts lots of fish there are many fishing ports located in this area, especially around Ishinomaki in the Northern part of Miyagi. With more than 247 ton of annual fish catches Miyagi is placed third compared with the 47 prefectures. This shows that the main industry of Miyagi are fishing and rice ("Statistics Japan", n.d.).

Section

In figure 8 the most important aspects of the conclusions are shown. The section illustrates the process of compressed water volumes that cause an overflow at the coastal area. In addition, an abstract representation is shown of the Sendai Plains. The plains are divided in steep mountainous land that transition into terraces where Sendai is located. The terraces change into the long stretched out plains where most of the agricultural industries are situated. Passing a coastal embankment and forest there is a long shallow sea that eventually descends to the deep sea at the Japan Ridge.





Sapporo
Kusiro
Okusiri To
Hakodate
Aomori
APAN SEA
Akita
Morioka
Yamagata
Sendai
SADO
Niigata
Hukusima
Toyama
Kanazawa
Nagano
Utunomiya
Maebasi
Mito
Hukui
Tokyo
Kohu
Tiba
Gihu
Yokohama
Kyoto
Nagoya
Sizuoka
Kobe
Nara
Tu
Osaka
Wakayama
O Sima
Miyake Zima
Hatizyo Zima
IZU

Earthquakes

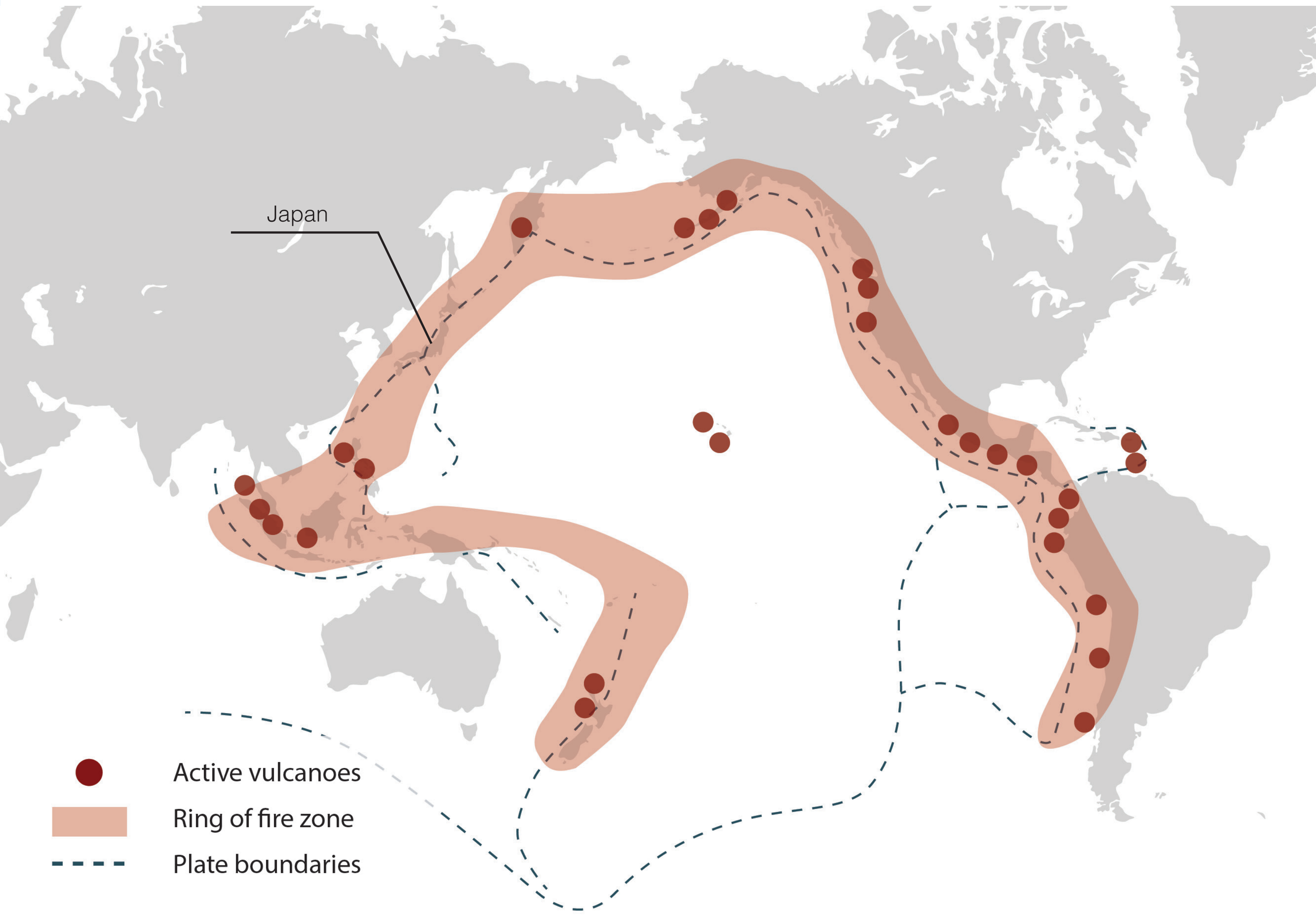
Japan is situated in an area called the Ring of Fire (figure 9). This is a 40,000 km (horseshoe shaped) area around the Pacific Ocean with intense volcanic and seismic activity. The name is derived from the fact that around 75% of the world's active volcanoes is located in this ring and 90% of the world's earthquakes occur in this area (Rosenberg, n.d.).

The Ring of Fire is the result of a series of tectonic plates colliding, sliding and shifting beneath each other. Japan is located on the edge of two tectonic plates which results in major seismic activity and Mount Fuji as the most well-known active volcano of Japan. As many as 1,500 earthquakes are reported yearly where magnitudes from 4 to 6 are not uncommon.figure 10 shows the shallow earthquakes that occurred between 1926 and 1987. The intensity of earthquakes that happen around Japan is very high.

In some occasions a high magnitude of an earthquake produces a tsunami. The East coast of Japan, where Miyagi is located, has the most activity related to earthquakes. Because of the many earthquakes and the less frequently tsunami's Japan has gotten well experienced on the impacts and measures that should be taken in order to recover from such a disaster situation. In the next chapter the four main earthquake disasters that resulted in a tsunami are compared to the most recent 3/11 disaster.

◂ *figure 9. Overview of earthquakes in Japan. The national atlas of Japan*

▾ *figure 10. The ring of fire around the Pacific Ocean. Author*



History of Disasters

Throughout history Japan has dealt with multiple large disasters. Each disaster has its own main impacts and specific reconstruction processes that were used to recover. This chapter describes the disaster and the reaction that governmental bodies took. It also explains about the reconstruction efforts and processes that occurred. On the next page a table is provided that compares the three main earthquakes and tsunamis to the 3.11 earthquake. It is important to learn from these past disasters and how it affected the way Japan protects themselves against these kind of disasters.

Great Kanto Earthquake - 7.9

Disaster and reaction

On September the 1st, 1923 the metropolitan area of Tokyo and surroundings got hit by an earthquake with a magnitude of 7.9. This resulted in 105,000 casualties and 110,000 destroyed houses. The main cause of damage by fires which were spreading simultaneously in the downtown areas of Tokyo and Yokohama and reducing most of the urban areas to ash. These large fires resulted in the destruction of various social infrastructures such as water supply, communication, the transportation network and electricity supply threatening the livelihoods of the people. In that time the fire department was equipped with advanced technologies to fight the fires. However, due to unexpected conditions such as no water supply many fires could spread.

Three days after the disaster a meeting was held at the Temporary Rescue Office for Disaster Victims. Here they discussed the plan for temporary housing to accommodate around 150,000 people that were affected by the disaster. They came up with a plan to construct barracks which were cheap and simple dwellings not covered by any law. This gave the opportunity to quickly build shelter without any restraints. Most of the unaffected parks and former elementary schools were used as building site. The barracks were provided with basic needs such as public toilets, kitchen and baths. In addition, additional facilities were added like a nursery room, consultation offices and medical clinics (JICA, 2013).

Reconstruction

Originally, the vision for reconstructing the city was not just rehabilitation but to conduct a complete and radical conversion, developed by Shimpei Goto, Minister of Interior part of the central government. He conducted basic policies for reconstruction that mentioned to apply the newest technologies in urban development taking place in Europe and the USA. Furthermore, he noted in order to realize the desirable urban development the Imperial Capital Reconstruction Department (ICRD), i.e. central government, should work together with firm attitudes and in consultation with landowners. 3 billion JPY had to be provided for this plan. However, after many discussions the original plan was heavily reduced in its content and size. Shimpei Goto stated that the central government should start and conduct all the tasks for reconstruction directly such as emergency relief, urban reconstruction and reconstruction of livelihood to industries. However, they were limited to urban reconstruction only after conflicting opinions and financial conditions. This construction formed the base of Japan's current planning for reconstruction where the central government is limited only to road reconstruction and preparation of housing sites.

It might be difficult to imagine, but the devastation caused by the earthquake also had a positive side. Because large portions of the city were destroyed the opportunity arose for urban reconstruction as a whole. Large scale urban projects were developed from 1932 to 1930. Complete cityscapes were remodeled into modern urban areas with the reconstruction of channels, parks and streets. In addition, experts in the process of reconstruction became part of the urban planning process towards the completions of the reconstruction (JICA, 2013).

Sanriku Tsunami - 8.1

Disaster and reaction
March the 3rd, 1933, the towns at the Sanriku coast were struck by an earthquake with magnitude 8.1 and was followed by a tsunami 30 minutes later. The impact of this tsunami was massive, devastating 18 municipalities in the Miyagi prefecture and 36 in the Iwate prefecture. Complete villages were washed away, farmlands destroyed and fishing industries collapsed. The death toll was around 3,000 people of which most lived in the coastal villages. The tsunami waves reached heights up to 29 meters around Nesaki, Hirota Village (JICA, 2013). The Governor of Iwate Prefecture reported to the central government and made the request to the army and navy forces to help in the emergency relief for affected people. Simultaneously, the Iwate Prefectural Government conducted emergency relief from their own resources. However, this progress was far too slow with lots of constraints such as destroyed roads and heavy snow (JICA, 2013). This halted the transportation of emergency supplies by truck, resulting in the use of horses to deliver the supplies.

The most important contribution came from the central government that proposed 10 countermeasures to mitigate tsunamis: 1) Relocation of dwelling houses to high ground, 2) Coastal dikes, 3) Tsunami control forests, 4) Seawalls, 5) Tsunami-resistant areas, 6) Buffer zone, 7) Evacuation routes, 8) Tsunami watch, 9) Tsunami evacuation, 10) Memorial events (Renaud & Murti, 2013). Next, the central government divided the municipalities in two groups and developed planning policies for each group. Topics of these policies were composition of community members, road construction, selection of sites and building protection facilities from tidal waves. In addition, a bylaw was created that restricted building in certain areas to ensure an efficient reconstruction process (JICA, 2013).

Reconstruction
The central government provide main subsidies for the reconstruction of residential areas and roads. From the 60 communities in Miyagi prefecture, 11 were relocated upland as a group and 49 choose individual relocation. In Iwate prefecture all 38 communities selected the group relocation. Many of the tsunami mitigation and prevention measures mentioned above were implemented in the affected areas. Taro Village took drastic actions due to the fact that this was the second time in history that the village was destroyed by a tsunami. They decided to build a wall of 7.7 meters high and with a length of 1,350 meters. The construction took almost 25 years to complete and by that time it got integrated in a larger project of a 2,433 meter long sea wall. 500 meters of this sea wall was situated at the coast and got completely destroyed during the 3.11 tsunami. Similar to the Great Kanto Earthquake of 1923, this disaster also gave opportunities for development. Two villages, Kiri-kiri area and Ootsuchi Town, developed their towns towards the most ideal fishing village economically and socially. The Town Authority provided site preparation and housing construction and the credit cooperation were taking care of maintenance and providing public facilities. As a result of local bodies taking their own initiatives they helped tremendously with the recovery of the circular flow of the local economy (JICA, 2013).

Great Hanshin Earthquake - 7.3

Disaster and reaction
On January the 17th, 1995, an earthquake occurred south of Awaji Island with a magnitude of 7.3. The death toll was around 6,400 people. The disaster became known as "the largest and most terrible disaster in urban areas following World War II". The earthquake exposed the weaknesses of modern large metropolitan areas and cities towards large scale natural disasters. Damages due to the collapse of buildings and destruction of critical infrastructures were beyond a scale that was far beyond anything anticipated. This resulted in massive costs from damages, estimated around 10,000 billion JPY. A unique feature of this disaster was the concentrated damage in the old town areas on the line called "linear array of devastated areas". These areas were located on reclaimed lands with a shallow ground water zone that had soft and weak grounds. Another feature was that almost 90% of the deaths were caused by collapsing wooden buildings and structures. The group that was most affected were elderly and other social vulnerable people. The direct response to the

	Great Kanto Earthquake	Sanriku Tsunami	Great Hanshin Earthquake	3.11 Earthquake
Magnitude	7.9	8.1	7.3	9.0
Date	Sep. 1, 1923	Mar. 3, 1933	Jan. 17, 1995	Mar. 11, 2011
No. of fatalities	99,331	3,064 incl. missing	6,437 incl. missing	20,000 incl. missing
No. of Totally destroyed buildings	128,266	Washed out by flood: 4,034 Collapsed: 1,817	104,906	129,724 Mainly by stunami
Major features of disaser	- Seriously affected urban areas, mainly Tokyo and Yokohama. - Widespread fire: 3,470 ha (44% of the Tokyo City area) was destroyed by fire.	Massive tsunami damaged 54 municipalities in Sanriku area.	- Total collapse of wooden houses burned by fire with obsolete building codes as a background factor. (Buildings destroyed by fire: 6,558)	- Wide-area and complex disaster earthquake, tsunami and nuclear acident. - Worst economic damage, up to 16.9 trillion Japanese Yen, from earthquake in the world.
Specific features of reconstruc-tion work	- Implementation of urban reconstruction and reconstruc-tion in the affected areas as a whole.	- Introduction of comprehensive protection measures against tsunami.	- Introduction of community based participatory planning. - Rise of volunteer activities in recovery phases.	- Establishment of Reconstruction Agency. - Reconstruction by local authorities supported by subsidies from central govern-ment. - Inter-regional partnerships partly complemented the lack of human resources.

figure 11. Comparison between the three main disasters and the 3.11 earthquake in the history of Japan. JICA, 2013

disaster were evacuation shelters provided through the utilization of public facilities. Parallel to this process the construction of temporary houses took place, decreasing the amount of evacuees over time. Policies for reconstruction were created by the Kobe City Authority to facilitate a fast recovery in the affected areas. Similar to the Sanriku tsunami, article 84 of the building code was applied that restricted the development new buildings that could intervene the implementation of recovery projects. A negative impact on the speed of recovery was the massive amount of debris caused by collapsed buildings. Due to the progressive debris removal many houses that could be rebuilt for use were also tore down, slowing down the recovery process even more.

Reconstruction
To grasp the complexity of recovery, the City divided the area into three main categories depending on how severe the damage was. This resulted in “Black” zones where full scale reconstruction according to article 84 was implemented, “Grey” zones that prioritized reconstruction with rehabilitation projects and “White” zones where the city only facilitated a select few reconstruction projects. Interesting to see is that the “Grey” zones were not developed under the urban planning law but followed the guidelines for comprehensive development of residential areas and the promotion of environmental improvements in densely built areas (JICA, 2013).

New to the reconstruction process was the facilitation of community participation during the planning process. The idea behind this was that there would be more and faster consensus between the city and their residents. The amount of registered associations went from 10 communities before the disaster to 100 communities after. Another new concept that was implemented during the recovery was the development of buildings solely for elderly people. These were building blocks facilitating 10-14 dwelling units, a living room and common kitchen. In addition, there was a staff operating and providing regular and emergency support for the residents 24 hours a day. Miyagi Prefecture assisted the recovery by gifting group home-type temporary housing for Ashiya City which triggered further development of temporary housing in those areas.

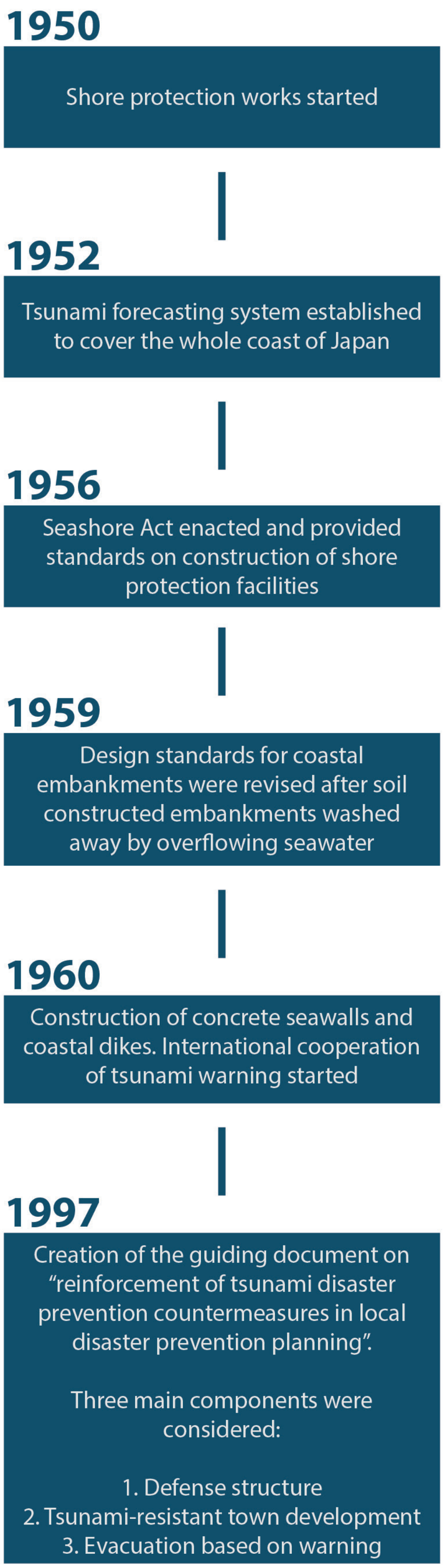


figure 12. Actions for better protection against tsunamis. Renaud & Murti, 2013

Problem Statement

Nature

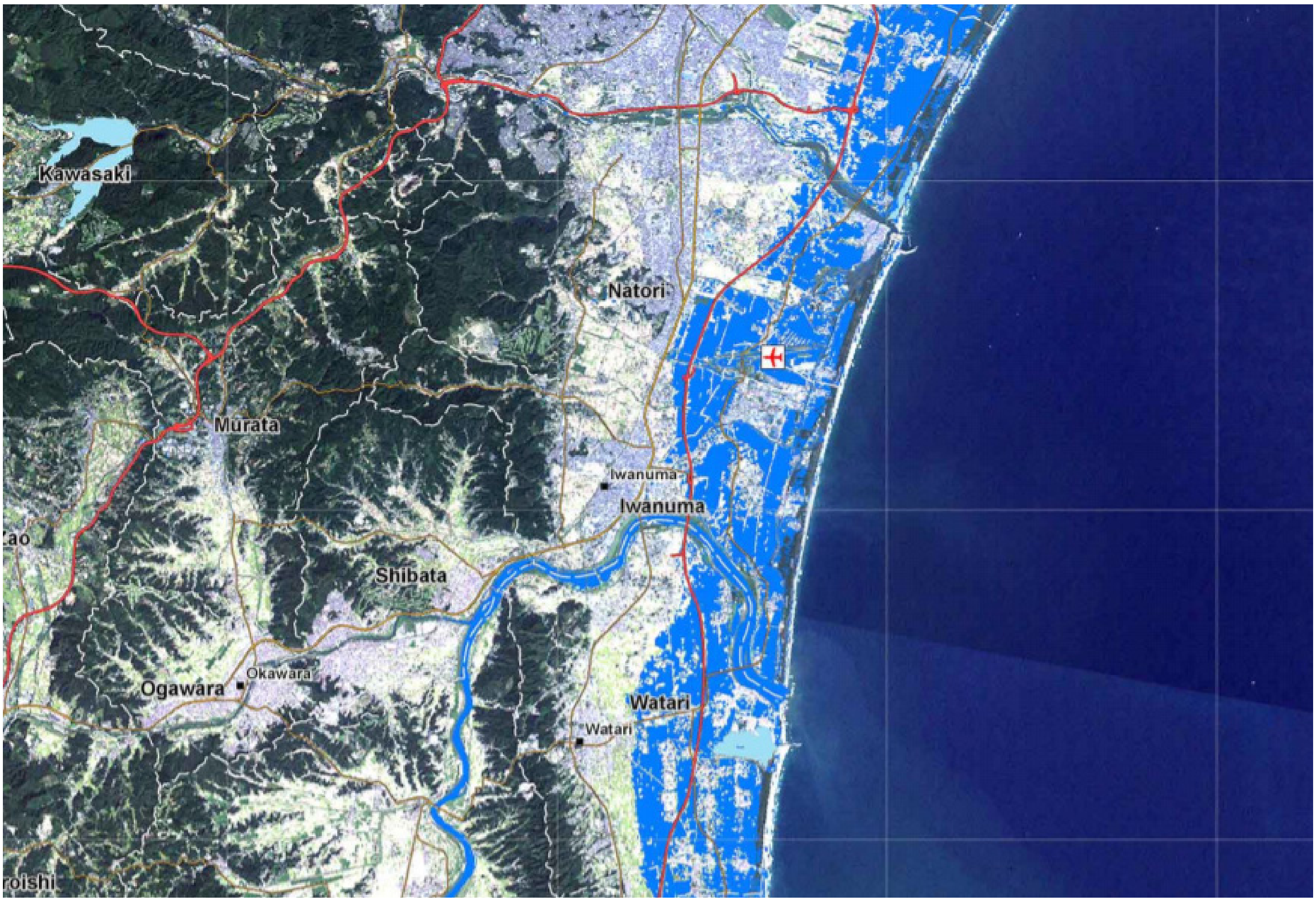
The past few years sea level rise affects delta cities all over the world, there is an increase of storms and the average temperature has risen by 0.8 Celsius since 1880 (Hansen, Ruedy, Sato, & Lo, 2010). All these increasing numbers have an effect on cities around the globe, in particularly cities in low-land regions. Natori, a city in the prefecture of Miyagi, is situated in such a region and has to cope with high flood risks. Due to the frequent earthquakes Natori has the chance of a tsunami with the same strength as the 3.11 tsunami to happen within 500 to 1000 years from now. Although this seems like a small chance of happening, smaller tsunamis can occur in a shorter time span.
Japan copes with very high rates of precipitation that are only expected to increase in the future. In addition, more extreme periods of droughts will occur. These natural processes of earthquakes, tsunamis, precipitation and droughts will have a major impact on the livelihoods and safety of the residents in Japan.

There have been experiments with different techniques of tsunami mitigation such as mitigation forests, but the primary approach remains hard-engineering, constructing a 15 meter high concrete wall which has little respect to nature or its processes. Resulting in an unbalanced relation between land and water.

There are mixed feelings about this wall that is being built to protect the few remaining fishing villages. Residents of these villages prefer to have a physical and visual connection with the sea but with the wall in place this connection is completely broken. On the other hand, some of the people feel much more safer with a wall and therefore live with less fear.

◂ *figure 13. Impact of the tsunami at the Sendai Coast. Sadatsugu Tomizawa*

▾ *figure 14. Flood area of the Sendai plains. City of Natori*



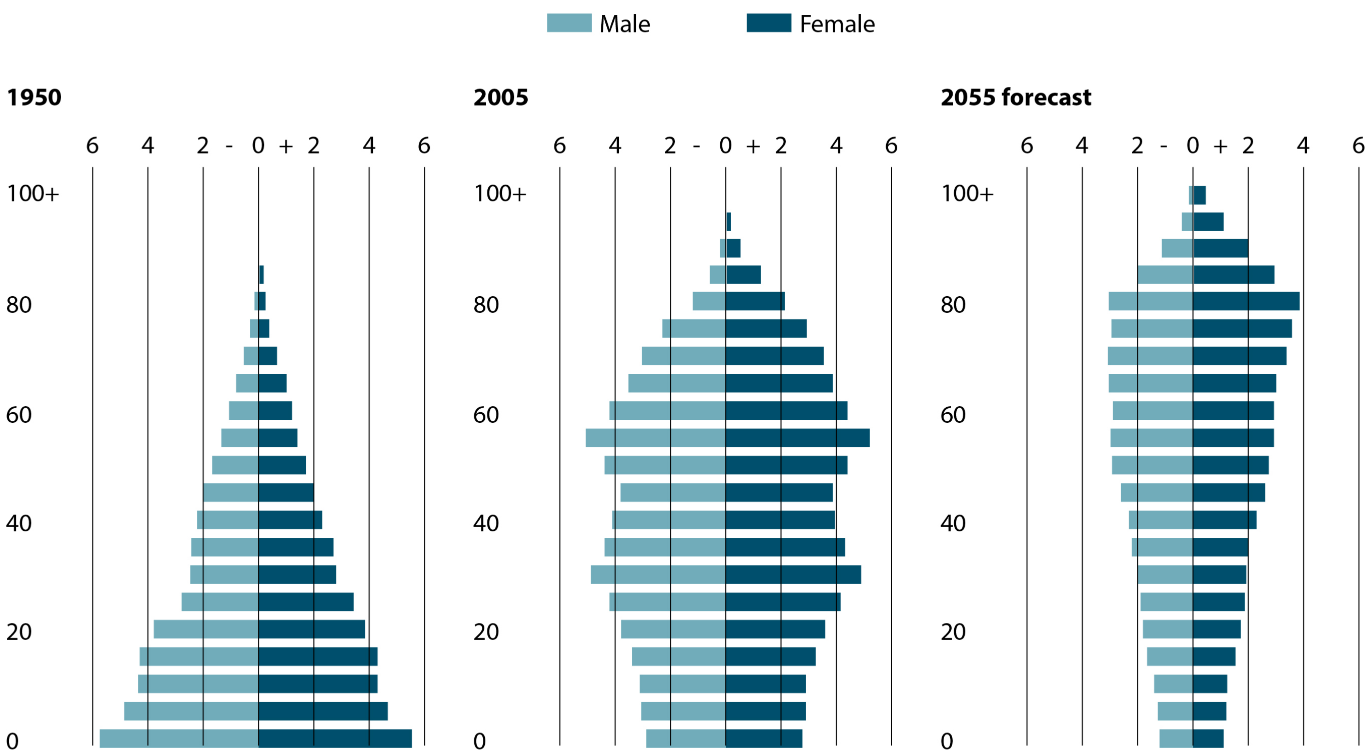
People

As of July 2017 the population of Japan is around 126 million people. According to the National Institute of Population and Social Security Research (IPSS) this number has been declining in the past decade and will continue this trend (“National Institute of Population and Social Security Research”, n.d.). The IPSS gave the prognosis that the population diagram will shift from a pyramid shape towards a kite, meaning an aging and declining population, illustrated in figure 15. Reason for this is that many Japanese have prided themselves with their cultural homogeneity. Due to the strict immigration laws, no more than 2 percent of the population are foreign nationalities (Sieg, 2014). These are trends that have an influence on the redevelopment process and should be taken into consideration during any reconstruction program.

During reconstruction it is very important to work closely with local communities because they are a major part of the Japanese culture. This community involvement greatly increases the chances of a successful recovery. However, in most cases top-down approaches are used for reconstruction and the residents are only surveyed to know how many dwellings should be built. Because of this and the high risk of the area residents don’t want to return to their former homes. The people that can afford a new house move to other locations whereas the less wealthy are located in temporary housing. This division causes communities to split up and fall apart (Santiago-Fandiño, Sato, Maki & Iuchi, 2018).

◂ *figure 15.   Commuters in Tokyo. Linda Sieg - Reuters*

▾ *figure 16.   Population forecast diagram of Japan. IPSS*

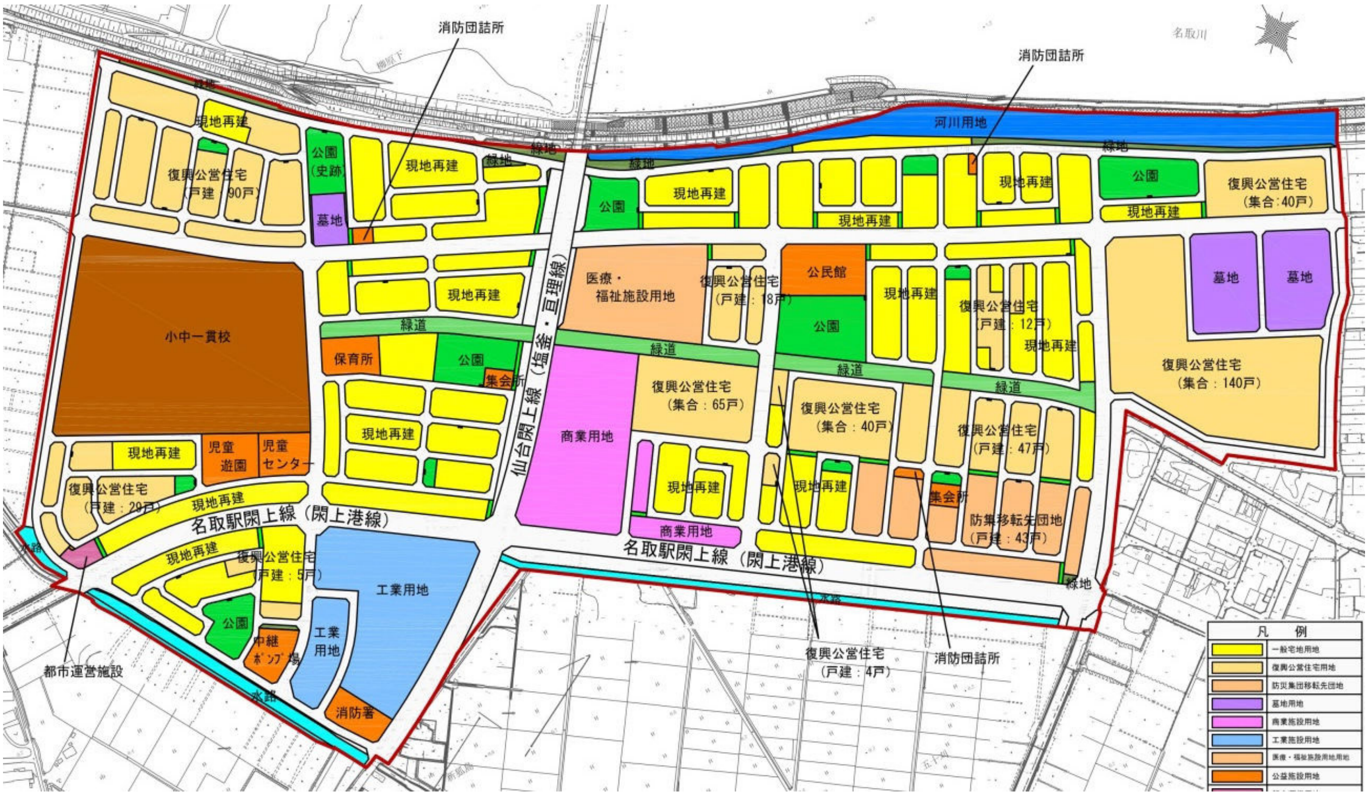


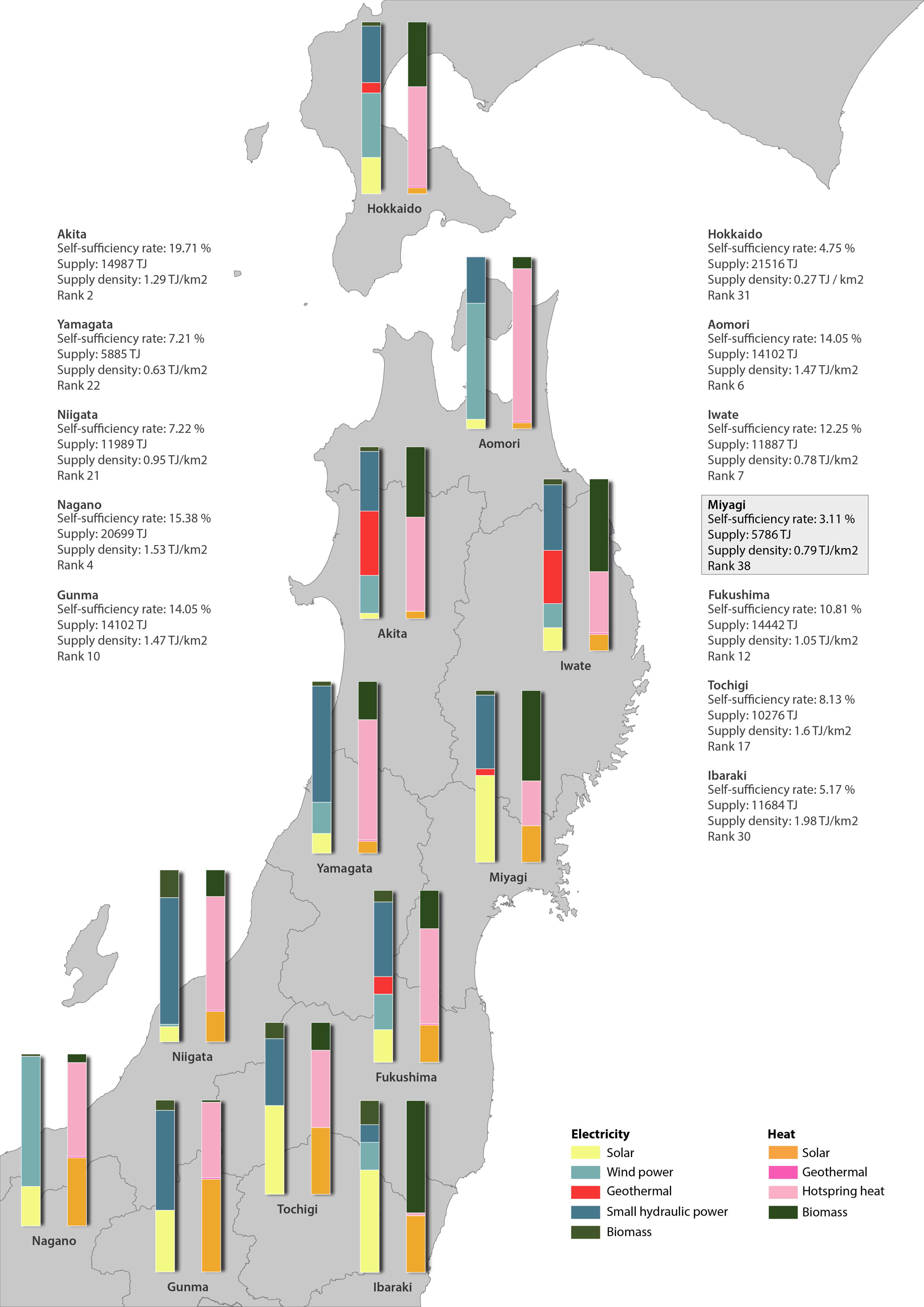
Process

To be able to rebuilt in these risk areas a set of laws and budget is established by the national government of Japan. Each municipality got a great influence on the outcome of its own reconstruction and took a different approach depending on their available resources and socio-economic conditions of the area (Santiago-Fandiño e.a., 2018). This resulted in a great variety of different projects with few that managed succeed and Build Back Better (BBB). Therefore, as a disaster society there is a need for a strategic framework on the municipality level that guides these processes towards a more successful and sustainable outcome. In addition, the current rebuilding process can be characterized as “Traditional Urban Recovery” where the main focus lies on recovering that what has been lost. The reason for this is the trauma that has been caused with the people by losing everything to the disaster. The affected people want to recover what they have lost, preferably in the same conditions. In the surveys that the municipalities hand out to the people the questions focus on what people need, instead of what people want. Certainly, it is important to recover pre-disaster situations, however, developments should take into consideration new techniques that will increase resilience of the area. Unfortunately this is not the case in many of the recovery programs for the cities or villages affected by the tsunami. While most of the settlements that were flushed away will not be reconstructed, Yuriage will be rebuild in the same location. To accomplish this, the process relies on major geotechnical and building-site preparation techniques. All of this is developed according a structured zoning plan which results in loss of spatial quality for the people and missed opportunities in integrating multiple functions together as a whole.

◂ *figure 17. Construction of the embankment in Ishinomaki. Author*

▾ *figure 18. Zoning reconstruction plan for the village Yuriage, Natori. City of Natori*




Hokkaido
Akita
Self-sufficiency rate: 19.71 %
Supply: 14987 TJ
Supply density: 1.29 TJ/km2
Rank 2
Yamagata
Self-sufficiency rate: 7.21 %
Supply: 5885 TJ
Supply density: 0.63 TJ/km2
Rank 22
Niigata
Self-sufficiency rate: 7.22 %
Supply: 11989 TJ
Supply density: 0.95 TJ/km2
Rank 21
Nagano
Self-sufficiency rate: 15.38 %
Supply: 20699 TJ
Supply density: 1.53 TJ/km2
Rank 4
Gunma
Self-sufficiency rate: 14.05 %
Supply: 14102 TJ
Supply density: 1.47 TJ/km2
Rank 10
Hokkaido
Self-sufficiency rate: 4.75 %
Supply: 21516 TJ
Supply density: 0.27 TJ / km2
Rank 31
Aomori
Self-sufficiency rate: 14.05 %
Supply: 14102 TJ
Supply density: 1.47 TJ/km2
Rank 6
Iwate
Self-sufficiency rate: 12.25 %
Supply: 11887 TJ
Supply density: 0.78 TJ/km2
Rank 7
Miyagi
Self-sufficiency rate: 3.11 %
Supply: 5786 TJ
Supply density: 0.79 TJ/km2
Rank 38
Fukushima
Self-sufficiency rate: 10.81 %
Supply: 14442 TJ
Supply density: 1.05 TJ/km2
Rank 12
Tochigi
Self-sufficiency rate: 8.13 %
Supply: 10276 TJ
Supply density: 1.6 TJ/km2
Rank 17
Ibaraki
Self-sufficiency rate: 5.17 %
Supply: 11684 TJ
Supply density: 1.98 TJ/km2
Rank 30
Aomori
Akita
Iwate
Yamagata
Miyagi
Niigata
Fukushima
Tochigi
Nagano
Gunma
Ibaraki
Electricity
Solar
Wind power
Geothermal
Small hydraulic power
Biomass
Heat
Solar
Geothermal
Hotspring heat
Biomass

Energy

In order to stimulate the use of renewable energy sources the Paris agreement as created which go into effect on November 4th, 2016. Japan however, was four days late to sign the agreement. This resulted in Japan being excluded from the list of participating countries to reduce fossil fuel use and increase the production of renewable energy. This put Japan in the spotlight from global society on how they would deal with the problem of climate change.

Many issues around the current energy network became evident after the 3.11 tsunami. Most of the nuclear power plants were positioned along the coast being very vulnerable in a case of a tsunami. So after the tsunami hit and the power plants had to shut down, a massive power shortage occurred in the region and nuclear disaster. This even resulted in a such power shortage that the complete transportation network of Tokyo, cash machines and other functions had to shut down for three hours (Bingham, 2011). This shows the vulnerability of being too dependent on only a few energy sources. Consequently, Japan drastically reduced its nuclear energy production as shown infigure 19 ("Current Status of Renewable Energy in Japan | JFS Japan for Sustainability").

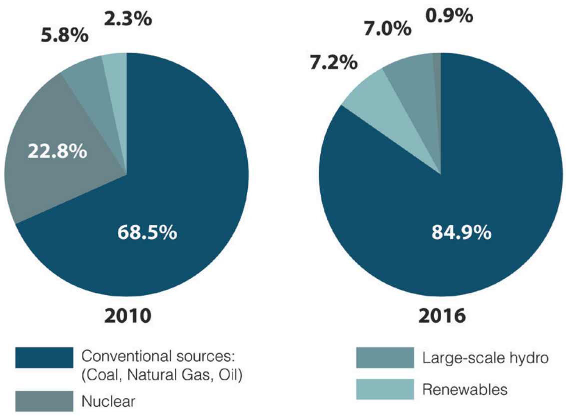


figure 19. Resources used for energy production in Japan, 2016. Institute for Sustainable Energy Policies (ISEP)

figure 20. Renewable energy production and self-sufficiency in Japan. JSF - edit by author

In order to investigate the possibilities of more sustainable energy production a group of researchers from the Chiba University and the Institute for Sustainable Energy Policies (ISEP) started a research project in 2007 named "Sustainable Zone Study". For each prefecture the research group studied the amount of food produced and renewable energy supplied. In addition, they calculated the self-sufficiency in energy and food of which the results are illustrated in figure 20.

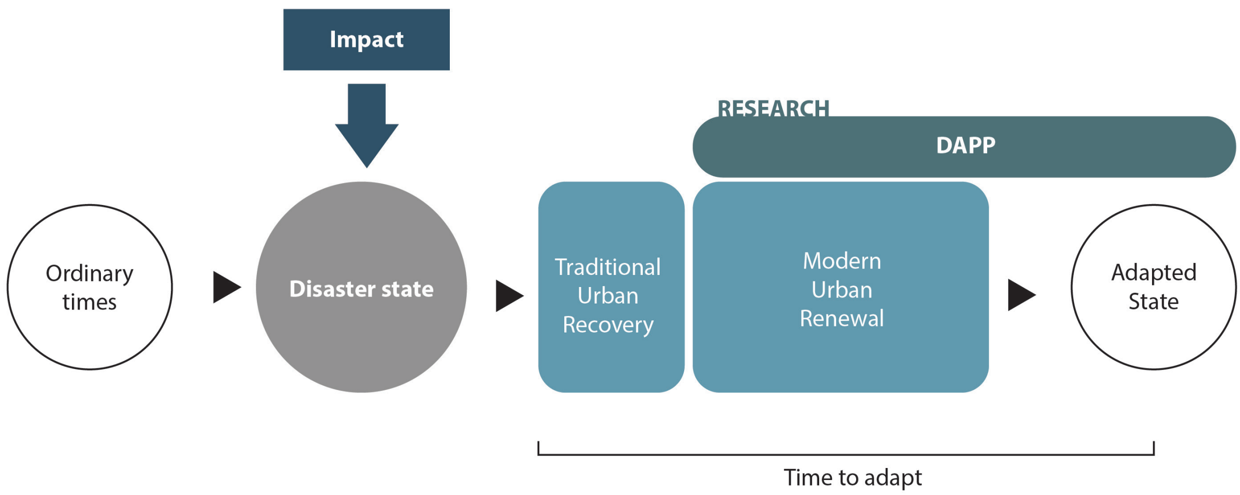
The best results came from Oita Prefecture with a self-sufficiency score of 38.6%. Oita has large geothermal plants that accounts for almost half of the electricity supplied from renewable sources (JFS). When looking at Miyagi Prefecture we can see that with a self-sufficiency rate of 3.11% it is positioned on the 38th place compared with the 47 other prefectures. This shows that there are still a lot of steps to make in order for Miyagi to become more sustainable in the case of energy production. ("Renewable Energy on the Rise in Japan")

FRAMEWORK

水一

Research
Theoratical Framework
Methodology
Research Framework

一国



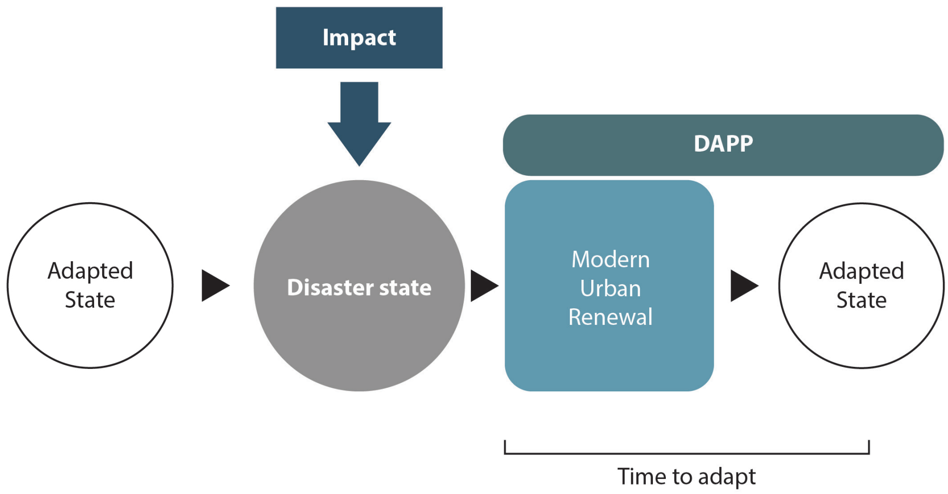


figure 21. Research context and hypothesis. Author

Research

Hypothesis

In the period after a disaster there is a need for a framework that will help fasten the recovery process. By taking advantage of designing on an empty slate innovative techniques can be applied for the mitigation of tsunamis and hydrological issues. The Dynamic Adaptation Policy Pathway approach can be used as systematic strategy that provides a solid framework for development in the context of a disaster society with many future uncertainties. By using the framework, the recovery process after the disaster will progress more quickly and reaching a resilient stage in a shorter amount of time, see figure 21. The framework can be used by multiple disciplines and supplemented or strengthened by approaches relevant to the situation. Doing so will result in a system that is able to cope with the stress that is put on the system. Furthermore, the framework will help develop for the long term stimulating a balanced use of hard engineered and building with nature solutions, resulting in a better balance between water and land.

This hypothesis acts as preliminary suggestive assumptions for the methods to be used. During the research process these methods are tested.

Objectives

The objectives of this research are,

1. Develop a strategic framework that can be used after a tsunami disaster and help shift from Traditional Urban Recovery towards Modern Urban Renewal more quickly.

2. To develop this framework in a systemic way which operates across spatial and temporal scales to address deep uncertainties in the reconstruction process.

3. To find the balance between hard-engineered and designing with nature mitigation techniques which can be applied in the framework.

Research question

How to shift from Traditional Urban Recovery towards Modern Urban Renewal after a tsunami disaster in coastal cities of Japan?

To help answer this research question the following sub-questions are formed:

1. What are important elements and the role of trauma in traditional urban recovery?

2. What is modern urban renewal in Japan in the conext of a disaster society?

3. How to deal with uncertainties in the redevelopment process?

4. How to balance natural and hard-engineered flood mitigation approaches?

figure 22. Participatory project of Koizumi with multiple disciplines. 景観を考える！

Societal Relevance

Due to the topographical location of Japan in the 'Ring of Fire', the country is prone to many disasters such as earthquakes and tsunamis that occur very frequently. In addition, Japan is prone to heavy rainfall that cause floods and landslides. All these factors make result in the identification of Japan as a disaster society.

Tohoku, the northern part of Japan got affected by these global changes. In 2011 the region got hit by a level 1 tsunami resulting in almost 16.000 casualties and damages estimated around 122 billion dollar (Arm, Vervaeck, & Daniell, 2012). The damages caused to people's lives, and the economically and ecologically damages are still noticeable to date. This makes it highly relevant in today's world with an increased amount of disasters related to flooding. Uncertainties caused by climate change make it difficult to plan far ahead (van Veelen, 2016). The increased frequency of heavy storms but also higher chances of tsunamis has amplified its characteristic of uncertainty.

Thousands of people lost their homes and the redevelopment processes took off very slowly. With help from the national government temporary housing projects were initiated. However, due to the slow reconstruction process almost 50.000 people still live in these temporary conditions in February 2017 ("Reconstruction Agency"). This results in the decrease of traditional Japanese communities because it was difficult for community members to find each other or to be placed together in the temporary housing. Therefore, it is important to have a strategy which guides the reconstruction process to help these communities recover. Furthermore, disasters have a massive traumatic effect on the people that were affected. Therefore, it is important to take this trauma into account where most of the people want to recover what was lost. This causes a friction between the urge to develop new areas and recover what was there before.

Scientific relevance

Many studies exist in the field of urban resilience and adaptivity. However, research on how to implement these concepts in a flexible design process is still limited. Traditionally, decision makers assume the future can be predicted. They develop a static optimal scenario or 'most likely' future plan that will produce acceptable outcomes in most plausible future worlds (Haasnoot, Kwakkel, Walker, & ter Maat, 2013). However, reality shows that the future is unpredictable and in many occasions differs from the constructed scenarios. The Dynamic Adaptive Policy Pathway approach (DAPP) is a newly developed method to provide a systemic framework for future developments. By providing multiple timelines and actions to reach the desirable future chances that a project will succeed is greatly increased. In addition, this research explores other methods to supplement the DAPP in order to create a robust framework for redevelopment after a tsunami disaster.

One of these methods is the multidisciplinary approach. There are many problems in a disaster society such as in Japan which cannot be fully addressed by one scientific discipline. To resolve problems of a disaster society, contributions from many disciplines are needed, with inputs that should preferably be balanced and integrated (Buanes & Jentoft, 2009). The hope that multidisciplinary working will become more common in the field of disaster recovery still thrives, however it is not always clear how multidisciplinary strategies can be applied in resolving many issues related to the disaster society (Camic, Joas, Camic, 2003). By applying the multidisciplinary approach as the main underlying method in this research, the thesis strives to provide a better insight in the relationship between disciplines and their contribution in the context of a disaster society.

Theoretical Framework

Adaptation

Adaptation is frequently seen as the process of socio-technical or social-ecological system to improve its resilience. In addition, adaptation is regarded as the ability to move a system away from unsustainable conditions. Pelling (2010) states that adaptation is creating opportunities for other pathways that could lead to different socio- and social-ecological futures. Adaptation is regarded as a dynamic process rather than a stable condition or state. Similar to resilience the characteristics of adaptation can be distinguished between backward and forward looking. For the backward looking characteristic adaptation is established by the capacity to cope during moments of disruption and impacts on the system. The forward looking characteristic of adaption however, cannot be revealed through impacts because they did not happen yet. Instead it is made apparent through theoretical supported elements linked to adaptive capacity (Pelling, 2010). These can also derive from risks that have been identified for a certain system. The definition of Smit & Wandel (2006) corresponds with this statement by defining adaptation as individual or collective attempt to reduce the impact of disruptions or risks and thus increasing the resilience of a system (Smit & Wandel, 2006). An important part of characterizing adaptation is the degree of adjustment the current system needs in order to minimize the impact of disturbances (Risbey, Kandlikar, Dowlatabadi, & Graetz, 1999). A coastal village that faces extreme flood risks can for example implement simple solutions such as placing sand bags. A higher degree could be improving the drainage system and infiltration capacities. An even more substantial solution could be to completely raise the surface level. These are mostly technological or physical interventions, but there may just as well be institutional, behavioral or social interventions (Pelling, 2010). The degree of adaptation is closely related to scale. Small degree adaptations can be part of or have an effect on a strategy on the larger scale systems. Next to the constant stress of earthquakes and tsunamis, climate change is one of the biggest disturbances or risks that impacts current systems through all scales. Therefore we need to shift from adapting *to* climate change, towards adapting *with* climate change (Castree, 2001). This agrees with Pellings' statement of adaptation as a dynamic process where one should transform with an impact on the system. The shift to adapting with climate change is a great step which requires an admittance that anthropogenic climate change is now with us. It becomes a product of humanity's conducts, choices and principles, but also its co-transformation with the environment. Therefore neither environmental nor social adaptation is an independent process and should be approached simultaneously (Castree, 2001).

figure 22 illlustrates the process of an adapting system. It shows that the system responds to the induced stress and is able to recover from the impact to the former state. In order to be able to react and recover from impacts short term solutions are needed. This way a system can return to the previous conditions more quickly. When looking into the more distant future a different approach is needed in case of the returning stress levels. When this is the case urban resilience provides a more sustainable way for long term solutions.

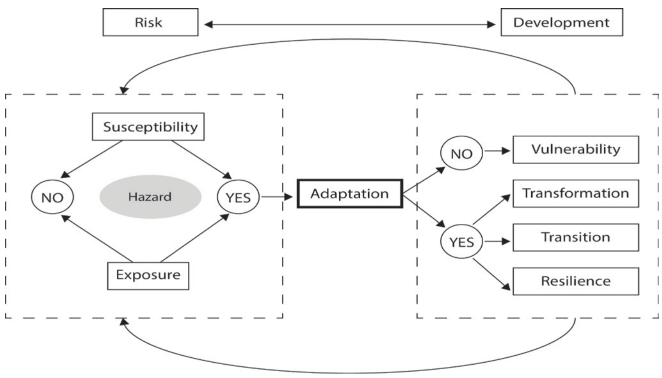


figure 24.   Adaptation intervenes in the coproduction of risk and development. Pelling, 2010

figure 23.   The capablity to respond to an impact and recover to the former state of the system. Author

Urban resilience

The theory of resilience is part of a larger group of complexity concepts that were developed in the late seventies. These concepts were used to explain the non-linear processes and behavior of complex systems (B. Walker & Salt, 2012). Resilience originates from ecological-system sciences where it is used to research the amount disturbance an ecosystem could cope with and then recover from that (van Veelen, 2016). Van Veelen states that there are three main focuses in the theory of resilience: [1] a focus on resistance or robustness (engineered resilience), [2] a focus on maintaining stability and ability to return back to normal (ecological resilience) and [3] a focus on adaptation and transformation of systems (socio-ecological resilience) (van Veelen, 2016).

An important aspect of the concept of resilience is that it was developed together with ideas on cross-scale interactions and interdependencies between sub systems within a larger system (Folke, 2006). This means that resilience is produced and influenced by lower and higher systems.

The core definition of resilience can be described as the capacity to recover quickly from difficulties (Oxford Dictionaries). The word is derived from the Latin word resilio which translates “to bounce back”. This definition has been criticized because it means being reactive, backward looking and that the system has to return to the original state. The ability to transform the system to be able to cope with the induced stress is more valuable than going back to the original state. Therefore the definition of resilience needs to consist of more than the notion of bouncing back.

A good example of only bouncing back is the redevelopment process for the village Yuriage in the Miyagi prefecture. Instead of incorporating new techniques and ideas that increase the coping abilities in the future, the village is rebuild exactly the same as before. The only difference is that they raised the ground with 5 meters of sand.

Meerow and Stults state in their paper ‘Defining urban resilience’ that the definition needs to incorporate six important conceptual tensions; [1] notion of equilibrium, [2] resilience as a positive concept, [3] pathway to resilience, [4] understanding of adaptation, [5] timescale of action, [6] conceptualization of “urban”. In addition this incorporation should be done in a flexible and inclusive way. This results in the following definition:

> *Urban resilience refers to the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity. (Meerow, Newell, & Stults, 2016)*

Important factors such as temporal scale, general adaptability and a conceptualized urban system are processed in the definition. Urban resilience is a dynamic process about various pathways towards a state that is anticipating to change. Each recovered state of the system is an improved state that can cope better with future induced stress. This process is illustrated in figure 24. The main difference between adaptation and resilience is that resilience includes the ability to acquire new capabilities, and in some cases emerging stronger from the struggle, whereas adaptation entails preserving existing resources (Wong-Parodi, Fischhoff, & Strauss, 2015).

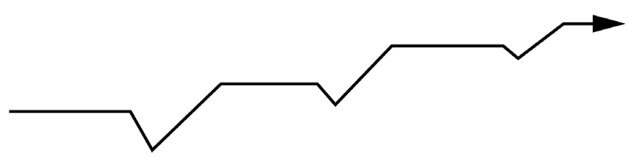


figure 25.   Adapt the system to the constant stress and continues its operation. Author

Methods

Framework

figure 25 shows the framework of how the used methods are related to each other. The main method, DAPP, has a central position in the framework. This method is supplemented by four other methods: 1) Backtracking and forecasting, 2) scenario writing approach, 3) SWOT analysis, 4) Kaizen approach. These methods will fuel the DAPP approach towards a strategy. By using research by design the strategy is translated in the physical domain. The whole research process is supported by the multidisciplinary approach that contain five different disciplines that are related to the research project.

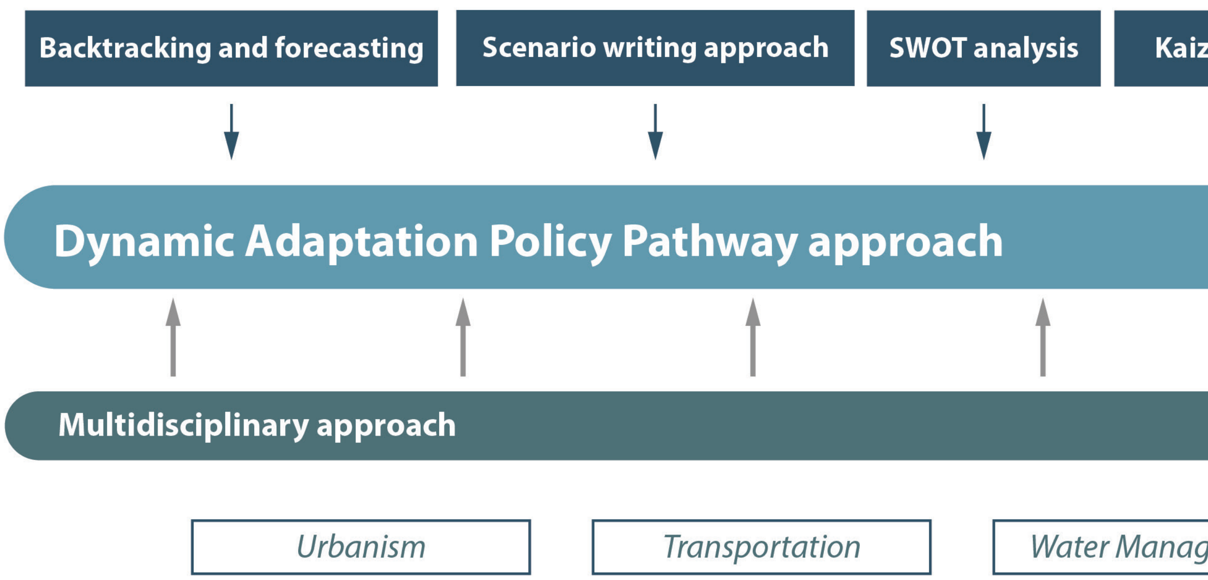
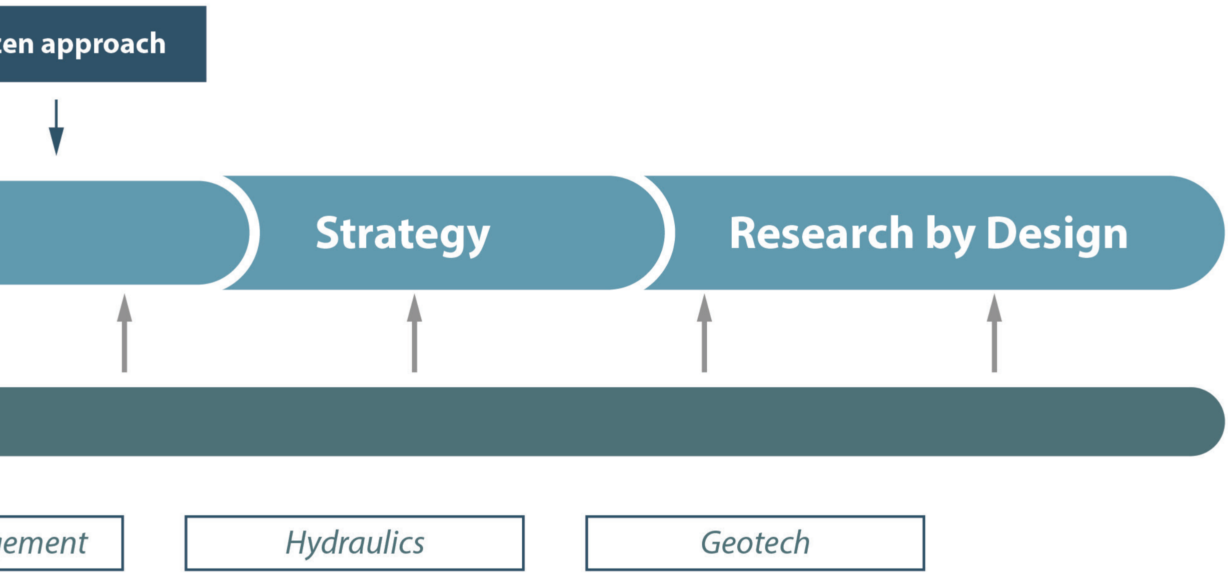


figure 26. Methodology framework. Author


Strategy
Research by Design
Hydraulics
Geotech

Dynamic Adaptive Policy Pathways

Decision makers and stakeholders face deep uncertainties about a wide range of external factors. Environmental conditions and societal perspectives and preferences may change over time (Haasnoot, Kwakkel, Walker, & ter Maat, 2013). Therefore it is important to develop methods that can cope with these changes and uncertainties. One of the methods used for this is the Dynamic Adaptive Policy Pathway approach (DAPP) which will be explained in the first section. In the second part of this chapter additional methods are explained that can contribute to the process of the DAPP.

A new paradigm for planning under conditions of deep uncertainty has emerged in the field of urban development. A planner should create a tactic vision of the future, and in addition plan short-term . This should be established in a framework to direct future actions that will happen in the future (Haasnoot e.a., 2013). The Dynamic Adaptive Policy Pathway approach (DAPP) is an approach that proposes a method to create this framework. Opportunities for creating alternative pathways should be part of this framework, as stated by Pelling, (2010) in the previous chapter. A way to form these alternative pathways are adaption tipping points. The term "tipping point" developed in climate change research literature to point out where a system change is initiated by an external forcing, and the moment this point no longer requires the external forcing to sustain the new pattern of change (Kwadijk e.a., 2010). These tipping points can help to reach a resilient state of a system and increase the adaptivity. For example, Meerow e.a. (2016) indicates three pathways to a resilient state: persistence, transition, and transformation. Where persistence reflects the engineering principle that systems should resist disturbance. Whereas transition and transformation seek to incrementally adapt or fundamentally change the systems' structures (Meerow, Newell & Stults, 2016). A tipping point is defined by the moment when the conditions under which an action no longer meets the specified goals or objectives is reached (Kwadijk e.a., 2010).

Additional actions are needed when a tipping point is reached and thus a pathway is created. To help visualize these tipping points, actions and pathways the Adaptation Pathways Map (APM) is used. To create a clear communicable tool the APM is structured as a tree diagram or roadmap as seen infigure 26. The DAPPA shows a series of possible actions after each tipping point. Each route through the map shows a different pathway to the end goal. The date of the adaptation point depends on the given scenario. They way these scenarios are implemented in the roadmap generally depend on the result of computational scenario approaches. In this way the distribution of the sell-by date across a large ensemble of transient scenarios can be assessed (Haasnoot e.a., 2013). The distribution of the scenarios is then visualized on the roadmap. While these scenarios are specific moments in time the exact moment of tipping points are less important. However, it should give a rough assumption. For example, "the tipping point should be reached within 30 years, at earliest in 20 years and latest 40 years".

In order to create carry capacity amongst different stakeholders, values and worldviews, cultural perspectives can be used to map these out (Offermans, Haasnoot, & Valkering, 2011). This can be a valuable aspect when applying the DAPPA in a different cultural context. The end goal of a pathway is always the same, but the APM shows alternative routes to be able to reach that desired goal. Every line or route in the map represents a minimum performance level which is specified from the start of the project or development, a norm for infiltration capacity in public spaces for example. Haasnoot e.a. (2013) makes an interesting comparison where you can compare the APM as a metro network. The pathways are the tracks, tipping points the terminal stations, the available actions after this point are transfer stations, and the goal your end station.

In order to structure the APM, and form an overview of the results, a disaggregated approach in which the impacts of tactics are presented in the form of tables or rather scorecards as Walker labels them (Walker, 2000). This scorecard can give an overview of cost and benefits as stakeholders or decision makers may prefer a different pathway and assign the weight they deem appropriate to each impact. The amount of detail however, can make it difficult for the decision makers to see patterns. Color-coding can help recognizing these patterns and trade-offs as shown in figure 27. In this way decision makers and stakeholders can identify opportunities, timing of action and no-regret actions (Haasnoot e.a., 2013). The APM can be used in the planning process for actions that need to be implemented on the short term and for incorporating steps that are needed to prepare for future changes and still be able to achieve the desired actions. The APM combined with the scorecard can make stakeholders or decision makers conversant with the options available so that they can make a well informed decision.

In short, adaptive pathway planning needs [1] to identify key 'triggers' that act as warning signals that indicate that the system is moving to an unstable state and [2] to identify tipping points in the future where [3] actions can be implemented to correct or take advantage of opportunities that arise (van Veelen, 2016).

	Path actions	Relative Costs	Target effects	Side effects
1		+++	+	0
2		+++++	0	0
3		+++	0	0
4		+++	0	0
5		0	0	-
6		++++	0	- -
7		++	+	-
8		+	++	- - -
9		+++	+	- - -

figure 28. Scorecard example. Haasnoot e.a. - modified by author

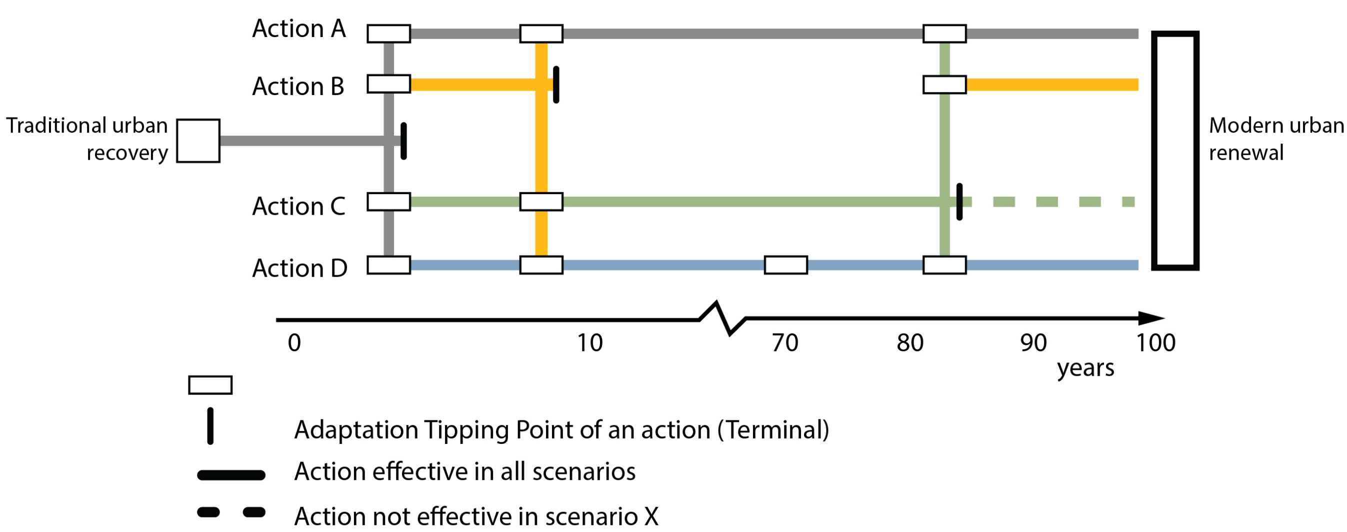


figure 27. Example of an Adaptation Pathways Map. Haasnoot e.a. - modified by author

The 10 DAPP steps

The DAPP approach is a relatively new method in the field of urban development that consists of ten steps that result in a dynamic adaptive plan, figure 28.

Step 1: Current situation

The first step is to describe the study area, including the system's characteristics, the objectives, the constraints in the current situation, and potential constraints in future situations. The result is a definition of success, which is a specification of the desired outcomes in terms of indicators and targets that are used in subsequent steps to evaluate the performance of actions and pathways, and to assess the 'sell-by dates' of the actions. The description of the study area includes a specification of the major uncertainties that play a role in the decision-making problem.

Step 2: Problem analysis

The second step is the problem analysis. In this step, the current situation and possible future situations are compared to the specified objectives to identify whether there are any gaps. Both opportunities and vulnerabilities should be considered. Opportunities are developments that can help in achieving the objectives, while vulnerabilities are developments that can harm the extent to which the objectives can be achieved. This creates a basic SWOT (Strengths, Weaknesses, Threats, and Opportunities) analysis which forms the base for step 3.

Step 3: Determine actions

In this step *possible actions* are identified that can be taken to meet the definition of success stated in step 1. In order to create these actions the SWOT analysis is used supplemented with the *confrontation matrix*, (explained in the next chapter). This will result in a set of possible actions which can be categorized for different perspectives.

Step 4: Assess efficacy, sell-by date of actions, and reassess vulnerabilities and opportunities

After the set of possible actions is created they need to be evaluated according pre-determined criteria. These criteria can be derived from the first two steps that determined important aspects for the desired outcome. This way the effects of individual actions can be assessed on the outcome indicators. In this step the sell-by date of each action is also decided. To create a clear overview the results of step 3 and 4 are put in a table that shows the action, impact on criteria, sell-by date and the costs of the action.

Step 5: Develop pathways

The table from the previous step is used as the input to assemble the pathways. This is then visualized in the pathway map to create a clear representation of all possible actions. When a set of actions is suitable pathways can be designed. These pathways consist of a set of actions, where new actions are activated once the former action no longer meets the definition of success. Each route is than evaluated according to the criteria and its performance. From this promising pathways can be developed that meet certain fundamental criteria such as severity of the impacts, the urgency of actions, the amount of uncertainty that comes with an action and the desire to keep options open. (Haasnoot, Kwakkel, Walker, & ter Maat, 2013).

Step 6: Select preferred pathways

In this step a selection of the pathways is chosen that is the most preferred. These pathways fit the best in a specified perspective. It can prove useful to select two pathways with opposite perspectives and compare them with each other. To help decide which pathway is the most preferred the scorecard can be used. The chosen pathway that is preferred the most will result in the basic structure of a *dynamic adaptive plan*.

Step 7: Determine contigency actions

In the seventh step the goal is to increase the robustness of the preferred pathways by defining actions to keep the pathways on track for success. These can be actions to anticipate or prepare for one or more preferred pathways or function as corrective actions to stay on track of a certain pathway in case the future turns out different than anticipated (Haasnoot e.a., 2013). There are three types of contingency actions: defensive, corrective and capitalizing actions, that are related with a monitoring system and trigger values. The monitoring system specifies what to monitor, and the triggers specify when a contingency action should be activated (Haasnoot e.a., 2013).

Step 8: Specifiy a dynamic adaptive plan

In this step the developed strategy from the pathways is tested in a *dynamic adaptive plan*. The plan is a summary of all the previous steps taken and contains targets, problems and the chosen pathways. In addition, the plan specifies actions that have to be taken directly, actions that have to be taken in order to keep open future adaptations, and the monitoring system.

Step 9: Implementation

When everything is decided the actions that have to be taken directly are implemented on the project location.

Step 10: Monitoring

After implementation the monitoring system is enabled and monitors the complete process. Signpost information that is related to the triggers is collected and evaluated. According to this information, actions are started, altered or stopped (Haasnoot e.a., 2013).

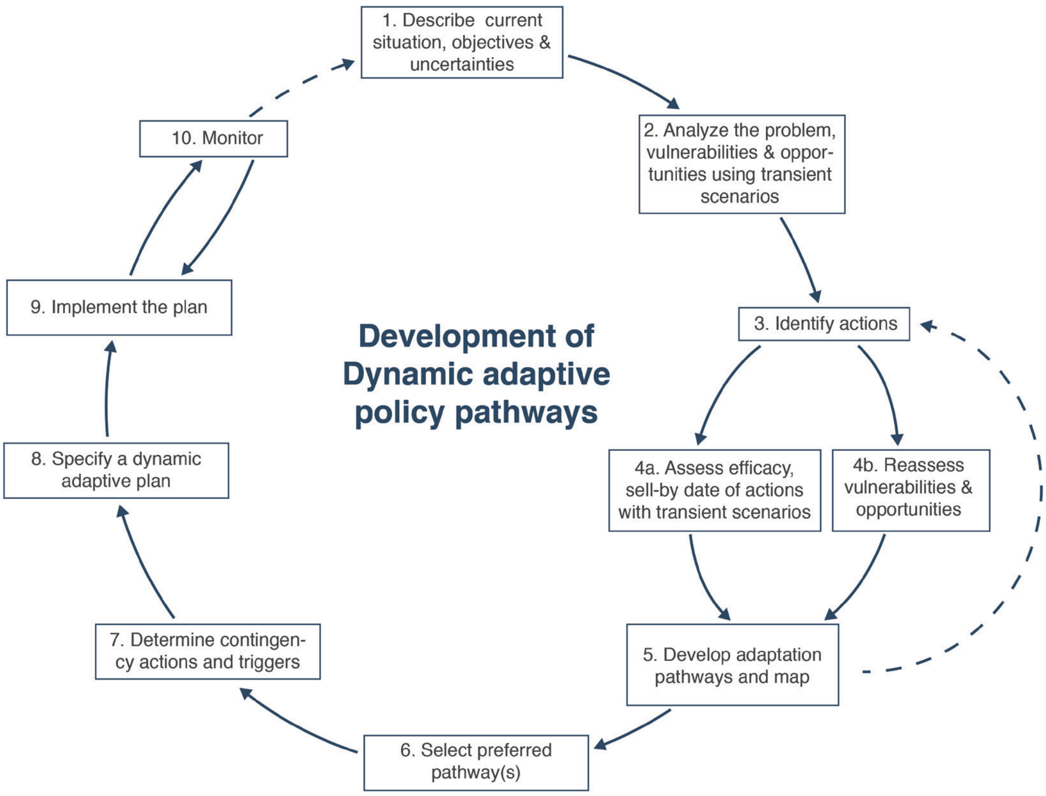


figure 29. The 10 steps of the development of Dynamic Adaptive Policy Pathways . Haasnoot e.a. - modified by author

A range of methods can be used to help construct the Adaptive Planning Map and the corresponding scorecard. These additional methods can strengthen the development process and make it more suitable for decision makers and stakeholders.

Multidisciplinary approach

Attention to inter-multi-disciplinary working are not new as an approach to problem solving. From the beginning of development mankind has strived to optimize and automate. In this process the term "principle" was developed as a form to comprise the taking-on of intrinsic value (Crowder, Carbone, & Demijohn, 2016). Through time we began to organize, manage and expand these "first principles" into different fields that we currently know as disciplines. The discipline's knowledge base and essential characteristics separate these disciplines from each other. Buanes and Jentoft (2009) state in their research three main pillars in which aspects of a discipline can be categorized. The first is the regulative pillar which lays the focus on rules and standards for what defines a particular discipline. The second one is the cognitive pillar which views disciplines as containers of knowledge. The third pillar focuses on the basic norms, values and world views that members of a discipline share (Buanes & Jentoft, 2009). This approach of having various disciplines in the field has proven to be successful however, most disciplines evolved over the centuries turning into more inward looking areas of expertise. As science continues to expand at an immense rate and information content increases, disciplines experience new levels of uncertainty and many new unknowns (Crowder e.a., 2016). Therefore, in order to develop the disciplines are compelled to extend the scope of investigation beyond the limitations of the current discipline's "First principles" and concepts. Jun Matsushita, professor at the Chuo University in Japan, mentions three types that a discipline can be. The first one is the I-type, where there is a limited view and only one specialty. The second one is the T-type, that represents a broad view, but still one specialty. The third one is the π-type, which has a broad view and two specialties. Ideally, each discipline should be a π-type where there are at least two specialties and therefore, the ability to create a better cooperation between disciplines that also have these specialties.

Inter-disciplinary and multi-disciplinary working are often used with the same meaning. However, there are differences between the two. With the multi-disciplinary approach methods from two or more disciplines are examined to determine topic benefits within any one discipline. In the case of Inter-disciplinary working, the focus lies on transferring methods from one discipline to the topic of another discipline, illustrated in figure 29 (Crowder e.a., 2016).

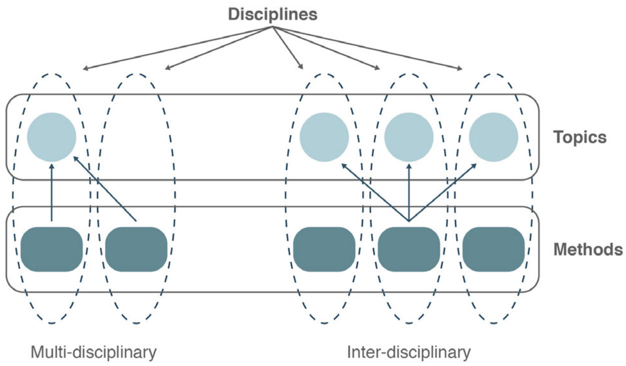


figure 30. Discipline type comparison. Crowder e.a., 2016

Backtracking and forecasting

In order to set the direction for sustainable developments three different time-based approaches can be used, 1) forecasting, 2) backcasting and 3) backtracking. Forecasting is needed when we want to estimate the consequences of current developments and the long-term effects of the proposed intervention. It is useful to predict trends that have developed over some time already. Backcasting describes the desired future state and translating this back to strategies that need to develop in the current situation. This approach can cause substantial change, however, it is rather detached from real life scenarios most of the time. Finally, backtracking uses solutions from past circumstances at the time when there still was a sustainable equilibrium. This approach can be used to link past qualities to the present situation. Using all three time approaches a synergy is created and using the best solutions from history, the present, and the desirable future (van den Dobbelsteen e.a., 2006). This method will be helpful when integrated in the disaster recovery framework illustrated in figure 30.

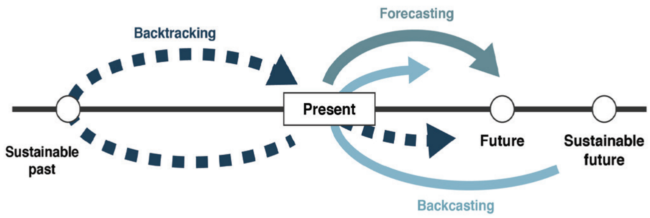


figure 31. Illustration of backtracking, forecasting and backcasting. van den Dobbelsteen e.a., 2006

Scenario writing approach

In order to decide the adaptation actions in the Adaptation Pathway Map the scenario writing approach is a useful method. The goal of this development approach is to help professionals, managers, and clients develop new conceptions of the programs and services they plan and deliver (Hirschhorn, 1980). Scenario writing can help establish or clarify goals by providing them with theories, concepts and other means of information. Scenarios consist of process based assumptions by linking cause and effect sequences. This can be translated back to the APM (Adaptive Pathway Map) as the action points.

SWOT analysis

When performed correctly the SWOT analysis can identify and clarify the fundamental policy choices regarding the desired future. SWOT is an strategic planning acronym for Strengths, Weaknesses, Opportunities, and Threats (Kearns, 1992). When performing the SWOT analysis one should first start with the external environment (opportunities and threats) before analyzing the internal environment (strengths and weaknesses). This way there has to be responded to the external environment which influence what the strengths and weaknesses are of the internal environment. The external environment includes large scale processes that happen over time and have an impact on the physical environment. For example trends such as global warming, aging society or fossil fuel depletion. The internal environment consists of physical elements such as geographical location, touristic attractors or protective measures against flooding already in place. How the external environment is perceived may differ, where one sees a trend as an threat another might view it as an opportunity. There are a few common pitfalls when using the SWOT analysis. The most frequently and important error is failing to link the assessments of the external and internal environments (Kearns, 1992). In order to prevent this from happening Kearn developed the *confrontation matrix*. This is a tool to map interactions between the external and internal factors and visualize them in a table. In this table each combination forms its own classification as shown in figure 31. This way, decision makers and stakeholders can analyze if a certain combination causes actions that can be implemented in order to reach a successful outcome. The SWOT analysis is a critical part for the DAPP approach because it is used to find actions that are needed to reach the desired goal.

	EXTERNAL FACTORS	
INTERNAL FACTORS	**Opportunities**	**Threaths**
Strengths	Comparative Advantage	Mobilization
Weaknesses	Investment/ Divestment	Damage Control

figure 32. SWOT analysis: Issue Classification. Kearn, 1992

Practice in Japan

As mentioned at the start of this paper the region Miyagi has to deal with a wide scope of problems. The aging and declining population (“National Institute of Population and Social Security Research”, n.d.) and constant risk of tidal and pluvial flooding. These trends cause uncertainties in the future which need to be taken into consideration during (re)development projects the region. The Adaptation Pathways Approach (APA) gives insight into the action sequence over time. Besides that it takes a large ensemble of temporal scenarios into consideration. This proves to be helpful as public and governmental officials are quickly able to understand the information it provides. Especially for identifying the infrastructural options that should be investigated more carefully and those that should not be taken into consideration (Walker, 2000). The visualization of the Adaptive Pathway Map is positively received by policymakers during a case study in The Netherlands (Haasnoot e.a., 2013). Because of de resemblance with a metro network it is easy to understand and recognize. This can be a valid aspect when applying the method to Japanese scenarios who will recognize the map in a similar way. Therefore it can be implemented more easily with the stakeholders or decision makers. Another use of the APA is that it is flexible enough to integrate different values, worldviews, and cultural perspectives into the framework (Offermans e.a., 2011). This can be useful when applying the approach in the Japanese cultural context and coping with the cultural differences between Western and Eastern visions.

An interesting method used in Japan is the Kaizen approach. This method can be applied in almost every field of research as it means “continuous improvement” (Wittenberg, 1994). The approach builds on previous made steps, towards a more desired point of improvement in the future. Every action should lead to this goal in the future, where the goal is improvement. Therefore the process is continuous as illustrated in figure 32. An example is the step-by-step infrastructure development process by Jun Matsushita. In this document he describes the Kaizen approach for flood mitigation systems coupled with storm water Run-off reduction measures. Five stages of improvement are described that happened from 1955 to date. This method can be useful for clarify future goals and reporting progress that has occurred, however it is still a very linear process that builds only on historical progress and a limited amount of trends in the future. A practical use of the Kaizen method is the clear overview of actions that are provided step-by-step. This can easily be integrated into the APA and APM as action points or goals. Although history shows that Japan doesn’t implement Western concepts of development that easily (Shibata, 2008) there might be new opportunities as they become more collaborative with Western ways (de Graaf & Hooimeijer, 2008).

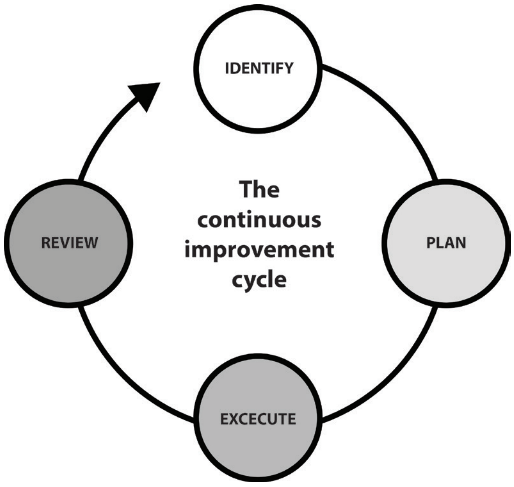


figure 33. Illustration of the Japanese Kaizen Approach. Q J, Startupguys.net

Conclusions and discussion

There is a wide variety of operations research tools available, such as simulation, Robust Decision Making and several policy planning approaches. However, because of the deep uncertainties decision makers have to deal with, there is a need for a new planning approach. The Dynamic Adaptation Policy Pathway (DAPP) approach provides insight into these occurring problems. It sequences actions over time, taking into account the temporal domain of scenarios that might or should happen. This allows for an extensive array of uncertainties about future developments which apply in the planning process. Elements such as trends and system changes, and uncertainty are included in the model which contribute to a more resilient and adaptive development process.
The model is fast and simple in its use because of the simple structure and creates a wide variety of possible pathways. These pathways and actions are visualized in a clear way with the Adaptation Pathways. This is important as representation of infrastructures have to be easily understood to be able to anticipate on changes. The APM (Adaptation Pathway Map) however, gives no guidance to the decision maker or stakeholder on how to translate this into an actual plan (Haasnoot e.a., 2013).
The DAPP has proven to be helpful in Dutch design processes that had to deal with deep uncertainties. But it still needs to be tested on a case study in Japan to find out if this approach can contribute to the Japanese way of planning. The DAPP is a flexible approach where other methods can be implemented to strengthen the model. This is an important characteristic of the approach which makes the model more resilient for future use. At this point conclusions can only be made from a theoretical point of view based on research in Western cases. Although, due to the flexibility and ability to add additional methods the approach has a high chance of succeeding even in a different context than Western countries. A major advantage of the DAPP is that actions and goals need to be set at the beginning of the planning process. Deciding and defining the tipping point still proves to be complex. The reason for this is that the moment a system reaches the tipping point is a gradual process instead of a fixed and easy identifiable point in time. In addition these tipping points might be politically sensitive at a certain moment to define. Despite these complex layers the APA is a valuable method to explore potential futures and identify new ways to reach a certain goal. Especially in scenarios where a better understanding is needed between flood risk, adaptation options and goals (van Veelen, 2016). The DAPP is best applied to a slowly moving transition. If the method is applied to a short term process too detailed information is needed to be added in the APM. This gap between the long-term strategic adaptation and short-term focused practice is still a problem that needs to be bridged in future research (Krabben, 2011), because it might even lead to a loss of resilience in the future.

On the next two pages the research framework is shown. It illustrates the structure of this project and which steps are taken towards the final design. There are three main phases: 1) Context, which forms the problem statement and research questions, 2) exploration, where the main analysis is conducted through the scales, and 3) research by design, where the conclusions are tested in a design.

Research Framework

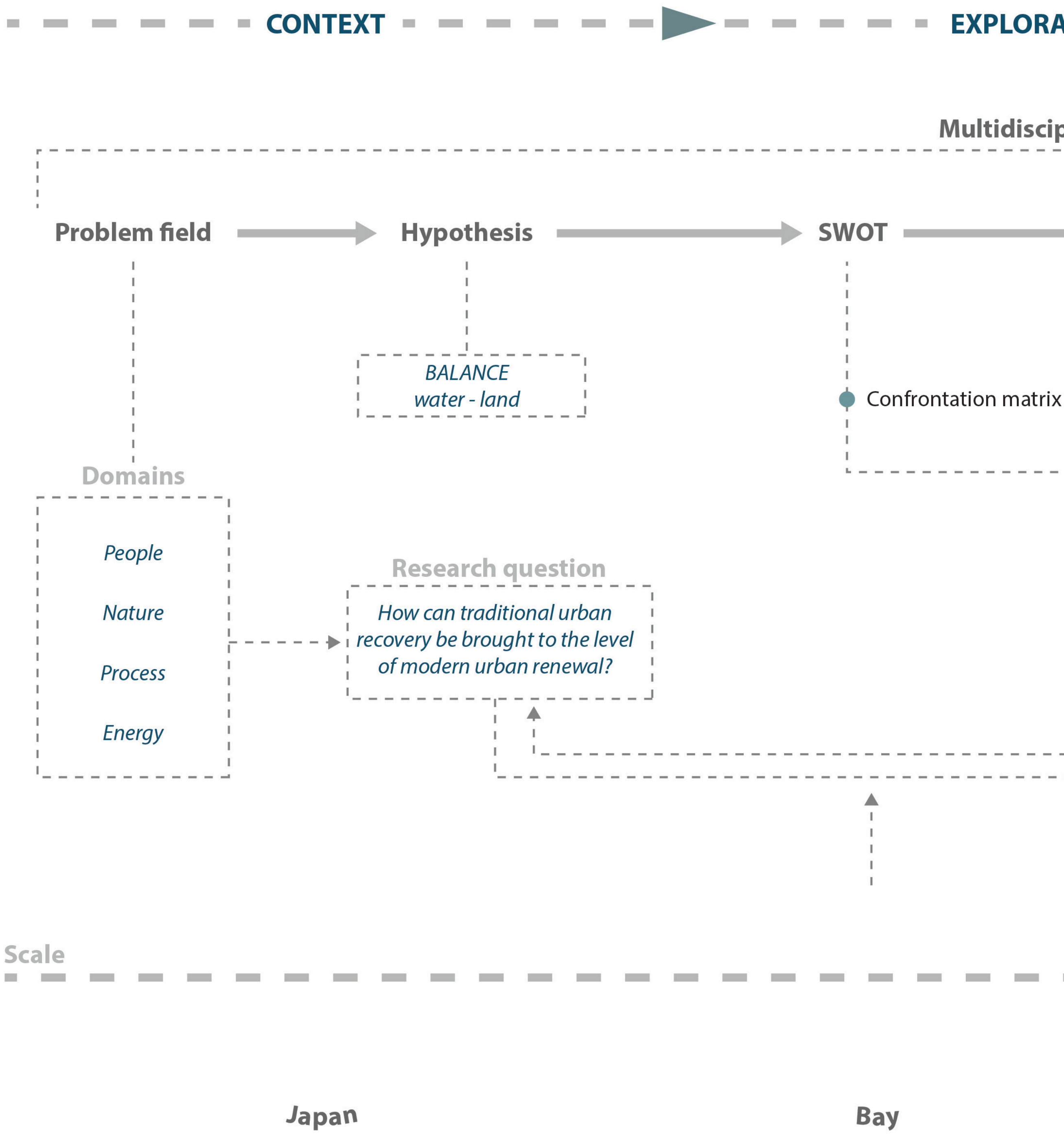


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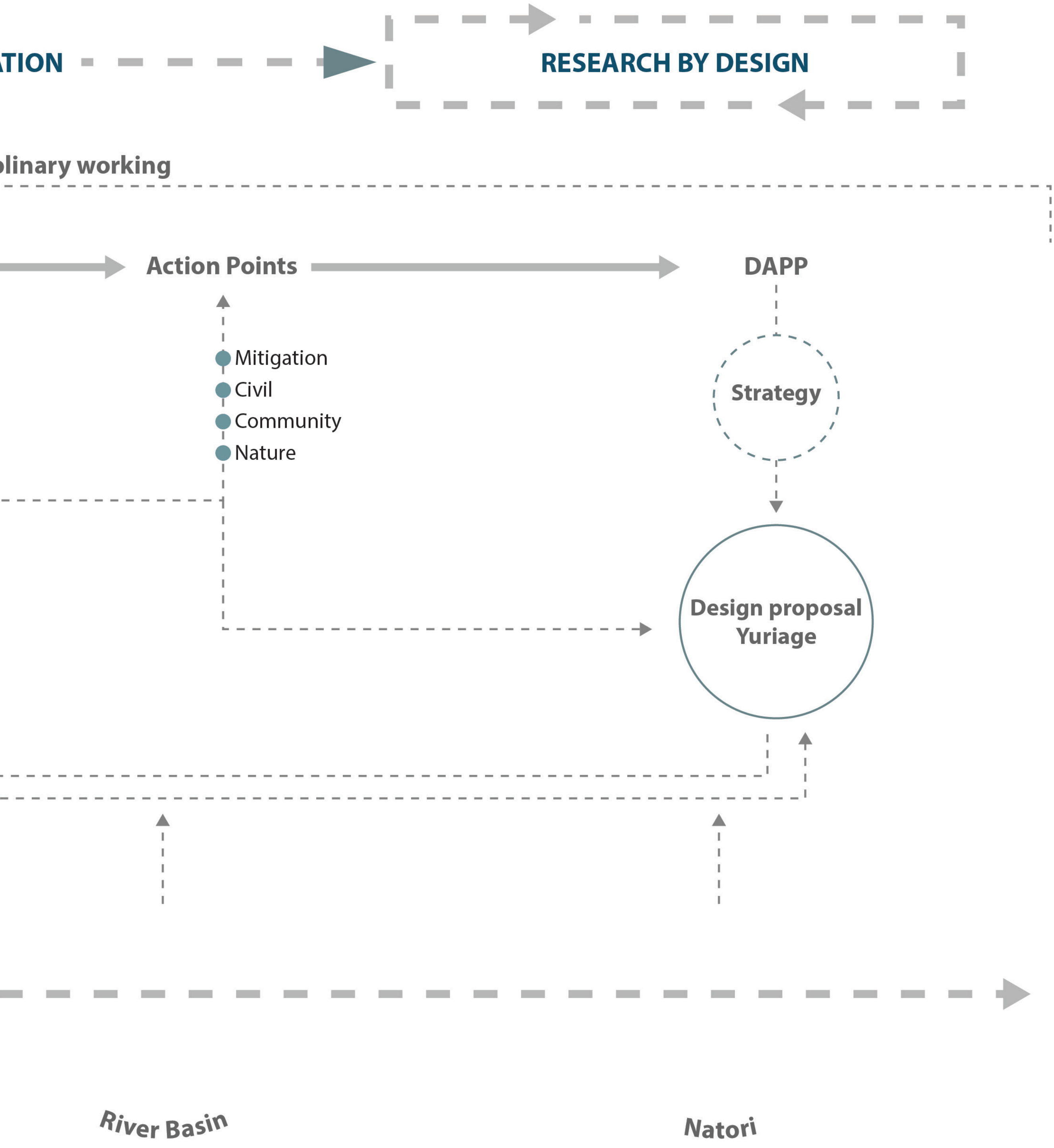
figure 34. Research structure



TION
RESEARCH BY DESIGN
plinary working
Action Points
DAPP
Mitigation
Civil
Community
Nature
Strategy
Design proposal
Yuriage
River Basin
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EXPLORATION

水 —

Scales
Bay
Reconstruction Process
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Natori
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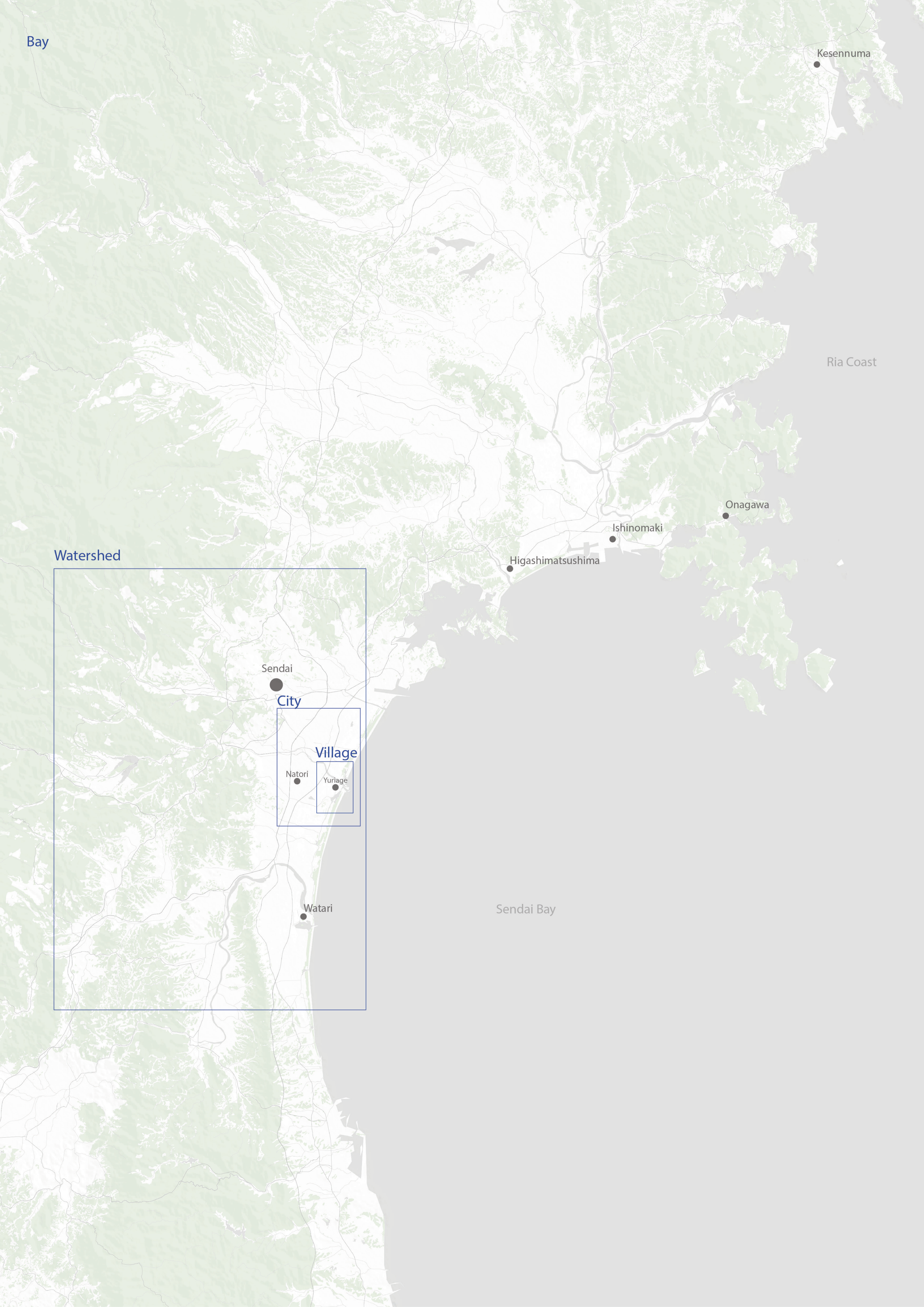


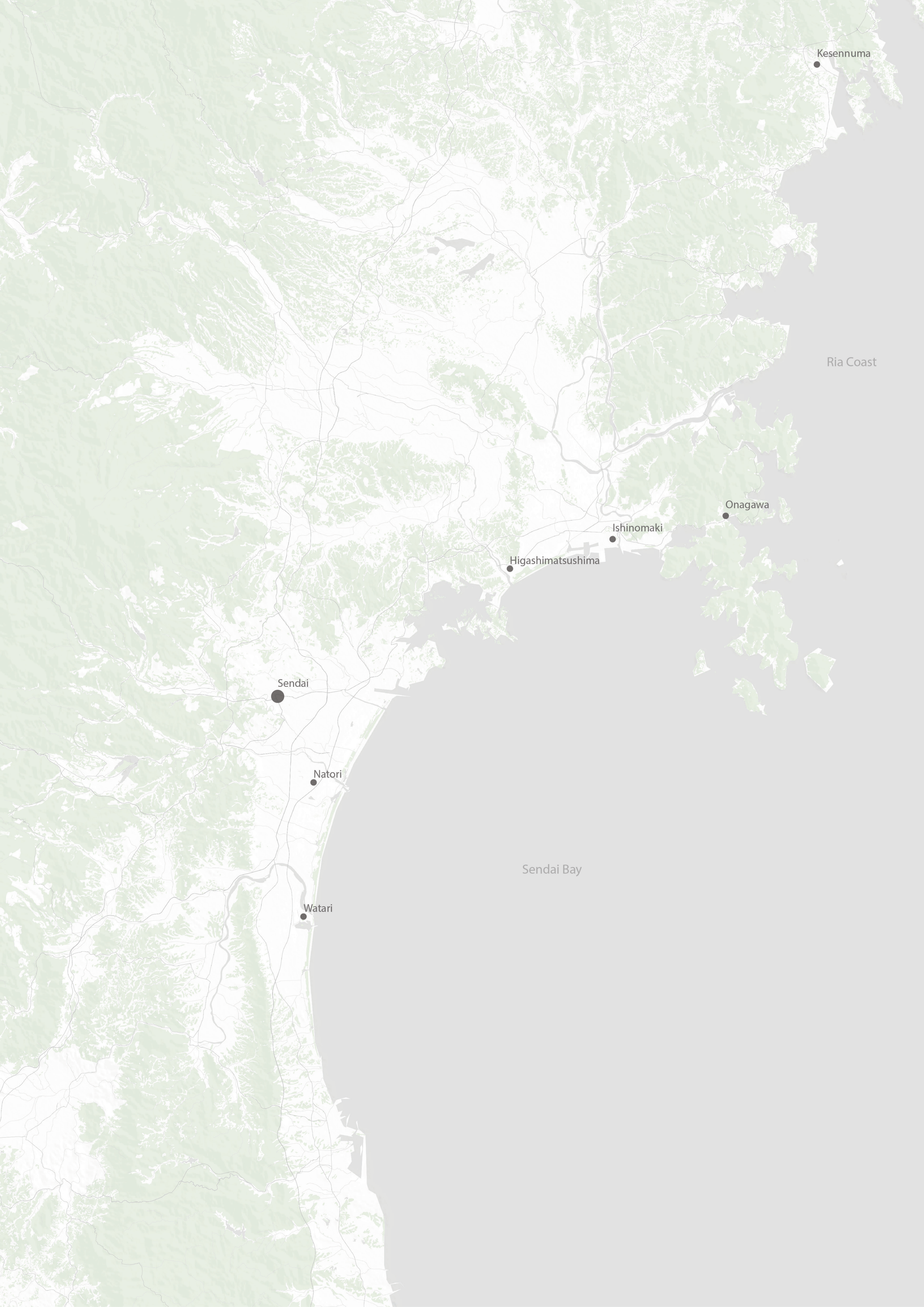
Bay
Kesennuma
Ria Coast
Onagawa
Ishinomaki
Higashimatsushima
Watershed
Sendai
City
Village
Natori
Yuriage
Watari
Sendai Bay

Scales

Issues and approaches are characterized differently per scale. Urbanism is about linking scales, and especially in the case of hydrological systems it is important to think in system scales. For example, a neighborhood can experience problems because of the condition of an entire watershed. In the case of the smallest scale (village scale) the entire Natori river basin exits at the Yuriage estuary. Due to natural processes such as the flow of a river, the scales are not bound by administrative borders but rather to natural systems. In total there are four different scales that are being uses illustrated in figure 34.

Each scale has various topics that are explored and investigated in this research project. The bay area will focus on reconstruction strategies that can be defined as Traditional Urban Recovery (TUR) or Modern Urban Renewal (MUR). The watershed scale investigates the natural processes of the Natori river basin. The city scale explores current developments around the recovery process and what solutions have been made in order to ensure a more safety. The village scale is used as a test case where the developed strategies are applied and help to bring Yuriage from TUR towards MUR.

◂ *figure 35. Scales of the project. Author*


Kesennuma
Ria Coast
Onagawa
Ishinomaki
Higashimatsushima
Sendai
Natori
Sendai Bay
Watari

Bay

The analysis of the bay scale focuses on larger recovery strategies applied to villages and cities with diverse landscape characteristics. These are formed by three main areas: The Ria Coast, Sendai Bay and the transition zone between these areas, see figure 35. Current reconstruction processes and direction in these areas are discussed. Case studies of innovative projects supports understanding of what Modern Urban Renewal in Japanese context could behold. By looking at these processes this chapter aims to answer the following sub-research questions:

1. What are important elements in traditional urban recovery?

2. What is modern urban renewal in Japan?

◂ *figure 36. The bay area of Miyagi. Author*

Reconstruction Process

Recovery after disaster

Most reconstruction processes are often explained as a timeline from the emergency relief stage to the recovery stage and then to the reconstruction stage but in reality these stages often happen simultaneously. The Tokyo Disaster Recovery Manual provides an overall picture of these stages as shown in figure 36.

The four main stages: 1) business as usual, 2) the period of living in evacuation shelters, 3) the period of starting reconstruction, and 4) the period of full-fledged reconstruction. When the reconstruction is completed the business as usual returns. Countermeasures that have to applied are 1) rescue and first aid, 2) system setup for recovery and reconstruction, 3) recovery of livelihoods, 4) building safe communities, 5) recovery of industries and economy, and 6) improve preparedness. The first three stages are described by JICA in their study of reconstruction processes from large-scale disasters, 2013.

Rescue and first aid activities
After the disaster, public buildings such as schools and community centers were appointed as primary shelter. At peak times 2.400 shelters accommodated more than 400.000 people at once. From all over Japan and abroad essential resources such as food, water and heating fuel were provided at these shelters for the people affected by the tsunami. However, because critical infrastructure was destroyed the supply of these shelters was delayed and obstructed. In addition, socially-vulnerable people such as children, elderly and disabled did not receive the proper support due to the lack of disaster preparation. Therefore, many actions were initiated to improve quality of life in the shelters. Child-care was established for the children and parents and educational support was given for students

Securing houses and livelihood
One of the most urgent items was providing temporary housing for the people affected by the tsunami. More than 120.000 units were created by building temporary housing and subsidizing private and public housing rentals. After six months most of the shelters could be closed. The temporary housing was first build and after completion the focus could be shifted towards improving the quality of living. After the disaster many people became isolated because they lost family, friends, or jobs. Therefore, residents associations were organized to aid in community activities and assist individuals.

Reconstruction of towns and industries
In January 2012 the Reconstruction Agency was established by the government as a "one-stop

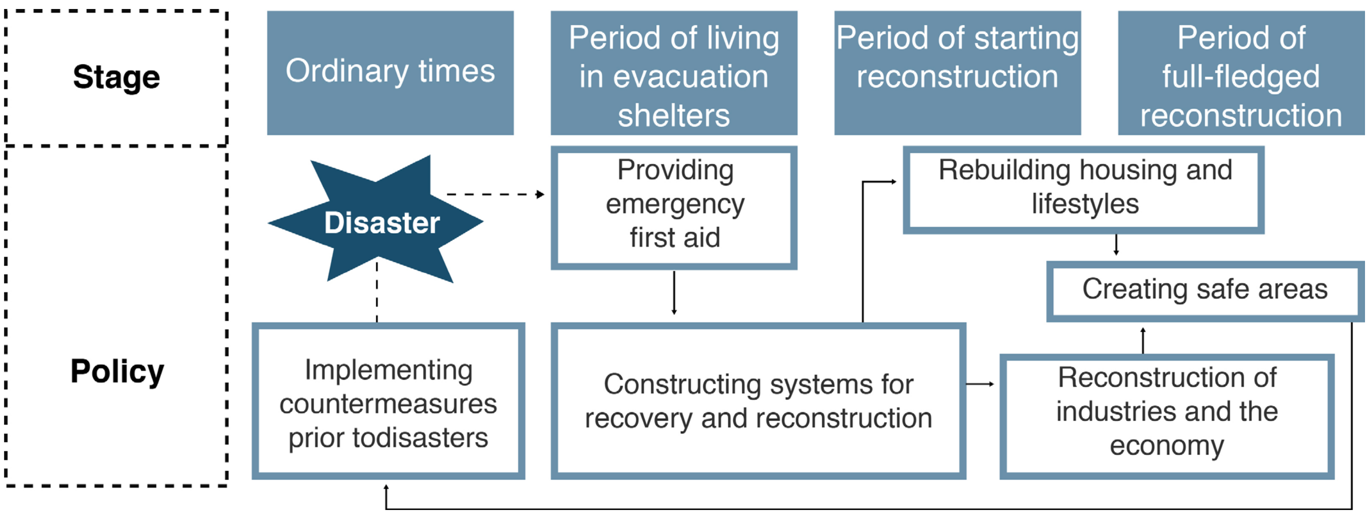


figure 37. Stages of the recovery process in Japan. The Tokyo Disaster Recovery Manual

service body” for local authorities in the affected areas. This governmental body aims to facilitate a smooth reconstruction process and financial processes. However, the lack of human resources in combination with insufficient experience slowed down the reconstruction work. The aging and declining population made it even more difficult to recover from the disaster. The municipalities put the emphasis on creating a general agreement between citizens to maintain and improve their communities. One of the main actions taken was the relocation of villages in risk areas along the coast. In total 325 areas were appointed for construction, however, in only 106 areas housing was constructed. At the start 21.000 dwellings were planned for the people affected, but after five years only 10% started construction. In February 2017 there are still around 150,000 evacuees without homes, of which 50,000 were still living in temporary housing, stated by Japan’s Reconstruction Agency.

Agriculture and fishery are the most important industries in Japan. After the tsunami a large portion of the agricultural lands were damaged through the impact and salt that remained in the ground. However, salt removal was done quickly and after two years most of the agriculture was recovered (JICA, 2013). As for the fishing industry, recovery is gradually but steadily progressing as a major local industry. After one year around 73% of fish was caught in comparison of the year before. The only location where the fish industry didn’t return was at the Fukushima prefecture due to the radiation.

Japan International Cooperation Agency (JICA) took surveys aiming to review the major cases of damage done by the 3.11 earthquake. With this information they produced a list of notions regarding “the necessary perspective for implementing effective disaster measures.” This resulted in the identification of various gaps between the expected capacity of regions and communities to respond to disasters at the planning stage and during these disasters. Interesting to see is that according to JICA other developing countries had these same issues (JICA, 2012).

Disaster plans in Japan are developed with worst case scenarios of a possible disaster. They consist of a combination of hardware and software as the main elements for the disaster plan. Hardware are constructions such as levees and dams, whereas software covers nonstructural measures, such as warning systems and disaster prevention education. However, despite this approach, regions and communities that had applied these measures suffered significant damages during the GEJE (Great East Japan Earthquake). Therefore, Japan has to recognize that implementing various measures alone was not enough, it was necessary for these measures to be effective.

figure 38. Kids’ room. Providing child-care needs for each household to allow mothers who are often mentally exhausted to have some relaxation. JICA, 2013

Policies

The 3.11 tsunami affected a part of the Tohoku region, each with its own characteristics. These include topographical, industrial and everyday living circumstances. For each of these diverse areas there is a need for measures and strategies that fit that specific location, resulting in five different typologies for the Tohoku region:

Type 1: Regions with urban functions that were almost entirely affected in low-lying areas.

Type 2: Regions where low-lying areas were affected and areas on high ground weren't damaged.

Type 3: Regions built on hills running down to the coast with few low-lying areas and settlements.

Type 4: Coastal plains.

Type 5: Inland areas and regions that were damaged due to liquefaction.

As the focus of this research lies on the Miyagi prefecture only the relevant types will be further explained. Derived from the previous it became clear that the city of Natori and the fishing village Yuriage are situated in the coastal plains and therefore, can be defined as type 4. However, type 1 is also relevant due to the fact that most of Yuriage got washed away during the 3.11 tsunami.

Type 1
The regions that were almost entirely affected by the tsunami should apply the strategy of relocation to higher ground. How the community is involved and to what extend is crucial in this strategy and determines the success of the relocation. In addition, a factor of delay are the issues of obtaining land for relocation and changing land ownership. These can be very sensitive matters especially due to the close relationship of families and their land. Although most of the settlements should be relocated to higher grounds, there can be certain exceptions. When a settlement has a high economic value because of commercial or industrial functions such as the fishery industries, it will be unavoidable to make use of these low-lying areas. In this case it will be important to redevelop according integrated land use and building regulations. In addition, land raising strategies are necessary when rebuilding housing in these risk areas. Extra attention should be paid to evacuation routing based on evacuation plans with evacuation towers alongside this route.

Type 4
The city of Natori and the settlement Yuriage are both situated on the Sendai plains and therefore defined under type 4. The Sendai plains suffered immense damages due to flooding from the 3.11 tsunami; agricultural industries were damaged the most. Similar to type 1, it is important in these areas to implement a combination of measures instead of only building a gigantic coastal levee. Land use restrictions, sand hill embankments and proper evacuation routes should be implemented in an integrated plan. Setback levees play an important role as they can function as boundaries for development and provide safe evacuation routes at the same time. Housing should be built behind these setback levees in order to create enough time for the people to evacuate and provide extra safety in case of flooding or a tsunami with the same intensity as the 2011 one. In addition, with the revitalization of agricultural areas and existing settlements community support measures should be taken into consideration (Reconstruction Design Council, 2011).

Hope beyond disaster

On the 25th of June, 2011, the Reconstruction Design Council published the document 'Towards Reconstruction, Hope beyond Disaster' in response to the GEJE. This policy document provides seven principles defined by all the members of the Reconstruction Design Council in their 4th session about forming a guiding philosophy and policies for recovery after the disaster, shown infigure 38. The difference between this document and others is the new take on disasters. The perspective is aimed at making new innovative concepts for rebuilding regions, starting from the acceptance of the possibility of a disaster (Reconstruction Design Council, 2011).

The Reconstruction Design Council has three guidelines for the actors for reconstruction projects. The first is that there should be a municipality-led reconstruction instead of decision making by the national government because it is the residents who are closest to their communities and understand local characteristics best. However, the national government should set the overall policy for reconstruction, including a vision, ideals, and types of assistance. Prefectural governments should take on wide-area administrative issues, as the governmental body that encompasses multiple municipalities.
Secondly, in order to respect the needs of local residents it is important to form consensus among residents and utilizing community development corporations. While taking these needs into account of local residents, it would also be beneficial for the appropriate body to consider methods of land use for the purpose of realizing a future vision for communities, including establishing land lease rights based on consensus among land owners (Reconstruction Design Council, 2011).
Thirdly, human resources assistance to support reconstruction due to the fact that it would be preferable for residents of municipalities to participate actively in reconstruction projects. In order to support resident-focused community development, the roles played by advisors will be crucial.

Important for recovering a region from disaster is that the applied measures will bring people together rather than split them apart. This results in the concept of linkage, which is crucial for revitalizing the local community. It is important to listen to the affected people and provide them with linkage (Reconstruction Design Council, 2011). The realization of these wishes will be carried out by people that ensure communication lines to the relevant locations. In addition, these persons will link people to organizations and gradually develop a communication network. This will also prevent affected people to become isolated which was one of the issues after the 3.11 tsunami. Therefore, community needs must be prioritized when reconstruction starts.

The main drive behind the new concepts is the idea to "Build Back Better" (BBB), mentioned in the Sendai Framework for Disaster Risk Reduction 2015. It is part of one of the four priorities developed by The United Nations Office for Disaster Risk Reduction (UNISDR) (Santiago-Fandiño, Sato, Maki, & Iuchi, 2018). It states that recovery, rehabilitation and reconstruction phase is an opportunity to Build Back Better through integrating disaster risk measures (United Nations, 2015).

1. For us, the surviving, there is no other starting point for the path to recovery than to **remember and honor the many lives** that have been lost.
2. Given the vastness and diversity of the disaster region, we shall make **community focused reconstruction** the foundation of efforts towards recovery.
3. In order to revive disaster-afflicted Tohoku, we shall pursue forms of recovery and reconstruction that tap into the **region's latent strengths** and lead to **technological innovation**.
4. While preserving the strong bonds of local residents, we shall construct **disaster resilient** safe and secure communities and **natural energy-powered** region.
5. we shall **simultaneously pursue reconstruction** of the afflicted areas and revitalization of the nation.
6. We shall seek an **early resolution** of the nuclear accidents, and shall devote closer attention to support and recovery efforts for the areas affected by the accidents.
7. All of us living now shall view the disaster as affecting our own lives, and shall pursue reconstruction with a spirit of **solidarity and mutual understanding** that permeates the entire nation.

figure 39. The seven principles as a set of recognitions after the 3.11 earthquake. Towards Reconstruction, hope beyond the disaster, 2011.

Eco-towns

The Eco-Town program was firstly initiated around 1997 by the Ministry of Economy, Trade and Industry (METI). The objective of this program is to promote local economic stimulation through fostering environmental businesses that utilize the strengths of local industries, and to create resource-recycling socio-economic systems by promoting local approaches for recycling and suppressing the generation of waste (“METI Ministry of Economy, Trade and Industry”). By connecting local citizens and local industries the aim is to achieve innovative approaches to urban development which are environmentally friendly and do not duplicate existing frameworks.
In order to assure the development of innovative unique projects a local government first creates an “Eco-Town Plan” that makes use of the region’s local characteristics. Next, the METI and Ministry of the Environment check if the basic concepts and concrete projects meet the requirements of originality and innovativeness, and if the plan has a potential to be a model for other local governments. When the two ministries approve the plan they provide financial aid to kick-start projects by local governments and private organizations. Subsidies are offered for two different types of projects, hardware and software projects. However, these subsidies have been cancelled in 2005 and 2004, respectively.
The process of creating an Eco-Town is shown infigure 40. In 2005 the Eco-Town program was expanded with the 3R, “Reduce, Reuse & Recycling”, concept. In order to overcome issues with the environment, scarce resources and depleting energy, it is necessary to create a sustainable society which can be achieved with the 3R’s. The goal is to achieve sustainable consumption and production through information access, market creation and networking, policy and strategy development regional corporation, and building sustainable commitment, shown in figure 39 (Foundation, 2005). In addition to the 3R, the Eco-Town concepts also include industrial ecology, green consumerism, green procurement, extended producer responsibility and integrated waste management. It is therefore a defined area, a laboratory, where various eco-concepts can be developed and implemented.
The national subsidies by the Ministries has finished since 2006, however, local governments still subsidize individual initiatives. The goal of the national subsidies was to give a kick-start for the recycling industries and for the development of resource efficiency.

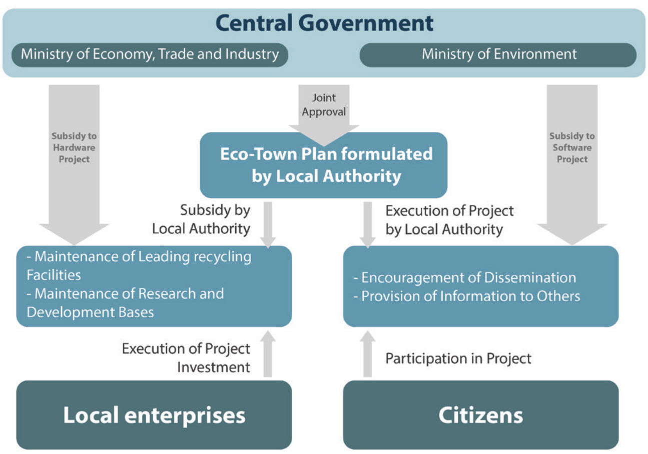


figure 41. Eco-Town program. METI, 2006

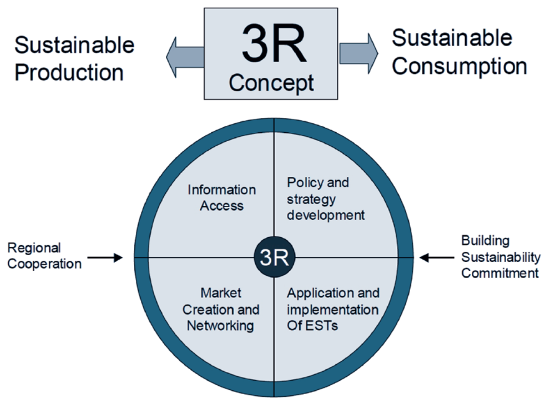


figure 40. 3R Concept. Global Environment Centre Foundation, 2005

Waste management

Continuing on the topic of recycling of materials in the Tohoku region, specifically the Miyagi, Iwate and Fukushima Prefectures that were affected the most by the 3.11 tsunami. Many buildings were destroyed and the streets were full of debris. Often the potential to recycle this debris is missed because priority is given to clean up the affected areas. Most of the time, the debris is used for landfills which are costly and have a negative impact on the environment (Copeland, Schierow, & Esworthy, 2006). However, because of the large quantities of debris after the disaster landfill was unfeasible and, therefore, debris should be recycled as much as possible. The Japan Society of Material Cycles and Waste Management (JSMCWM) stated that recycling should be considered in the management of debris because it can be used at places where recourses are limited. In their recommendations examples are given on how each material can be used. Concrete debris is used for rebuilding, wood scraps can be an alternative for fossil fuels to generate power, scrap metal and rubber tires are recycled (Asari e.a., 2013).

In addition of aiding the reconstruction efforts, using debris can also speed up the recovery process when executed in a successful way. In order to restore coastal embankments and levees, eighty-five percent of the recycled concrete debris and almost all of the tsunami deposits are planned to be used, see figure 41. Tsunami sediments were tested by the Ministry of the Environment and used in the national coastal disaster-prevention forest and coastal levee projects. In addition, many elevated structures such as elevated roads and evacuation hills use the debris and tsunami sediments as fill material.

One of the major challenges during the management process was dealing with the extraordinary amount of debris and its mixed composition. Sendai City had a waste management plan in place before 2011, however, it did not include tsunami debris. Furthermore, there was limited experience dealing with this huge amount of debris. Therefore, an extensive debris management plan should be prepared and scenario training for potential disasters is needed. Another challenge was the separation of the tsunami sediments from the disaster debris in order to be recycled effectively (Santiago-Fandiño e.a., 2018). This pushed the development of new technologies in the field of recycling in order to meet the Japanese Industrial Standards (JIS) requirements for recycled aggregate and are being utilized for public works projects.

The Eco-town concept and the way to approach waste management has many similarities with the concept of Circular Economy. This concept aims to trade products and services in closed loops and retain as much value as possible of products, parts and materials. System thinking is the foundation of Circular Economy where all actors (industries, people and organisms) are part of a network where the actions of one actor impact other actors. Many definitions of Circular Economy refer to the 3R's that is mentioned with the Eco-Towns. In addition most of the definitions mention that a system change is a fundamental part to reach Circular Economy and thus a more sustainable and resilient future (Kirchherr, Reike, & Hekkert, 2017).

	Project	Recycled material	Amount (including planned use)
Miyagi prefecture	Coastal or river embankment restoration	Tsunami deposits	103
		Concrete debris	
	Coastal disaster-prevention forest restoration	Tsunami deposits	110
		Concrete debris	
	Agricultural field restoration	Tsunami deposits	15
	Park construction	Tsunami deposits	262
		Concrete debris	
	Fishing port projects	Concrete debris	29
	Construction of temporary storage sites	Tsunami deposits	89
		Concrete debris	
	Other projects	Tsunami deposits	114
		Concrete debris	

figure 42. Major public works projects using recycled materials from tsunami debris. Santiago-Fandiño e.a., 2018

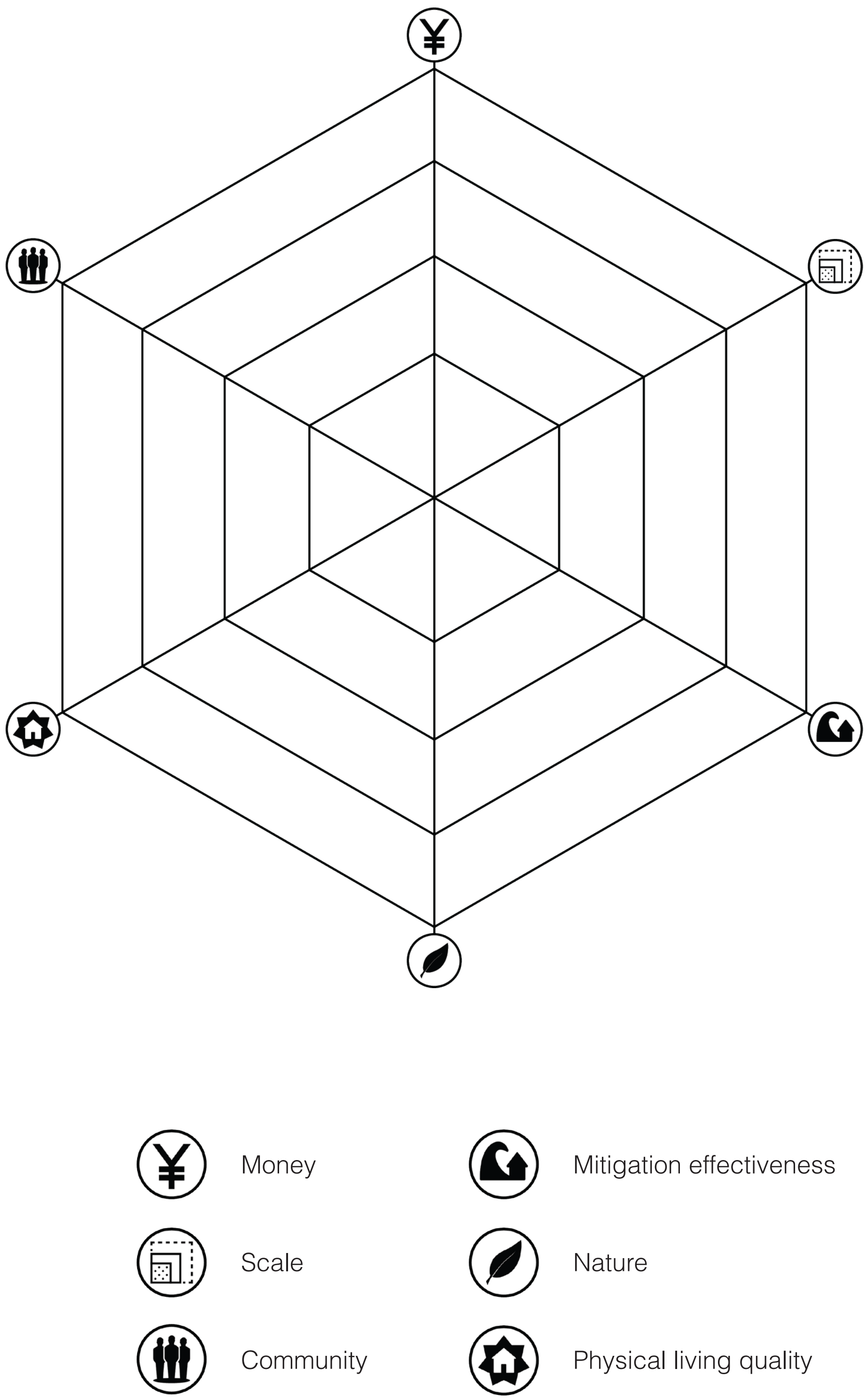


figure 43. Hexagon which is used as a tool to assess and categorize projects on six main themes. Author

Criteria

The six aspects

To be able to assess and categorize the actions for the DAPP a set of criteria has to be selected. This will help the decision making process and set directions to the defined goal. By analyzing the reconstruction process three main aspects are highly important for Traditional Urban Recovery (TUR). The first is the cost benefit which has a very influential impact in the decision making process. This will always be an important factor because financial support is needed to be able to develop. The second theme is the scale of the project, which is used to categorize projects and decide to what extend policies are needed. In case of regional projects a different set of policies is needed to guide the process than a community project on a neighborhood scale. In addition, the scale is important to consider project in context with the other criteria. The impact of a small project on the system is in most cases less than a large scale project but the costs will also be significantly lower. The third theme, community, is a very valuable element of the Japanese culture. As described in previous chapters the involvement of the community plays a large role in the reconstruction process.

These three main aspects of TUR are expanded with another three aspects derived from the future reconstruction vision and concepts. The first is the level of mitigation impact a project has on its surroundings. In the light of recent events such as the tsunami, mitigation measures become increasingly important in order to provide safe living environments. With the second aspect more attention is given to the environment. Nature plays an important role for a more sustainable and resilient future and should be in balance with the hard engineered projects. Japan is well known for its strong relationship with nature, however, measures taken against the tsunami caused a disconnection with nature. The last theme of this section is the physical living quality. Although this theme has a close relationship to the community it lies to focus more towards the physical aspects of the public space, whereas the community is about processes and interventions that strengthen communities.

This results in having six main that are used as criteria to assess and categorize projects and actions for the DAPP. figure 42 shows the hexagon in which each row represents the impact intensity of the project on a scope of 1 to 4. These criteria can be used to assess projects and decide if they contribute to Modern Urban Renewal. In addition, these criteria's are used to evaluate the actions used in the DAPP approach. This will provide a useful and clear overview of the impact of the actions and help decide which ones should be implemented.

Case studies

This hexagon will be used to asses three case studies situated in the bay area of the prefectures Miyagi and Fukushima and can be found in appendix B. In order to get a better understanding of how Japan defines modern urban renewal in the context of a disaster scenario the chosen case studies are all developed in the disaster areas. The cases explore new ways of reconstruction and sustainable development in the context of a disaster society. They are tested on their performance towards the six aspects. This will show the state of Japan in the process of translating the aspects to the physical environment and the progress towards Modern Urban Renewal.

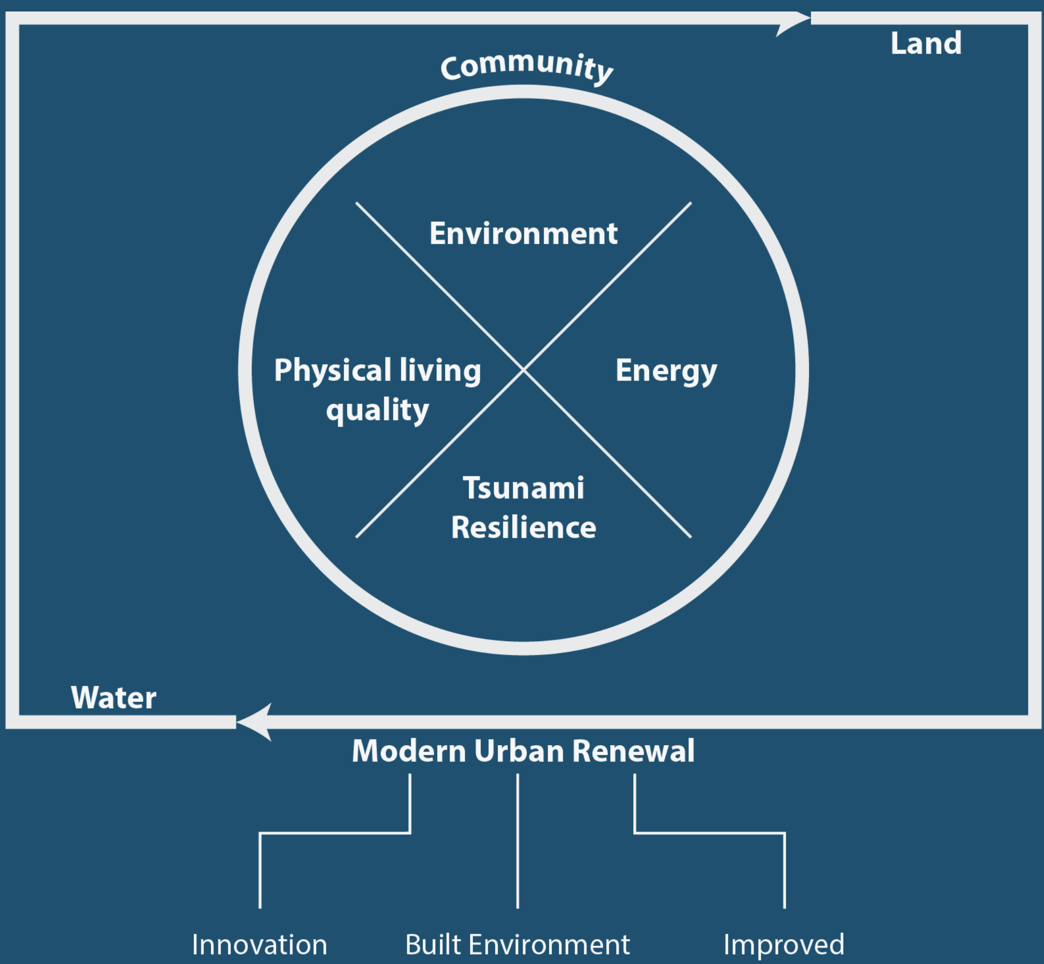


figure 44. Concept of Modern Urban Renewal

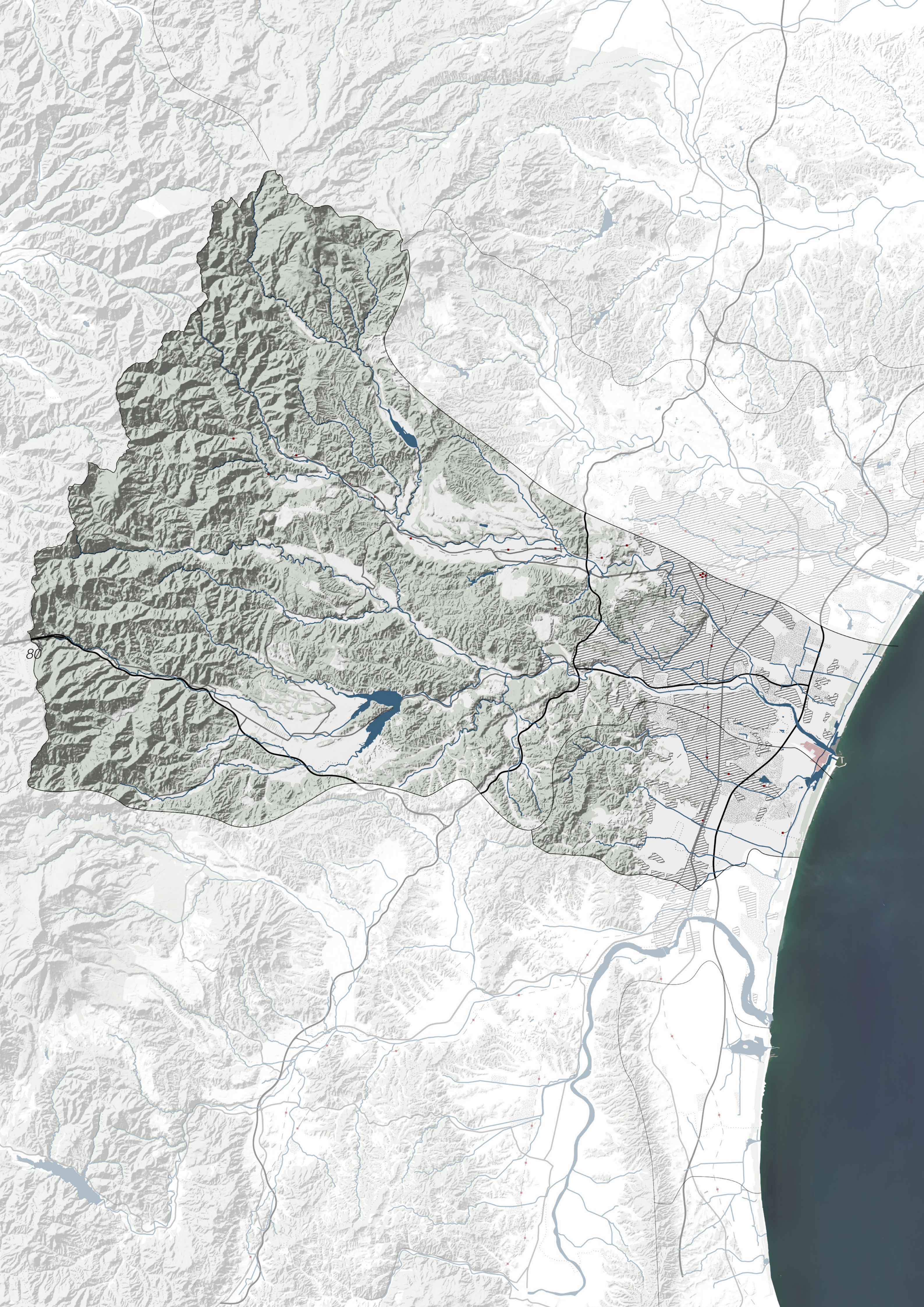
What is modern Urban renewal for Japan?

Because of the recent events of the 3.11 disaster, more attention is put towards disaster resilient development. The first response was to protect the coastline with hard engineered solutions such as an embankment, breakwaters and land raising. However, recently a shift occurred when people became aware that only using concrete structures has a negative impact on the environment and physical living quality. The introduction of more natural solutions is promoted in many new studies and visions. The use of coastal forests is one of the solutions. When integrating nature in the development it is important to combine various measures instead of using only one. An example is combining dune landscape with the current embankment to improve the connection with the sea. Furthermore, people realized that one cannot always protect itself completely against disasters and started to accept this, which formed the disaster culture.

Before the disaster the Eco-Town concept was already used to work towards a more sustainable Japan, but after the disaster the concept of tsunami resilience was added. The combination of the Eco-Town and the 3R's concept formed a solid framework to use during the recovery process. Unfortunately, there is a lack of visual representations of these visions to help implement the framework. However, through best cases we can get an idea of what is meant with modern urban renewal in Japan. These are used as model towns by the Japanese government and form an example on how other towns could develop. The Eco-Town concept combined with the 3R's and tsunami resilience form the three pillars towards modern urban renewal. In addition, a new topic high on the Japanese agenda is the energy production and consumption. Especially after the nuclear disaster of the Daiichi Japan puts a strong focus on renewable energy production. However, the production of renewable energy is not enough with the current consumption rates. Therefore, Japan plans to systematically decrease energy consumption. The case studies show the implementation of smart systems to increase the efficiency of energy usage and production. This idea of system thinking matches the Japanese culture where every individual contributes to the larger whole/system and in that way help each other. It is therefore important to provide a framework where community involvement is stimulated and strengthened. Because most of the modern concepts are only documented and explained through text there is still a lot to improve in the field of representation and promotion. The model towns that are being built are a good way to explore this and experiment with different approaches.

figure 43 illustrates the concept of Modern Urban Renewal where the core consists of four aspects; Physical living quality, environment, energy, and tsunami resilience. This core is bound by the community, which means that there should be a strong tendency towards community involvement in the reconstruction process and strengthening the community. This should be done in a context of constant consideration on the balance between water and land.

With the gathered conclusions on the bay scale about the process of reconstruction and MUR we can move on to the next scale which is the watershed. On this scale we transition to the physical domain and explore various natural processes that are important factors for the resilience of an area.


80

Watershed

Natori river basin

When dealing with water related issues the river basin is an important hydrological system. A river basin is the area of land that is drained by the river system consisting of the main course and the tributaries. The system of rivers and creeks flow downhill into one another where the final destination is the estuary at the Sendai Bay. Natori and Yuriage are both situated along the Natori River and it is therefore important to research the complete river basin as all the water upstream will eventually come across these settlements. In addition to the river system itself, the topographical layout defines the edges of the river basin. All the precipitation that is captured on the surface and transported downhill because of the topography form the edges of the basin (Shrestha & Kazama, 2007). In case of the Natori river basin this results in a surface area of 939 km2. From this surface area, 675 km2 is mountainous, 245 km2 is are plains, and 20 km2 are water bodies. The total length of the main flow channel is 55 (Watanabe, e.d., 2004). There are various land uses in the river basin such as paddy fields, urbanized areas and forestry.

figure 45. River basin. Author

River basin section

Japan has extreme height differences making rivers steep and flow fast. This is seen in figure 45 where the highest point of the river basin at around 625 meters high descends to a few meters over a relatively small distance of 25 km. To dissect the river basin and find possible threats or potentials two layers are important: the geomorphological land classification and the subsoil. These are used to find potential locations where for example groundwater can be recharged to decrease the threat of fluvial flooding. The upper part of the river basin has a lot of rocky subsoil which makes it difficult to store water. However, between the two highest points of the river basin there is a flat terrace that can store water. This terrace is already partly used by the Kamafusa dam which is used to generate electricity but there is still space to expand the water storage capacity.

The low-lying areas mainly consist of sand, clay and gravel. Interesting to see are the natural levees and sandy mounds in the coastal and valley plains. These form potential for natural defense measures against tsunami or earthquake threats. Furthermore, these sandy mounds also form stability for urban developments ("Ministry of Land, Infrastructure, Transport and Tourism").

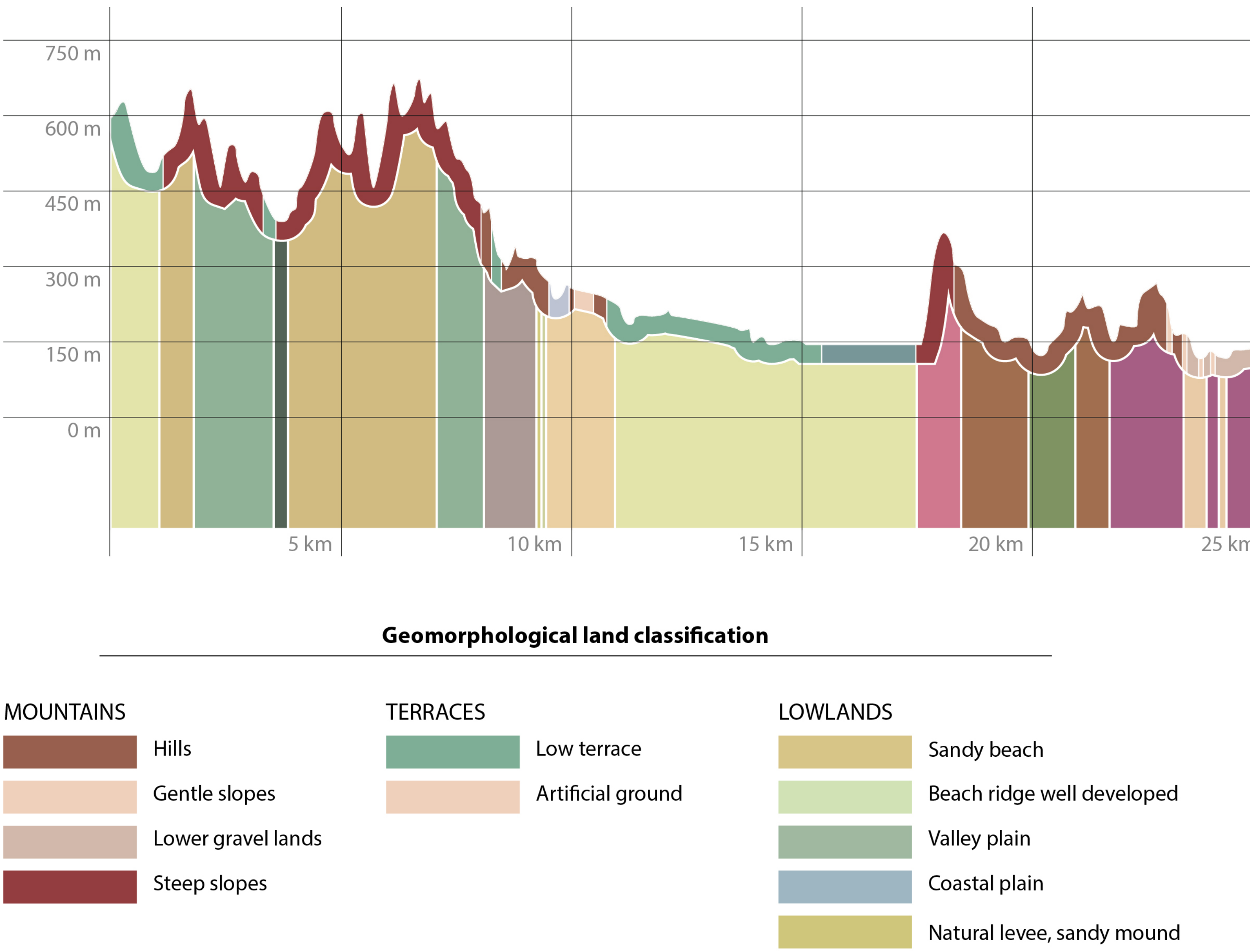


figure 46. Section of River basin. Author

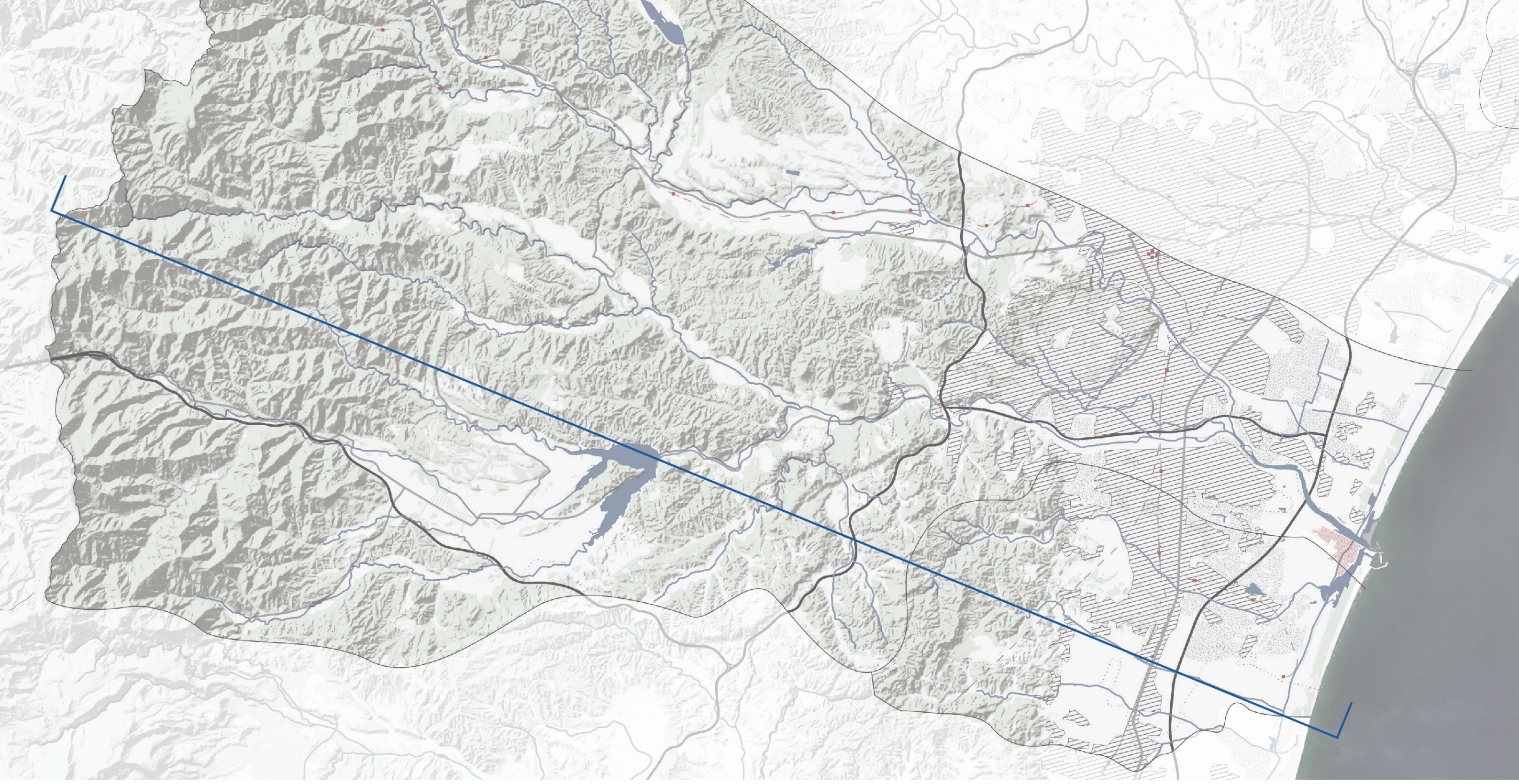
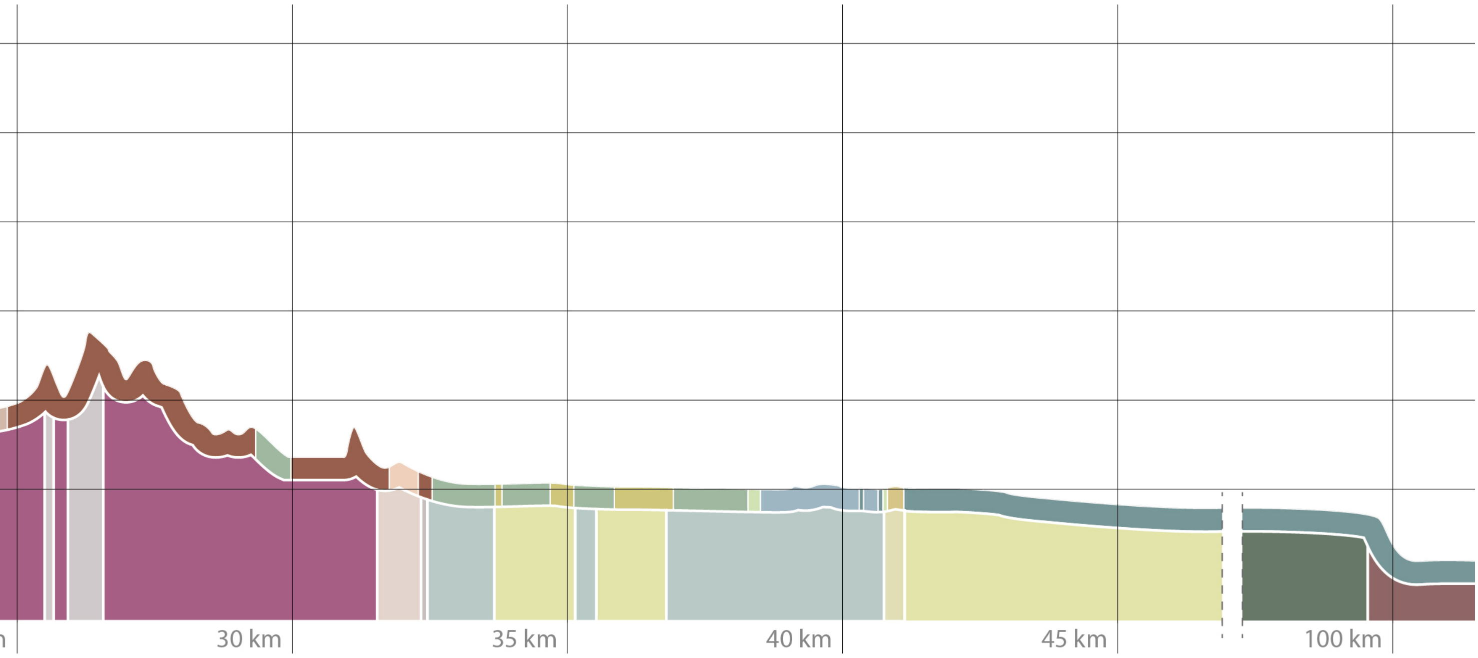


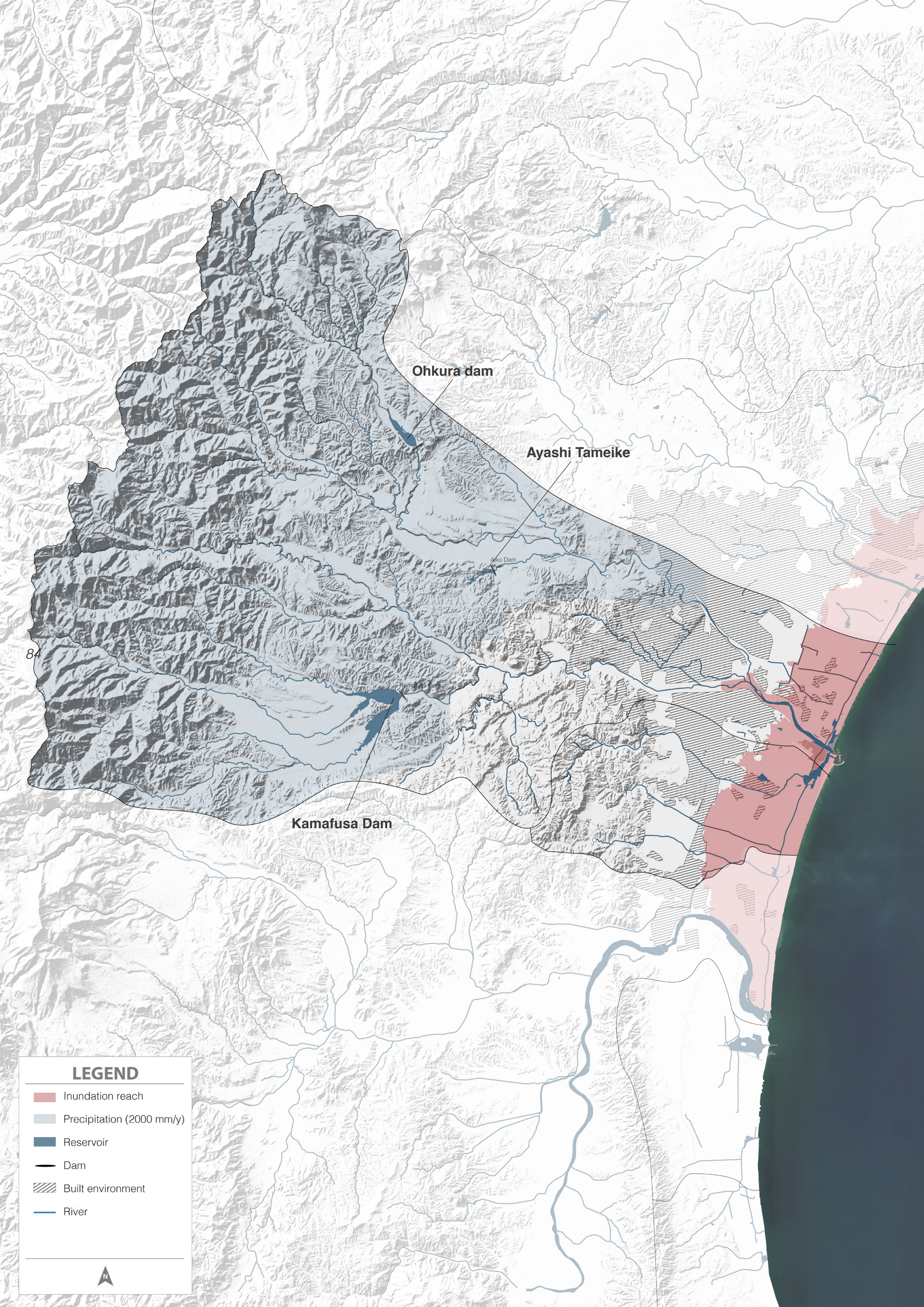
figure 47. Section of River basin on the map. Author



Subsurface

SOIL

- Sand
- Gravel, Sand, Clay
- Gravel, Sand
- Mudstone, Sandstone
- Loam
- Agglomerate
- Sandy Tuff
- Tuff breccia, lapillli tuff
- Rhyolite lava
- Andesitic tuff breccia, fine tuff
- Gravel
- Pumic Tuff, Sandy Tuff
- Conglomerate, Sandstone, Tuffaceous siltstone, Tuff, Lignite
- Conglomerate, Sandstone
- Dacate
- Gray, green & blue mud
- Brown, red-brown mud
- Andesitic Tuff
- Sandstone, siltstone, tuff
- Water


Ohkura dam
Ayashi Tameike
Kamafusa Dam
LEGEND
Inundation reach
Precipitation (2000 mm/y)
Reservoir
Dam
Built environment
River
N

Hydraulic system

The precipitation rates of Japan are extremely high in comparison to the rest of the world with peak moments of 4000 mm/y at some places in Japan, appendix A figure 3 on page 178 (“気象庁｜メッシュ平年値図”). The precipitation rates in the Natori river basin are around 2000 mm, during peak moments 400 mm of rain falls within a time span of 14 days (“Natori-Shi Monthly Climate Averages”). In combination with the steep mountains rain water discharge can cause major flood risks downhill. Multiple actions have been taken in order to control the volumetric flows of the. One of the main solutions in Japan are the flood control reservoirs and flood detention basins. These have been put at strategic places in the river basin where have maximum efficiency. As shown in figure 47 the three main flood reservoirs are placed where the topography flattens out in order to catch as much water as possible. The largest reservoir, the Kamafusa dam, is situated near the edge of the transition of precipitation intensity to maximize the catchment area. The reservoirs and flood detention basins reduce flood discharges downstream and directly modify the characteristics of floods in spatial extend of inundation, depths of flooding, and flood flow velocities (Babic Mladenovic, 2016).

To control the water in the lower river basin another dam is situated at the point where the Hirose river reaches Sendai. The river bed of the Hirose river that runs through the city and merges with the Natori river has an average width of 110 meters. The Natori river has an average width of almost 400 meters and at some points even reaches widths of almost 800 meters. All the factors mentioned above cause a substantial decrease in the volumetric flow of the river. At the estuary close to Yuriage the Natori River has a volumetric flow of just 6,3 m3/s which is extremely low for a river with a river basin of this size. Because of the high precipitation rates Japan is forced to control the water at this extend in order to provide enough safety against floods.

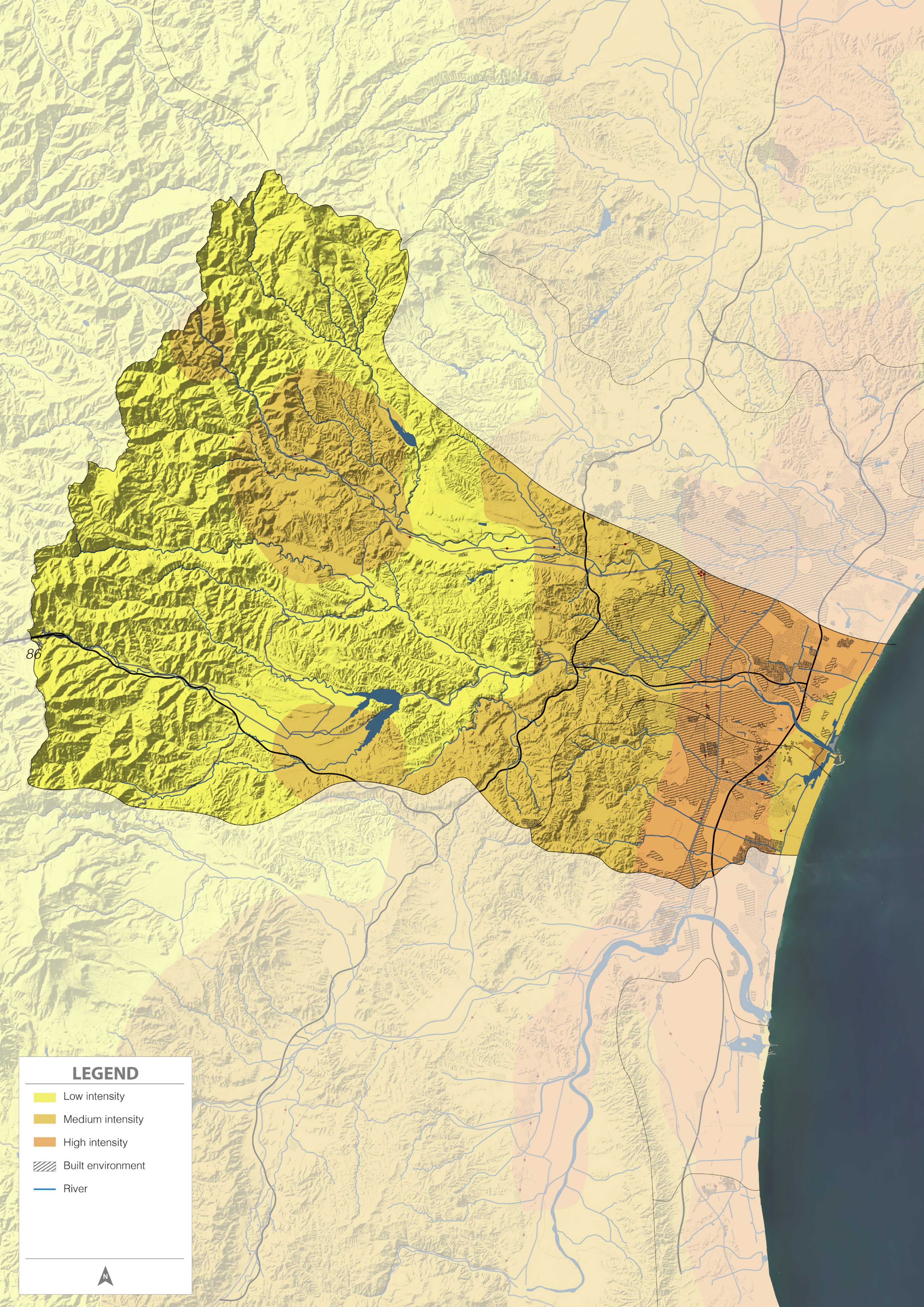
There are multiple functions such as urbanized areas, agricultural lands and forestry in the Natori river basin. These functions have an effect on the quality of the surface water of the river. Municipal and industrial wastewater and runoff from agricultural land have an impact on the quality of the water. The municipal and industrial wastewater discharge has a constant polluting input to the river, whereas surface runoff is related to seasonal intensities (Shrestha & Kazama, 2007). The aim of the river basin study is to see if new structures and measures should be applied in the river basin to control the water. However, the hydraulic system in its current state functions extremely well and has a very low risk of fluvial flooding, proven by the volumetric flow of the river estuary. Therefore, there is no need to add new measures to control water discharge that comes from uphill to downhill. The threat that is still apparent is the risk of surge flooding. In red the tsunami reach of the 3.11 tsunami is illustrated. This shows that all the coastal villages were affected by the tsunami and it almost reached Sendai by following the Natori River upstream.

Main dams:
Kamafusa Dam
Function: Flood control, Water supply, River flow maintenance, Water supply for industry, Hydropower
Catchment area: 195.3 km2
Reservoir capacity: 45.300 m3

Ohkura Dam
Function: Flood control, Hydropower, Water supply, river flow maintenance
Catchment area: 88.5 km2
Reservoir capacity: 28,000 m3

Ayashi Tameike
Function: Agricultural irrigation
Catchment area: 524 km2
Reservoir capacity: 1200 m3

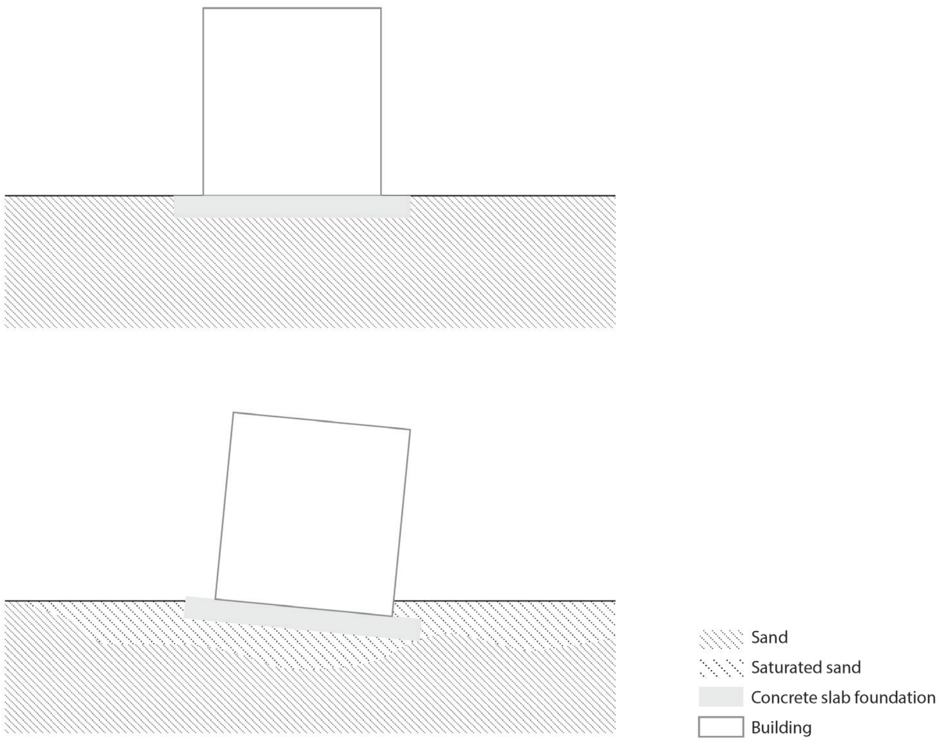
◂ *figure 48. Hydraulic system. author*


86
LEGEND
Low intensity
Medium intensity
High intensity
Built environment
River
N

Earthquake intensity

The 3.11 disaster started with an earthquake with a magnitude of 9.0 which already caused damages to buildings. On the map on the left is the shake intensity illustrated of the ground during the GEJE (Great East Japan Earthquake). As seen in figure 48 the highest intensities were measured in the low-lying areas of the river basin. The reason for this is the difference in soil stability, appendix A figure 1 on page 176. As described in the section of the river basin the upper part consists of rocky soils whereas the lower parts of the river basin contain softer soils. Therefore, the stability is less and the earthquake has more impact. Over 121,000 buildings were completely destroyed during the GEJE and around 280,000 were half destroyed (Reconstruction Agency). Therefore, it is of high importance to develop earthquake proof structures and buildings to reduce the damage.

Many high-rise buildings were built on concrete slabs instead of piles that reached to the stable ground. During the GEJE this resulted in the partly tipping over of these buildings. Then when de tsunami hit, these buildings were not stable anymore and completely tipped over increasing the damages, illustrated in figure 49. These are important factors to take into account when redeveloping and designing in these areas that have a high earthquake intensity and soft soils.



▲ *figure 50. The effect of liquefaction on a building with concrete slab foundation. Author*

◄ *figure 49. Shake intensity of the subsurface during the GEJE. Author*

Natori

The city of Natori

Natori City is located in the Miyagi prefecture south of the Natori River. Different from most parts of Japan is the population increase instead of the population decrease in most parts of Japan. Yuriage (in red) was annexed by the municipality in 1955 with the fish industry. The municipality of Natori has a surface area of 98 km2 and contains a lot of fertile soil suited for agriculture. Sendai airport is also part of the municipality which has a fast connection with Sendai that goes through Natori City. Therefore, it is a well-connected city to the other parts of Miyagi. A second infrastructural benefit is the Shinkansen that goes through Natori to Sendai which connects the city nationally. This gives many opportunities for leisure activities in the municipality of Natori. A third high quality infrastructural connection is the highway that connects all coastal villages, see figure 50.

◂ *figure 51. Municipality of Natori, with Yuriage (in red). Author*

Natori section

In figure 51 the subsurface and occupation layer are illustrated. The largest part of the Sendai Plains consists of agricultural lands because of the fertile soils. Just a small part of the plains are occupied with buildings for housing and industry. Interesting to see is the rapid transition from 50 meter above sea level of the flat plains towards the steep mountainous area that reach a height of almost 200 meters over an area of 1 km. Although this image is stretched out with a factor 5, it still shows the correct ratio of the heights.

The mountainous area has no occupation other than forestry because of the steepness of the slopes, whereas almost all the land of the plains are cultivated and occupied. Close to the sea are developments with solar fields to generate renewable energy for the city. Most parts of the subsurface is built up out of a combination of gravel and sand, and gravel, sand and clay. These are unstable soils especially in cases of an earthquake where the occurrence of liquefaction is a risk (Ministry of Land, Infrastructure, Transport and Tourism).

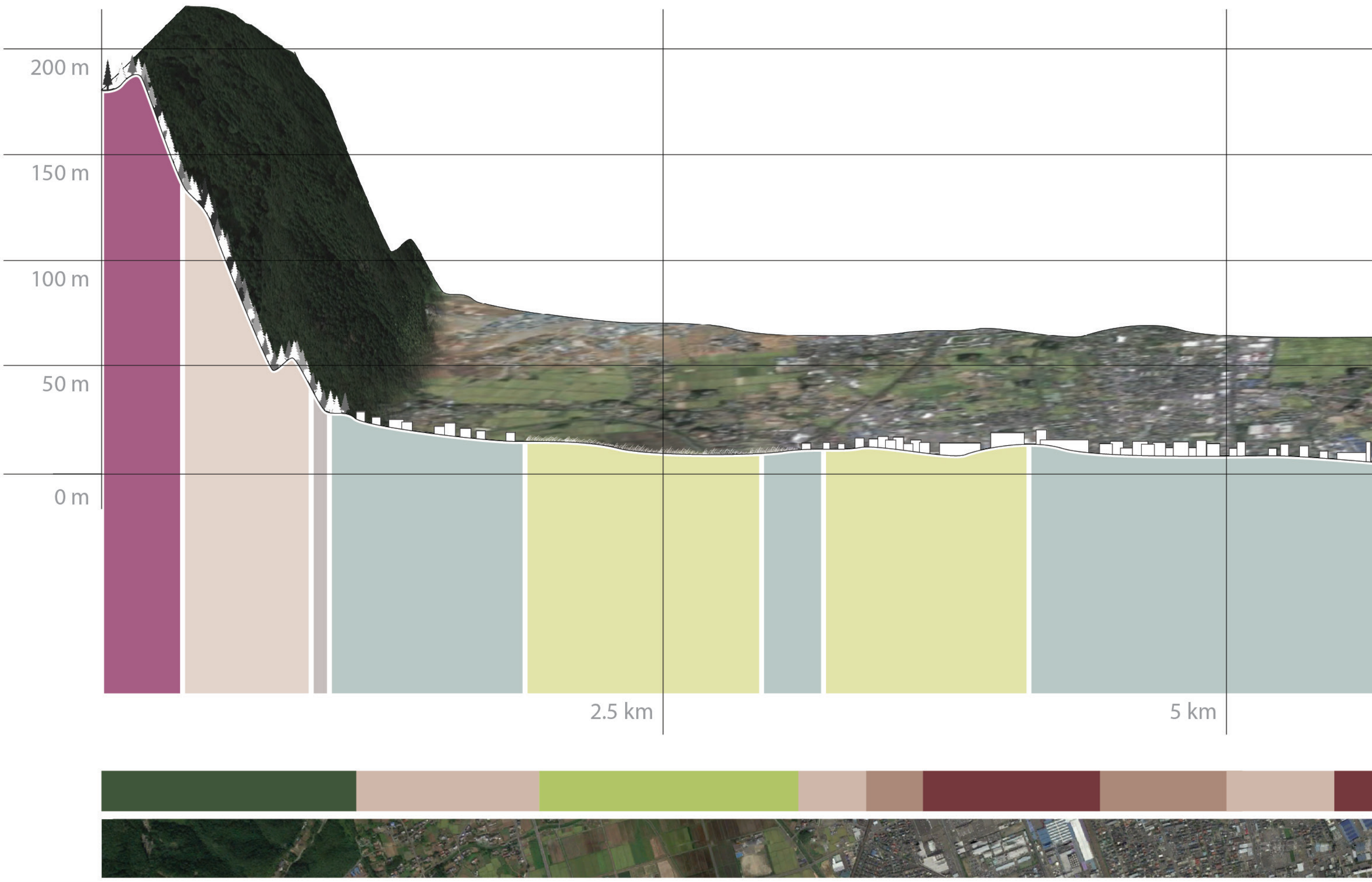


figure 52. Section of Natori with soils and functions. Author

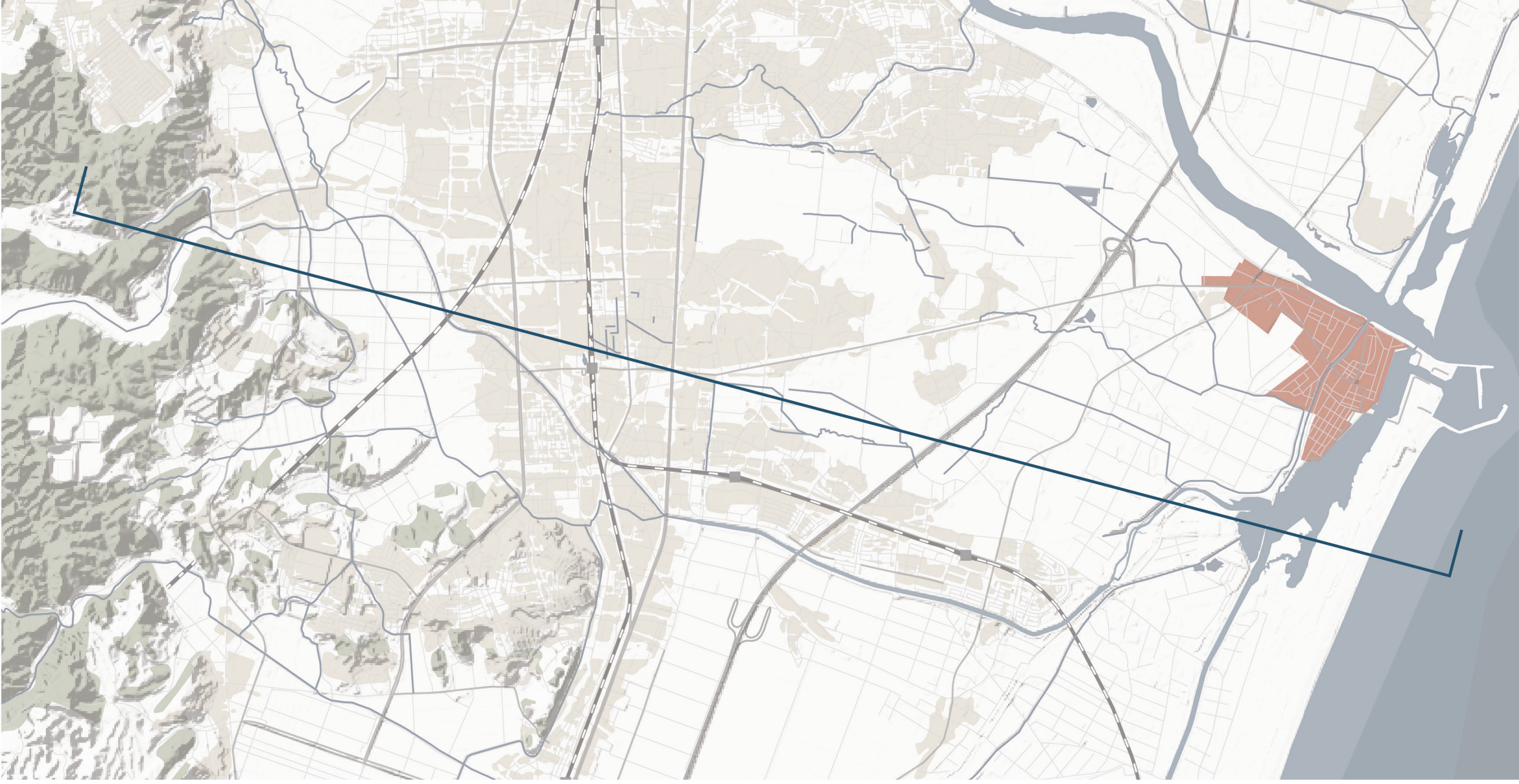


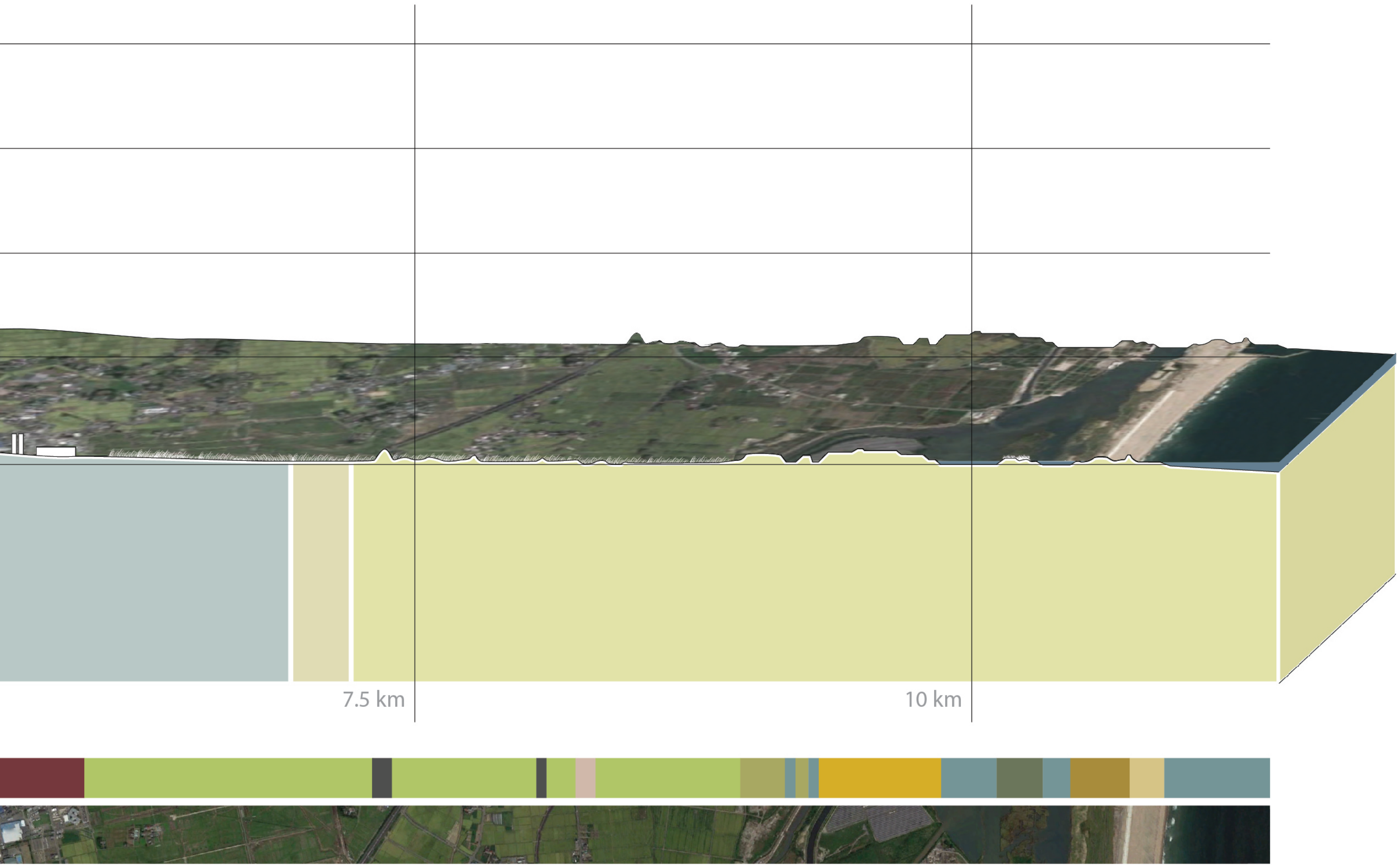
figure 53. Section of Natori on the map. Author

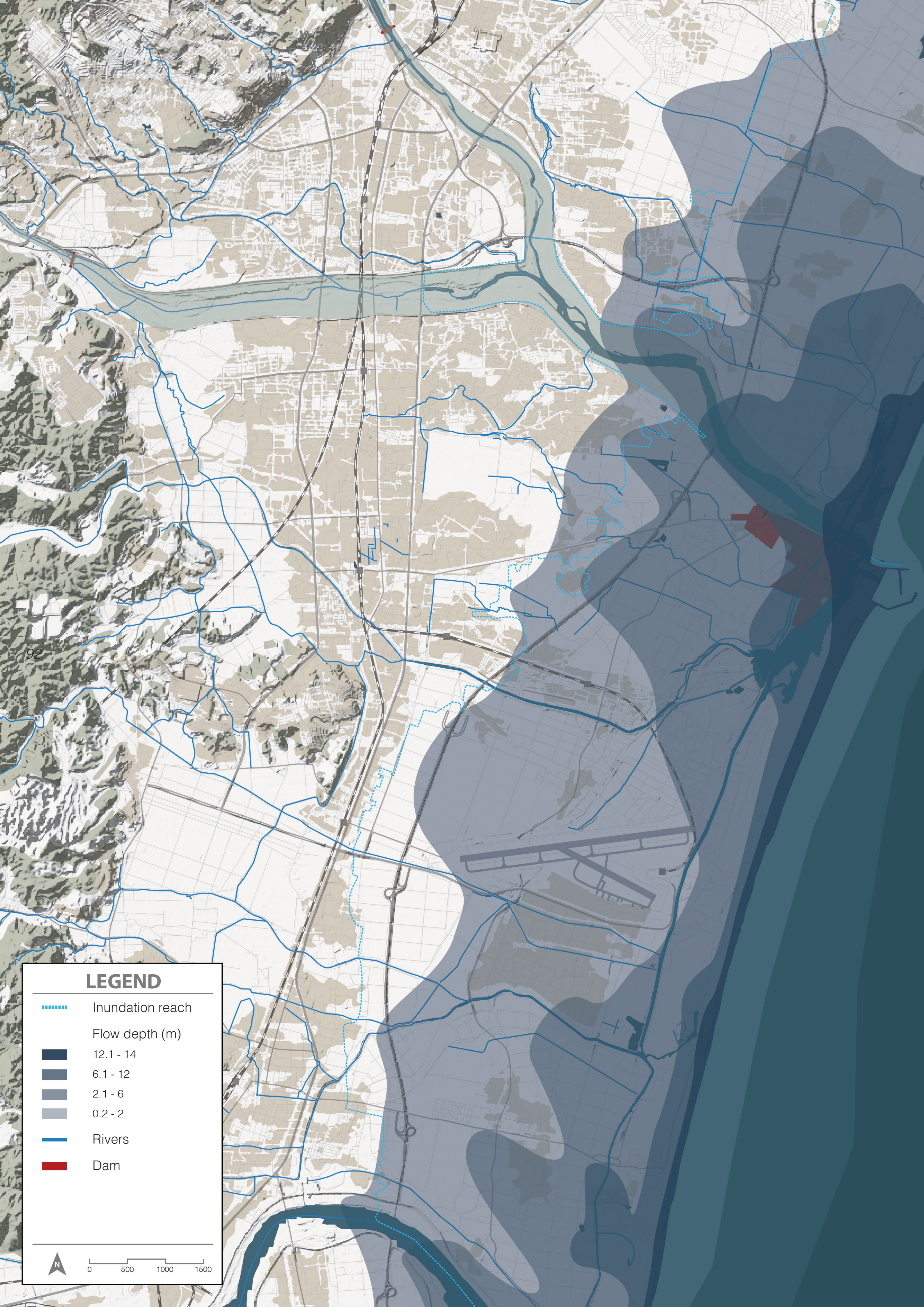
Subsurface

- Sand
- Gravel, Sand, Clay
- Gravel, Sand
- Mudstone, Sandstone
- Loam
- Agglomerate
- Sandy Tuff

Occupation

- Low density
- High density
- Main infrastructure
- Agricultural
- Solar panels
- Industry
- Empty/ no function
- Thick nature
- Beach
- Dunes
- Marshes
- Water




LEGEND
Inundation reach
Flow depth (m)
12.1 - 14
6.1 - 12
2.1 - 6
0.2 - 2
Rivers
Dam
N
0
500
1000
1500

Hydrological system

In figure 53 the hydrological system is illustrated in combination with the impact of the 3.11 tsunami. Lorenz Dolezalek calculated the flow depth of the tsunami according to the topographic layout of the Sendai plains and is shown with the blue gradients. This shows a big concentration at the estuary at the village of Yuriage.

In general, the maximum height of a breaking wave at any point along the coast is a function of the water depth at that specific location. The Base Flood Elevation (BFE) illustrated in figure 54 is used to calculate the break height of a wave. A wave breaks when it reaches a height equal to 78% of the water depth (Keenan & Weisz, 2016). During calm weather larger waves break a few thousand meter from the coast. However, in case of a tsunami the water volume increases and elevates the water levels which allows waves to penetrate much closer to the shoreline. A solution is to install breakwaters that decrease the height of the water volume and thus decrease the height of the breakpoint of a wave. However, even though breakwaters are installed in front of Yuriage there is still a flow depth of around 13 meters high. The reason for this is the massive water volume that is being pushed together in the shallow sea.
The blue dotted line represents the inundation reach of the 3.11 tsunami. Interesting to see is that the Natori River captured a large part of the water volume from the tsunami and reached all the way to Sendai. The water from the tsunami however, stays in the boundaries of the river bed and not damaging the buildings around it. This shows that with proper river systems water can be captured and guided upstream.

As mentioned in the hydrological system of the river basin, before entering the Sendai plains the river is controlled by two dams. These dams regulate the water volume of the Natori River and the Hirose river. This is important because the river bed contains agricultural functions such as paddy fields that need a specific amount of water.

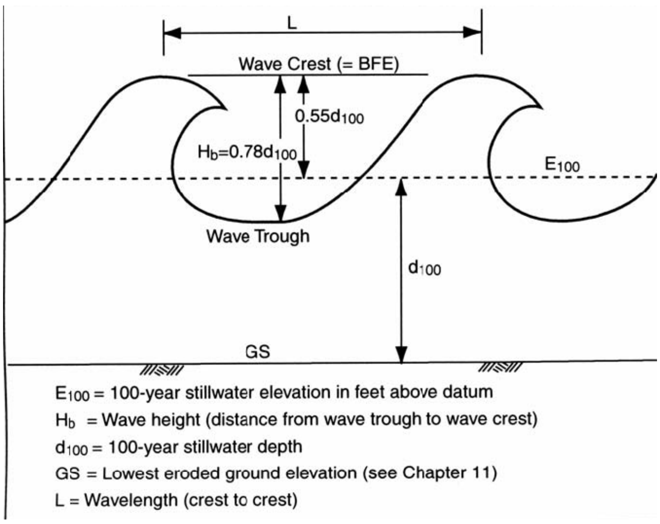
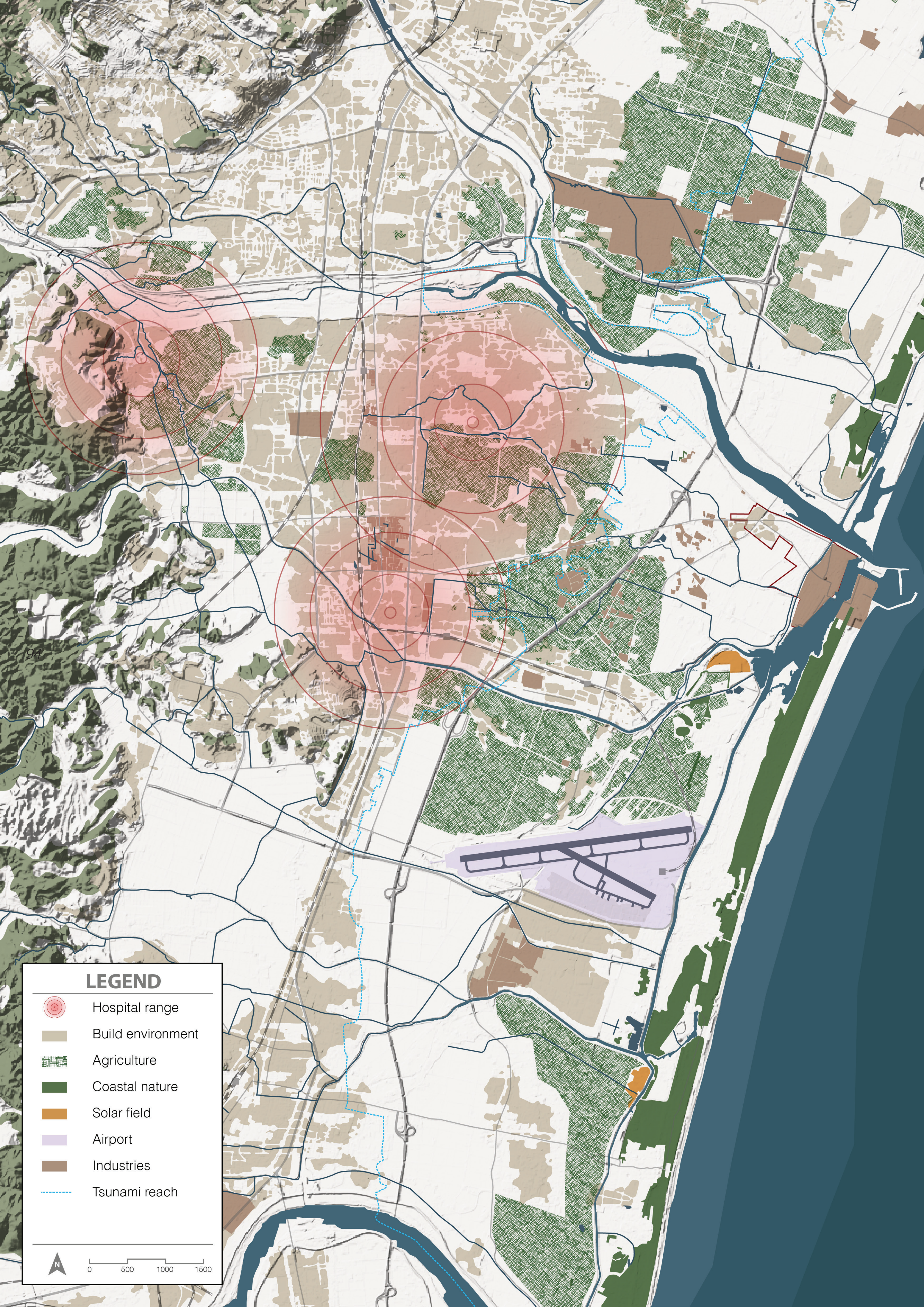


figure 55. Determination of the Base Flood Elevation. FEMA, 2000

figure 54. Hydrological system and dynamics in Natori. Author

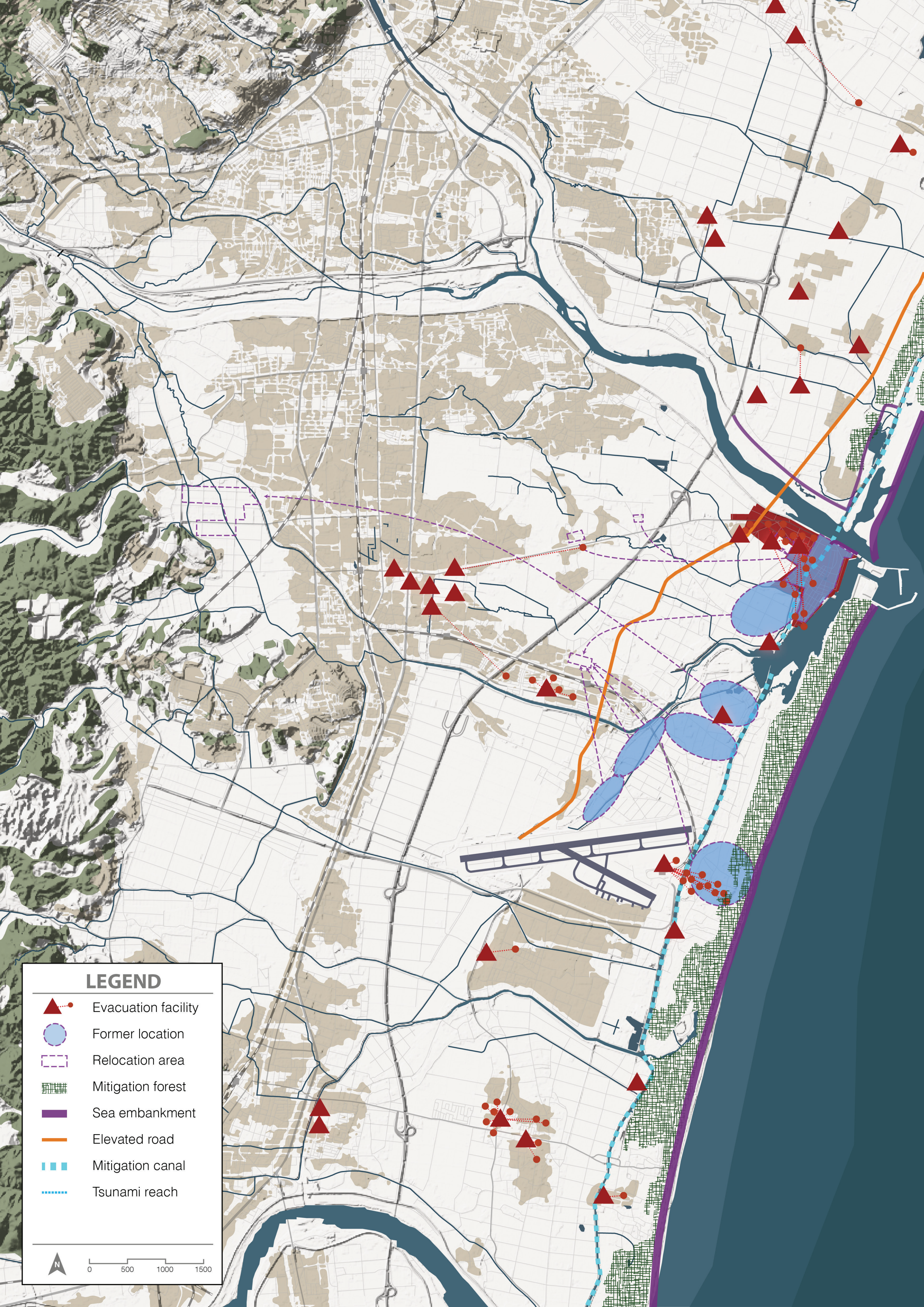

94
LEGEND
Hospital range
Build environment
Agriculture
Coastal nature
Solar field
Airport
Industries
Tsunami reach
N
0
500
1000
1500

Functions

Most of the critical infrastructure such as hospitals are situated in areas that were not affected by the tsunami. However, most of the economic damages were afflicted to the agricultural sector. Because all the agricultural fields are situated in the lower parts of the Sendai Plains they were completely inundated and destroyed by the tsunami. It took almost two years to fully recover from the physical, economic, and environmental impacts. At first the municipality was worried on how severe the soil was affected by salt from the tsunami, but because of the heavy rain the soil got cleaned relatively fast. As seen in 23532434525 Sendai airport was completely inundated obstructing any traffic from the air.

◂ *figure 57. Main functions of Natori. Author*

▾ *figure 56. Inundation of Sendai Airport. Reuters, 2011*



LEGEND
Evacuation facility
Former location
Relocation area
Mitigation forest
Sea embankment
Elevated road
Mitigation canal
Tsunami reach
N
0
500
1000
1500

Mitigation

As a response to the 3.11 earthquake and tsunami a set of mitigation measures was decided on and executed. The first step was to relocate coastal villages to higher areas where they will be safe from a tsunami impact. The cross-section in figure 57 shows all the tsunami mitigation measures developed by the Sendai City council. The main concept behind this section is a multi-layered defense structure where each line is a different solution with their own strength.

Closest to the sea is a concrete embankment which receives the first blow. This is to weaken the tsunami impact before it continues to the coastal disaster prevention forest. During the tsunami the coastal forest was completely destroyed due to two main reasons. The first was the lack of maintenance to the forest, causing many gaps and empty spaces in the forest resulting in a weak defense line. The second reason was that the trees were planted on unstable soil. After the earthquake the trees came loose and were taken by the first wave that reached the forest. The second reason can be solved by raising the land with at least 4 meters in order for the roots to settle in stable ground.

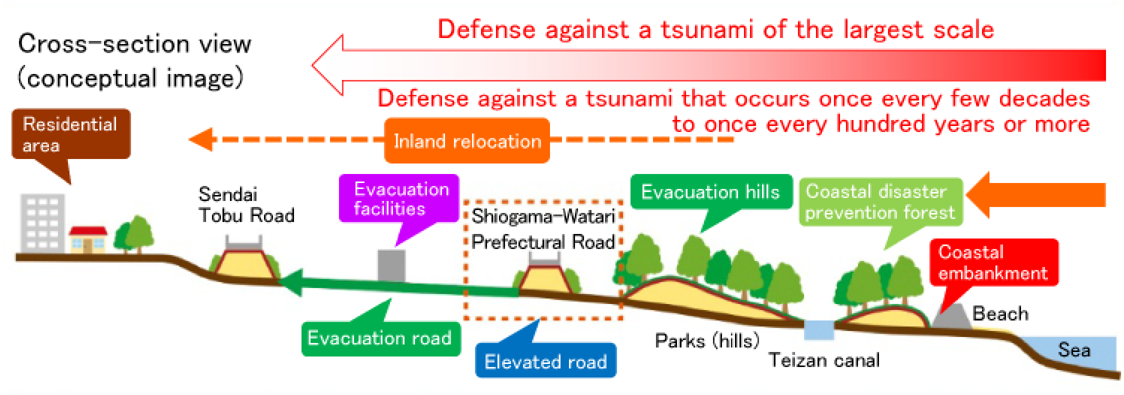
The next mitigation measure is the Teizan canal. This canal that runs parallel to the coastline can capture the first waves and store the water volume in the canal. Behind the canal there are multiple evacuation hills that function as parks. Next to these evacuation hills runs the Shiogama-Watari Prefectural road. This road is a good example of multifunctional mitigation measures where the road is elevated and thus also functioning as an embankment against the water. This elevated road lies in connection with the Sendai Tobu road through evacuation roads a few hundred meters further inland.

At strategic locations evacuation facilities are placed where people can find shelter during emergency situations, see figure 58. The evacuation facility choice behavior was researched by Yamada, Sasaki, and Kishimoto by using a logit model based on the data of Archives for Reconstruction after the Great East Japan Earthquake. The model is constructed considering distance from evacuee to the evacuation facility, the height of the evacuation facility, the footprint of the evacuation facility, and the height above sea level of the evacuation facility (Yamada, Sasaki, & Kishimoto, 2016). The most preferred facilities are located through this model which can be used to decide the capacity of an evacuation facility or potentially other functions.

The use of many different mitigation solutions increases the resilience of the system in the future, however, most of the solution are hard-engineered and have a negative impact on the environment. So in order to become truly resilient there need to be a better balance between natural and artificial solutions to protect against the tsunami threat.

figure 59. Tsunami mitigation measures taken by the city of Natori. Author

figure 58. Section of the tsunami mitigation measures. (SENDAI -Towards a Disaster-Resilient and Environmentally-Friendly City)



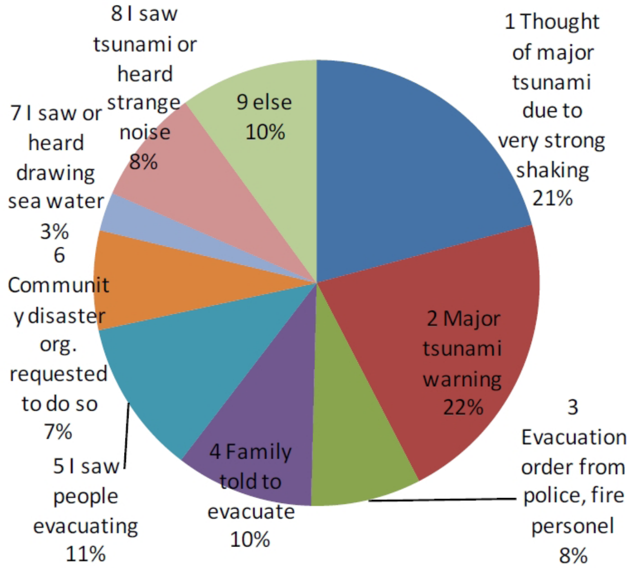


figure 60. Motivation of evacuation (n=250).

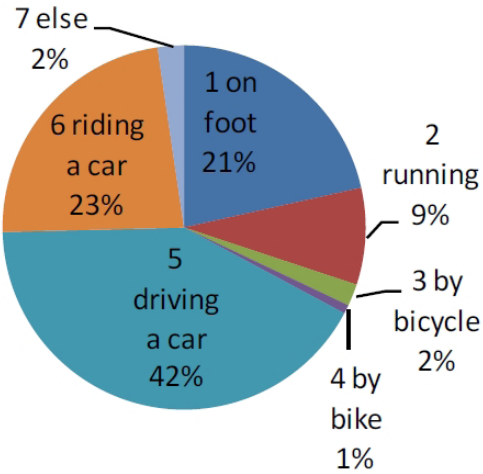


figure 63. Motivation of evacuation (n=256).

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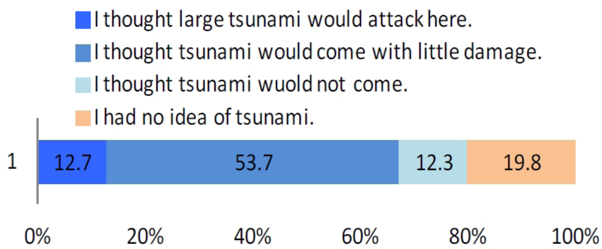


figure 61. People that thought a tsunami would come (n=390).

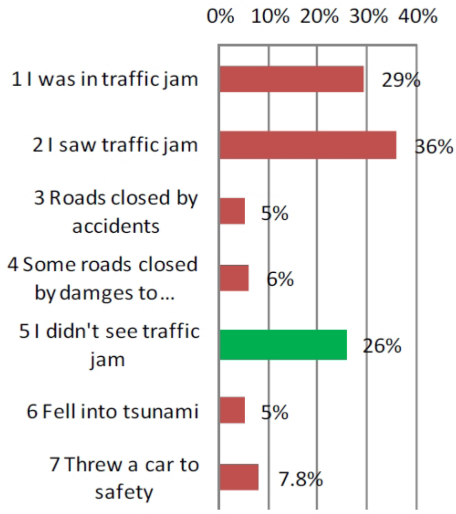


figure 64. Traffic jam experience (n=180 cases, MR)

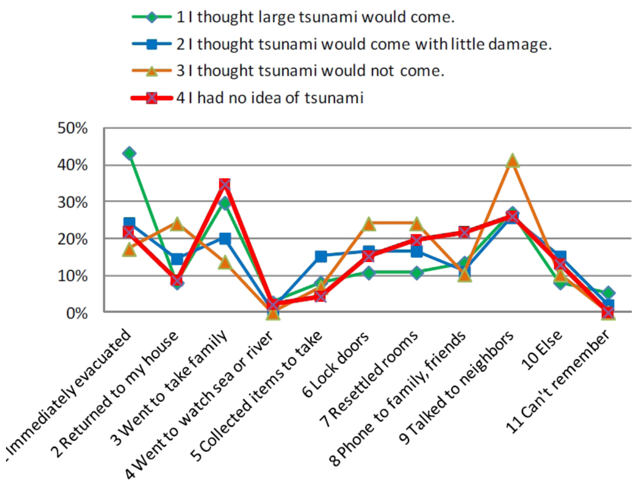


figure 62. Actions residents took before evacuation vs tsunami risk perception (n=256).

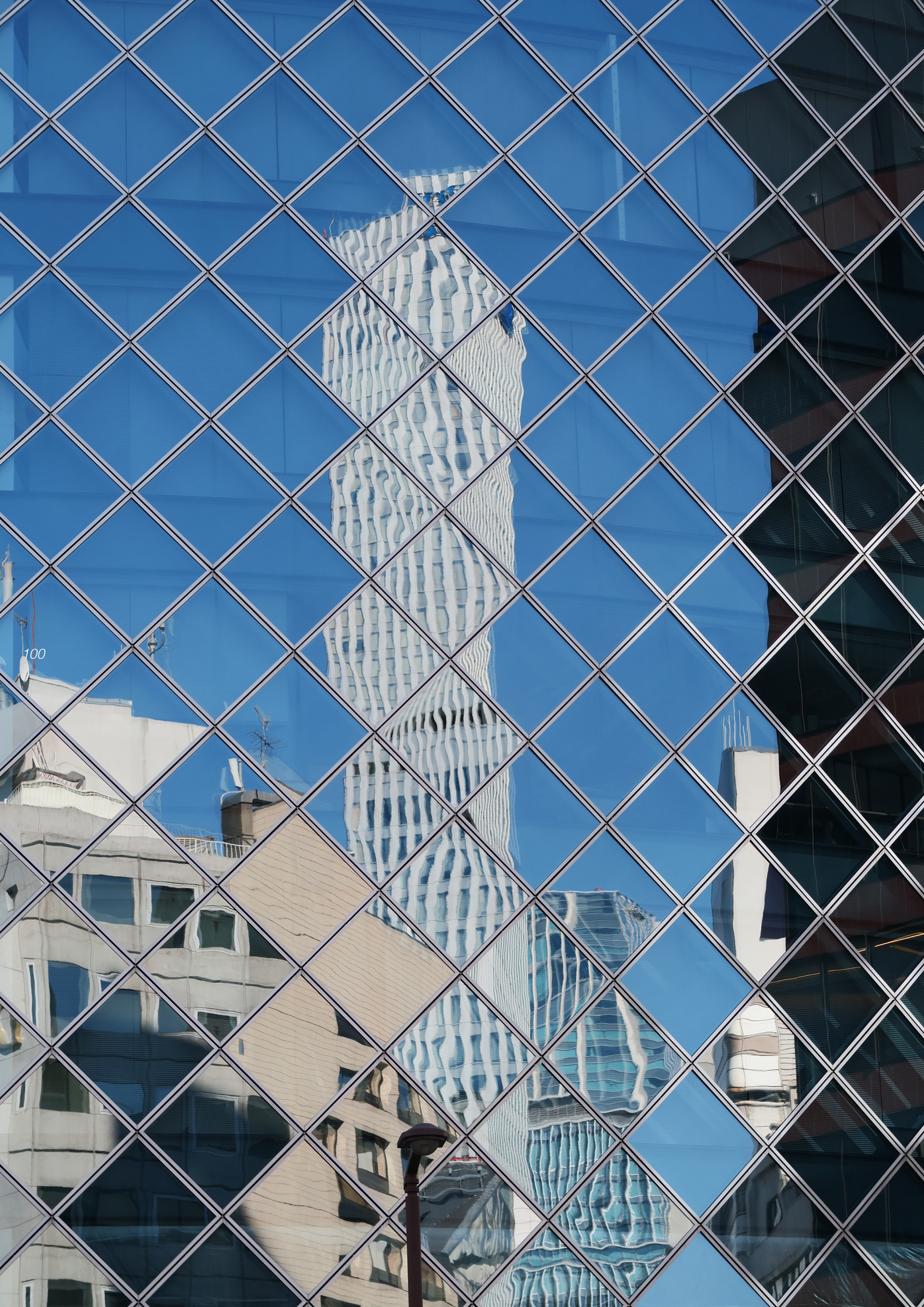
Figure 68 - 71. Evacuation data. Murakami, Takamoto & Pomonis, 2012

Evacuation

When the 8.8 meter high tsunami hit the coast of Sendai it reached up to 4 km inland because of the topography of flat plain. This makes evacuation condition difficult and dangerous. The life loss in Yuriage was higher than some of the villages at the Ria Coastline which were closer to the tsunami center than Yuriage (Murakami, Takimoto, & Pomonis, 2012). In a study of the Yamaguchi University Murakami and Takimoto the evacuation behavior of the residents of Yuriage was analyzed. After the earthquake occurred the City of Natori used their digital wireless system for disaster communication. However, due to the shocks of the earthquake they could not broadcast the warnings and evacuation order. Residents had to rely on other sources such as the radio, television, families, and neighbors. figure 59 shows what motivated the residents to start the evacuation. Just 21% thought of a major tsunami due to strong quakes which is a surprising low amount and shows that there is a low risk perception among the residents. The other 79% relied on other people telling them they were in danger. figure 60 also shows that just 12.7% thought that a large tsunami would appear after the earthquake shocks. Those who had little to no idea that a tsunami would come evacuated not as soon as possible. figure 61 shows the relation between the risk perception and action taken of the residents of Yuriage. It is clear that the people who thought a large tsunami would come immediately evacuated and brought their family into safety. As seen in figure 62 the car was the most preferred means of evacuation. Because Yuriage had only two main exit roads a lot of cars got stuck in traffic jams. figure 71 shows the traffic jam experience of the evacuees, where the 26% of people that didn't see a traffic jam were one of the first evacuees and therefore, didn't experience them. Many residents evacuated to the nearby community center, high school, elementary school, and pedestrian bridge. However, before the tsunami arrived the warning system broadcasted an increased height of the tsunami which resulted in a second evacuation flow further inland. During this second evacuation the tsunami arrived causing the loss of many lives. An overview of the main infrastructure and evacuation points is shown in figure 64. A simulation of the tsunami shows the bottlenecks that took place during evacuation, figure 65. The black dots represent the active evacuees, the purple dots are evacuees in vehicles, the red dots are fatalities, and the yellow dots represent the bottlenecks (Mas e.a., 2015). The largest bottleneck occurred at the Yuriage community center because this was the first evacuation facility for most of the residents. Furthermore, the two main exit roads experienced the most bottlenecks.

figure 65. Main road network Yuriage with evacuation facilities. Mas e.a., 2015

figure 66. Simulation of the 3.11 tsunami. Mas e.a., 2015



SWOT

Introduction

In order to translate the information from the analysis of the previous chapters to a vision and strategy for Natori the SWOT tool is applied. When applied on Natori the strengths, weaknesses, opportunities and threats can be identified and used. The SWOT analysis is a critical part for the DAPP approach because it is used to find actions that are needed to reach the desired goal. Derived from the analysis a confrontation matrix is used that links the opportunities and threats to the strengths and weaknesses. These links are then translated into an action or intervention that is used to form the vision for Natori. On the next page the confrontation matrix is illustrated in combination with the links.

◂ *figure 67. Puzzleling the pieces together to find links. Author*

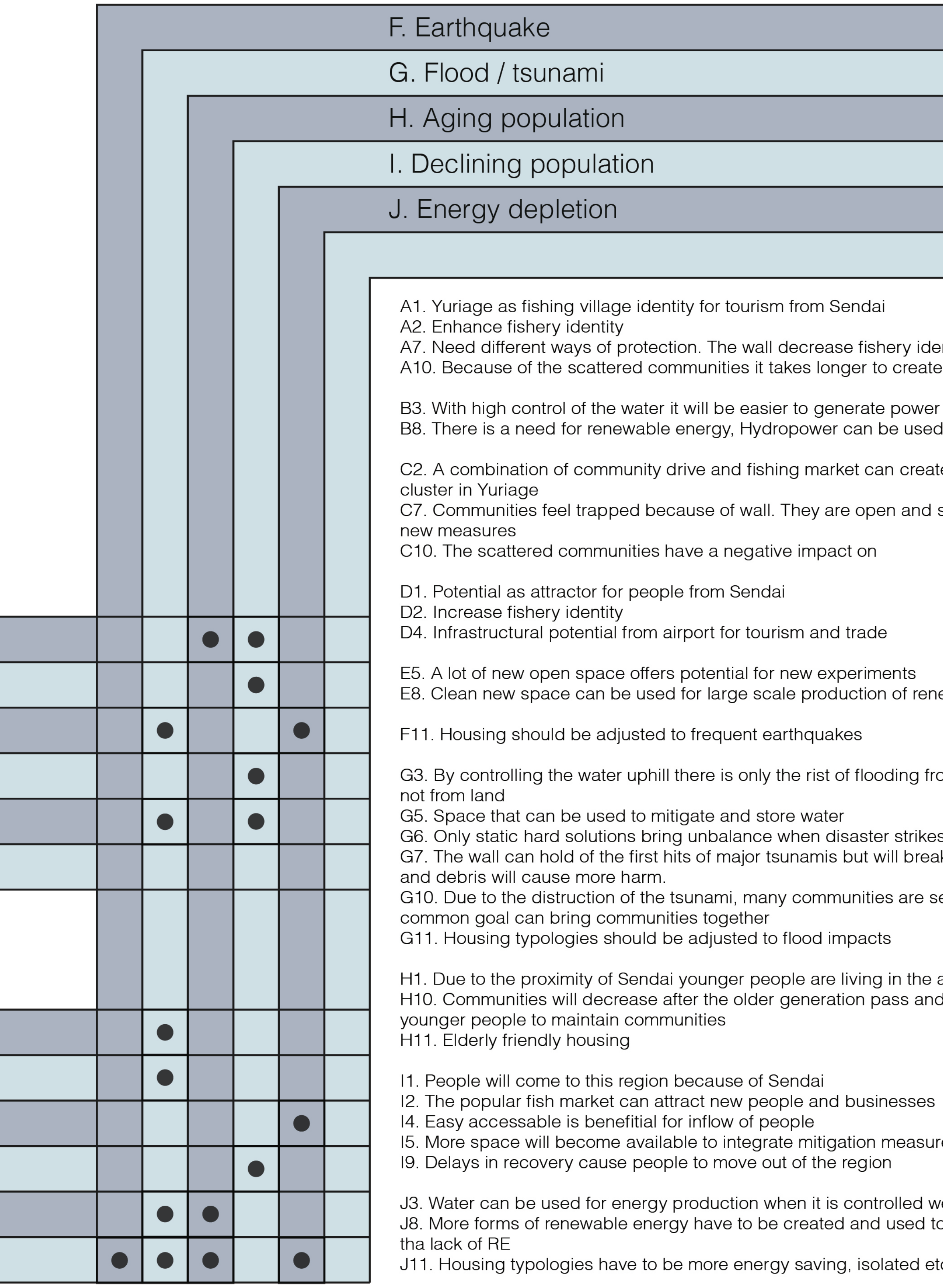
Opportunities

- A. Fishery identity
- B. Hydro power
- C. Community drive
- D. Morning fish market Yuriage (Culture)
- E. Tabula rasa

	A	B	C	D	E	
Strengths						
1. Close proximity of Sendai	●			●		
2. Fish market of Yuriage	●		●	●		
3. Control of water volume from uphill		●				
4. Close proximity of airport				●		
5. A lot of open space					●	
Weaknesses						
6. Mainly hard engineered solutions						
7. Great wall of Japan	●		●			
8. Lack of renewable energy		●			●	
9. Speed of recovery process						
10. Scattered communities after disaster	●		●			
11. Quality of housing						

figure 68. Confrontation matrix. Author

Threats



Links

A1. Yuriage as fishing village identity for tourism from Sendai
A2. Enhance fishery identity
A7. Need different ways of protection. The wall decrease fishery identity
A10. Because of the scattered communities it takes longer to create fishing identity

B3. With high control of the water it will be easier to generate power from it
B8. There is a need for renewable energy, Hydropower can be used.

C2. A combination of community drive and fishing market can create a powerful cluster in Yuriage
C7. Communities feel trapped because of wall. They are open and supportive for new measures
C10. The scattered communities have a negative impact on

D1. Potential as attractor for people from Sendai
D2. Increase fishery identity
D4. Infrastructural potential from airport for tourism and trade

E5. A lot of new open space offers potential for new experiments
E8. Clean new space can be used for large scale production of renewable energy

F11. Housing should be adjusted to frequent earthquakes

G3. By controlling the water uphill there is only the rist of flooding from the sea and not from land
G5. Space that can be used to mitigate and store water
G6. Only static hard solutions bring unbalance when disaster strikes
G7. The wall can hold of the first hits of major tsunamis but will break eventually and debris will cause more harm.
G10. Due to the distruction of the tsunami, many communities are separated. But a common goal can bring communities together
G11. Housing typologies should be adjusted to flood impacts

H1. Due to the proximity of Sendai younger people are living in the area.
H10. Communities will decrease after the older generation pass and there are less younger people to maintain communities
H11. Elderly friendly housing

I1. People will come to this region because of Sendai
I2. The popular fish market can attract new people and businesses
I4. Easy accessable is benefitial for inflow of people
I5. More space will become available to integrate mitigation measures
I9. Delays in recovery cause people to move out of the region

J3. Water can be used for energy production when it is controlled well enough
J8. More forms of renewable energy have to be created and used to make up for tha lack of RE
J11. Housing typologies have to be more energy saving, isolated etc

STRATEGY

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水一

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Tagajo
Sendai
Iwanuma
LEGEND
Mitigation forest
Embankment
Main transportation
Modern Eco-town
Local food production
Local food distribution
Coastal windfarm
Fishery industries
water network
N
0
500
1000
1500

Future of Natori

Modern Urban Renewal

Modern Urban Renewal (MUR) is translated through the scales from regional to housing. In figure 68 MUR is projected on the region of Natori where the four aspects are integrated in the region. The coastal area mainly focuses on tsunami mitigation with coastal forests and civil constructions such as the sea embankment and breakwaters. Yuriage functions as a model town for the MUR concept and is used as exploration lab for the Natori municipality. Innovative housing typologies (e.g. earthquake-proof housing) and energy consumption systems that are successful can be applied to Natori city.

Natori will transform into a sustainable region that is strengthened by community involvement and protected with multifunctional tsunami and earthquake mitigation measures. Natori will be connected to the surrounding villages through a heightened road network that provides safety during disaster periods and provide a backbone for developments. The close proximity to Sendai Airport in combination with the train and road network will strengthen the position of Natori nationwide and increases the potential for tourism.

A combination of coastal wind turbines, solar energy, and hydro energy will provide renewable energy sources. But in order to meet the requirements a decrease in energy consumption should be promoted. One of the solutions is decentralized food production and consumption which shortens the production line and decreases the energy needed. Water plays an important role in these low-lying lands and is a returning element in each scale.

Water flows through the region as a network of capillaries exiting at the estuary at Yuriage. Modern Urban Renewal is achieved on the regional scale if all the aspects are integrated. It is important that these aspects are applied in collaboration with the community in order to increase the sustainability of the MUR concept.

Tsunami resilience

In order to protect the residents and provide a safe environment various mitigation measures are implemented in the region. Civil constructions and nature based solutions are integrated in a way that they strengthen each other and at the same time have no negative impact on the environment. This way, a multi-layered resilient tsunami mitigation system will be developed that creates a balance between nature and hard engineering. The Natori river will function as the main water storage area, but is being aided by smaller creeks creating a stronger relation between water and land.

Energy

Yuriage will be the exploration lab for the use of renewable energy sources. Having as much variation of renewable sources as possible, such as wind energy on sea, solar panels, and hydro power, increases the resilience and possibility to cope with fluctuations in energy demand. In addition, energy consumption will become less due to the integration of smart system that optimizes the efficiency of energy usage. As part of reducing energy consumption the food is produced and distributed locally.

Community

The community works as a catalyzer to all the developments in the region. By creating a strong identity of fishery industries in Yuriage a hub is created that will attract people from Japan to visit. Tourists can see how the concept of Modern Urban Renewal is applied to the area and enjoy the traditional fish market. Natori and Yuriage are well connected with the rest of the coastal villages by land and by water. The Teizan canal functions mainly as an inland trading route, but is also used for leisure purposes.

figure 69. Vision for Natori. Author

Action	Impact					Sell-by date		Costs
	Community development	Nature	Mitigation effectiveness	Physical Living quality	Scale	Start	End	
Coastal forest	+	+++	++	+	++	2021	2200	++
Dune landscape	0	+++	++	+	++	2025	2200	++
Mangrove	+	+++	+	+	+	2020	2160	++
Creek system	0	+++	+	+	+++	2030	2200	+++
Sand deposition at beach	0	+++	+	+	++	2025	2090	+
Land Raising	0	--	++	+	+	2020	2150	++
Embankments	--	---	+++	--	+++	2021	2130	+++
Elevated road network	0	--	++	-	++	2019	2100	++
Horizontal canal	+	+	+	+	++	2020	2100	++
Housing typology flood impact	0	-	++	0	+	2020	2200	+
Fisheries (industry)	++	0	0	++	+	2020	2150	++
Relocation	-	0	+++	+	+	2011	2100	++
Community gardens	++	+	0	++	+	2025	2100	+
Community market (hub)	+++	--	0	+	+	2019	2100	0
Evacuation facility (Multifunctional)	++	-	-	0	+	2019	2080	+
Temporary housing	-	0	0	-	+	2011	2020	++
Hydro power	-	-	+	-	++	2019	2060	++
Solar power	+	++	0	0	++	2015	2080	+
Wind energy	0	++	0	0	+++	2015	2080	+
Local food production & consumption	+++	++	0	+	+	2040	2150	+
Water cleaning system	++	++	0	+	+	2060	2170	++
Circular Economy	+++	++	0	0	+++	2080	2200	0

Legend

- Nature based
- Community oriented
- Hard engineered
- Renewable energy

figure 70. List of actions that can help move towards Modern Urban Renewal. Author

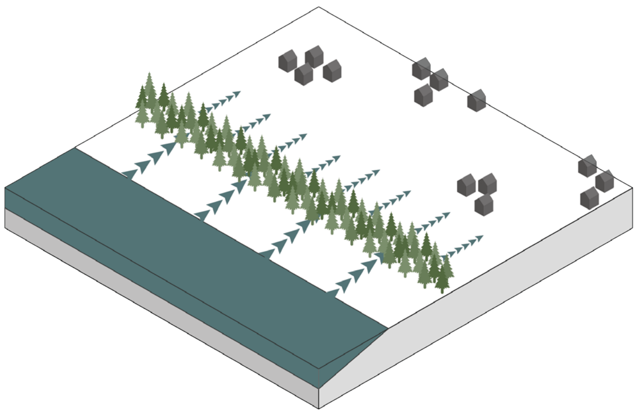
Actions

Action list

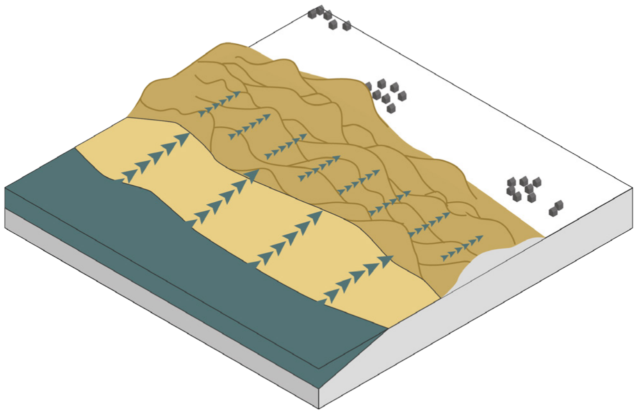
In the table of figure 69 all the actions derived from the SWOT analysis are categorized in the four aspects that are important to move towards Modern Urban Renewal: nature based (green), hard engineered (blue), community oriented (orange), and renewable energy (red). Each of these actions are evaluated on their impact, sell-by date and costs. The parameters for the impacts are derived from the criteria chapter on page 73. By evaluating the actions on these parameters decision makers get a clear picture of the impacts of each action. The sell-by date represents the year that an action can be initiated and when an action doesn't meet the requirements anymore in order to work towards Modern Urban Renewal.

The information in the table is derived from multiple sources such as papers, municipality sites and books. However, not all actions had enough proper data available to give exact numbers which in that case an educated guess was made. The table is used as a general overview and used in the first steps of the process. The values represent the impacts in a general way and can be used to make decisions. In order to get a better insight of the actions spatially, the next pages show the actions and their physical input. They are categorized in the four aspects from the table and explained in detail.

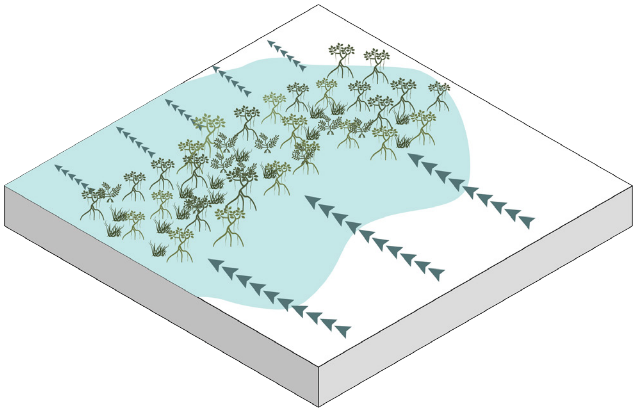
Nature based



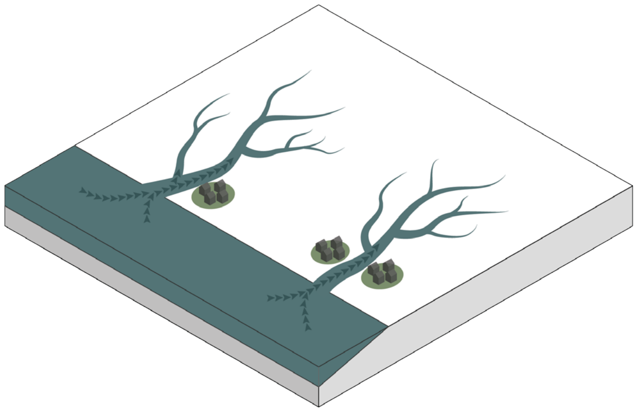
Coastal forest
A coastal forest can mitigate the first blows of a tsunami impact. Furthermore, the trees can stop debris to prevent further damage against buildings. They have a high environmentally quality when various tree species are used. For the proper effectivity the forest width needs to be at least 500 meters.



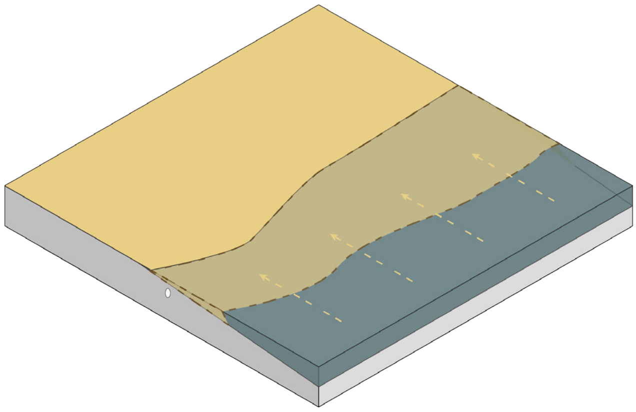
Dune landscape
Dunes can function as a natural defense line and provide habitats for animals and plants to live in and therefore enhance the biodiversity on the coastline.



Mangrove
The mangrove has the same function as a mitigation forest, however due to the strong roots they are more stable during a tsunami impact. The mangrove is the native species of the coastal wetlands in Japan.



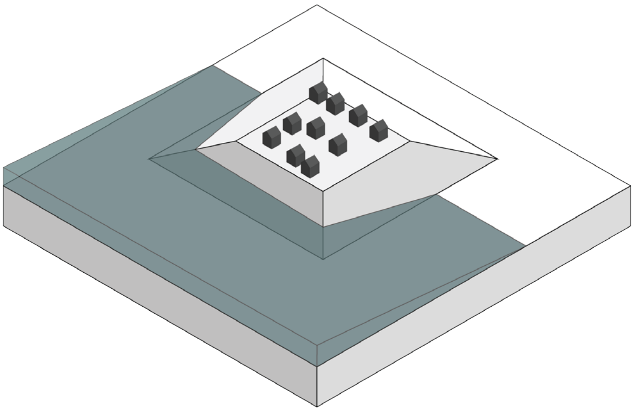
Creek system
By increasing the water storage capacity of the creek system there is more room to capture water that is being pushed inland. It also restores the former delta landscape and need less maintenance over time.



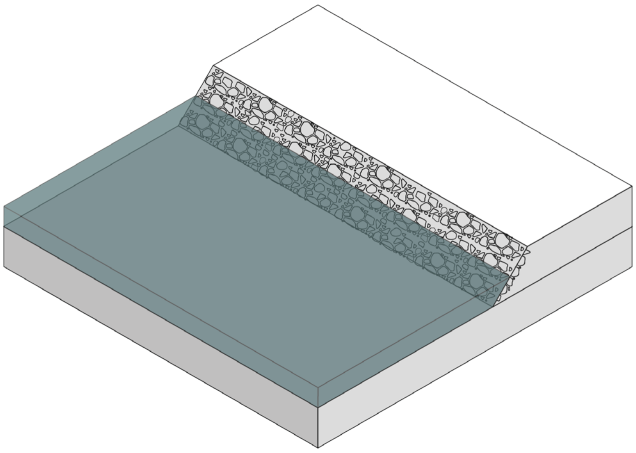
Sand deposition
By using a technique called the 'Sand Engine' the coast can be strengthened with little effort. The sand engine uses natural processes in order to deposit sand along the coast. Furthermore, erosion can be decreased by installing drainage pipes at the beach.

figure 71. Nature based actions. Author

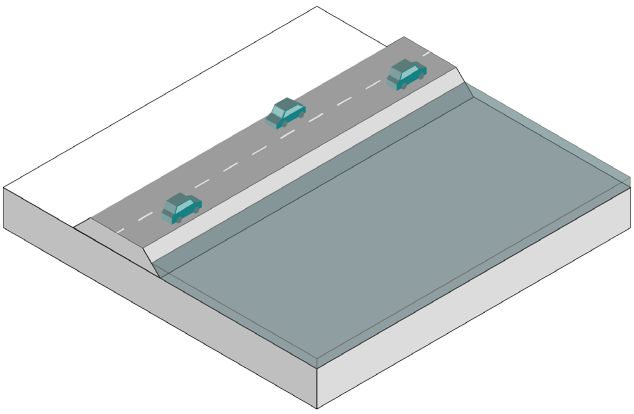
Hard-engineered



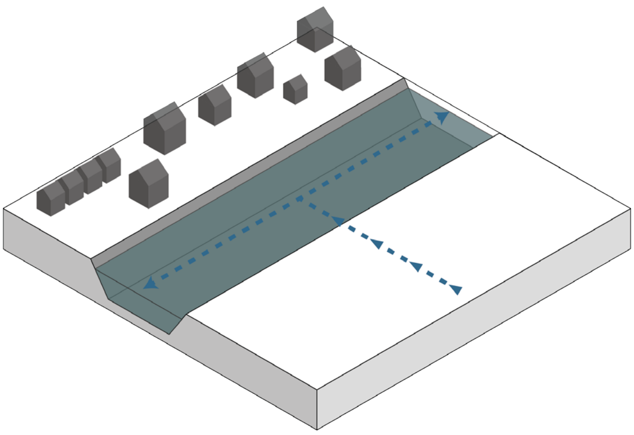
Land raising
The most common method for reconstructing villages in tsunami risk areas. Buildings will be safe by raising the ground to the necessary height.



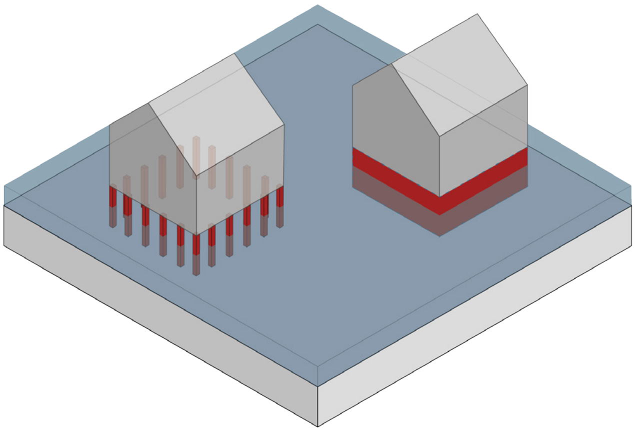
Embankments
Using embankments are the safest option against tsunami waves. They provide strength and stability but have a negative impact on the environment and connection with the water. There are ways to combine the embankment to make it multifunctional.



Elevated road network
A good example of a multifunctional dike is the elevated road network. They slow down the water and provide safe evacuation routes inland. During normal times it still functions as transportation network.



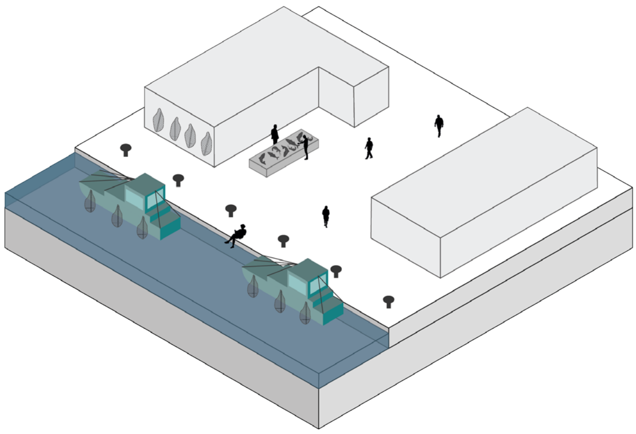
Horizontal canal
Similar to the elevated road, the horizontal canal can slow down the first tsunami impact before reaching the settlement. During normal times the canal can function as trading route or for leisure.

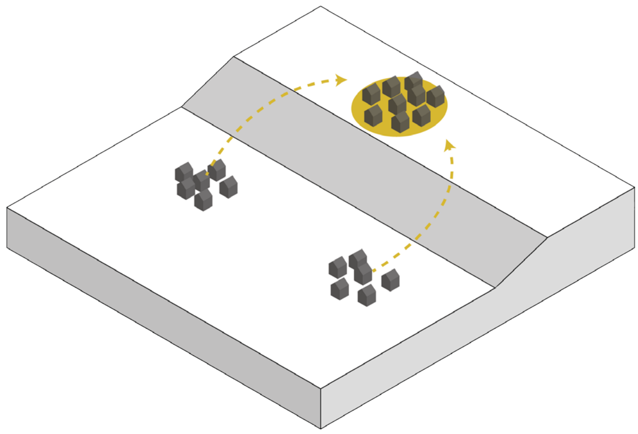


Building typology disaster impact
New innovative techniques are used to protect buildings against earthquake and tsunami disaster. They will be more expensive to build in comparison to normal building typology, however the life span of the building will greatly improve.

figure 72. Hard engineered actions. Author

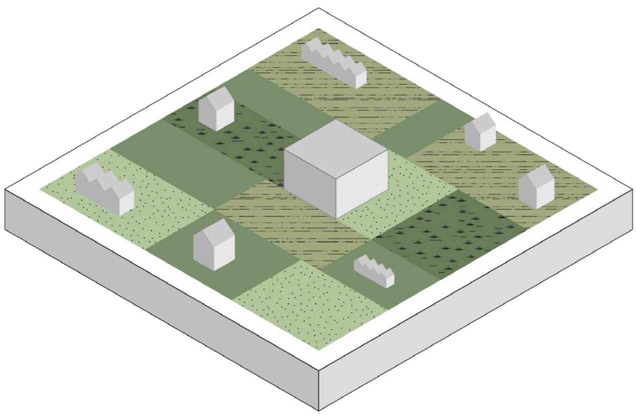
Community oriented

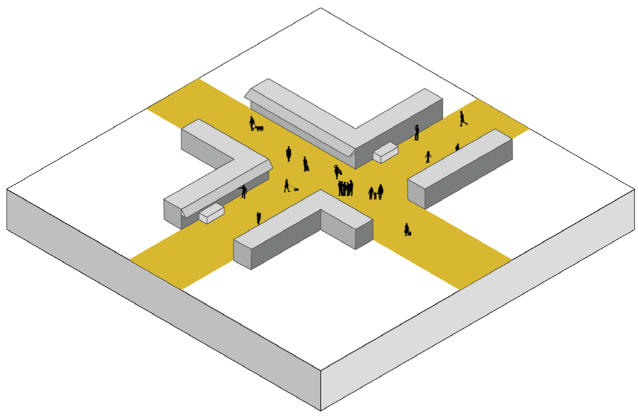




Fisheries (industry)
A strong identity as fishing village gives character to a settlement and provides character for the community. It can also attract industries and tourists to the area, giving an economic impulse.

Relocation
In cases where the risk is too high in an area or it is financially not feasible to rebuild the settlement relocation is the best option. It is very important to have proper communication with the community during this process.





Community gardens
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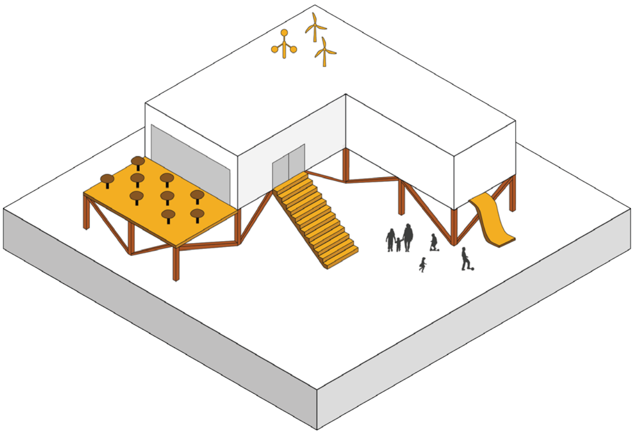
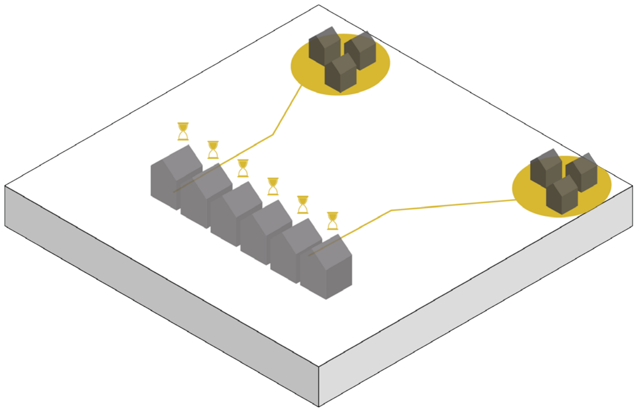
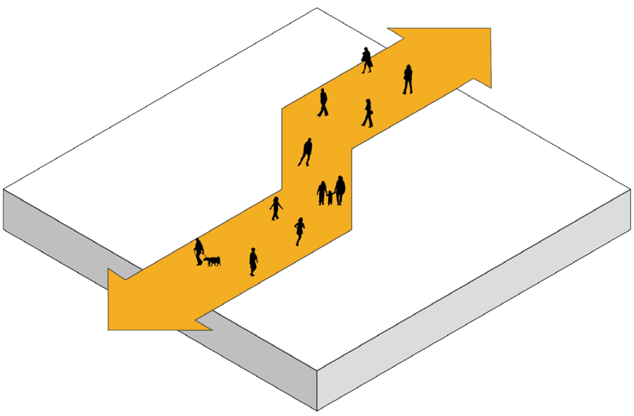
Community market (hub)
The community market provides space to buy and sell regional products. Having the market function as a community space increases the bonding between residents and within the community.





Evacuation facility (Multifunctional)
The evacuation facilities provide a safe structure to find shelter during disaster events. Outside of disaster times the shelters can be used for other functions such as a weather station, childcare, and lookout towers.

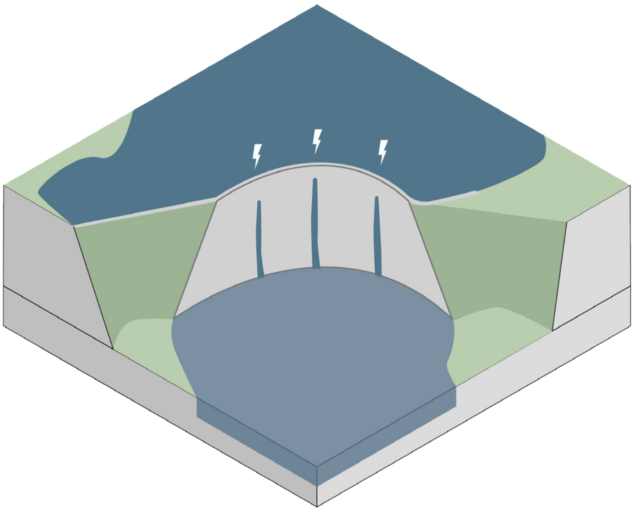
Temporary housing
Directly after a disaster there is a high need of housing for the affected people. The temporary housing units are fast and cheap to build, however, the living comfort is often very low. Therefore, governmental bodies should strive to rehouse the affected people as soon as possible.

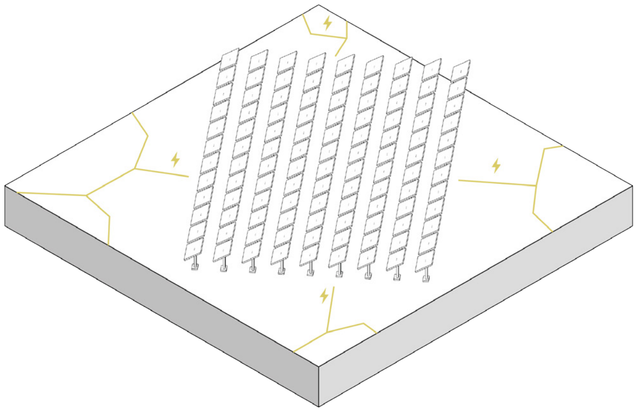


Pedestrian routing
There are two advantages to a proper pedestrian routing. The first is a comfortable connection between community spaces. The second is that during a tsunami disaster the road will be free of cars and stimulate people to evacuate on foot or by bike which reduces congestions.

figure 73. Community oriented actions. Author

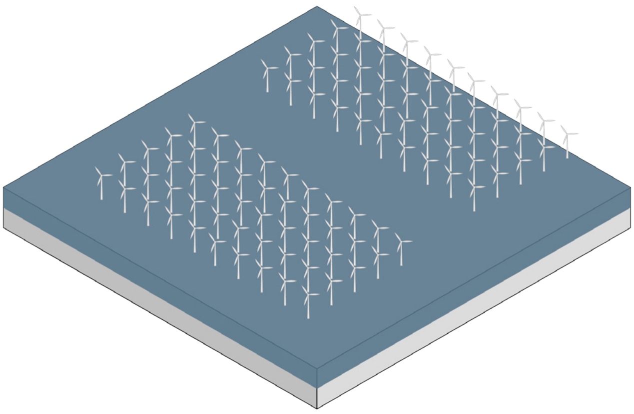
Renewable energy

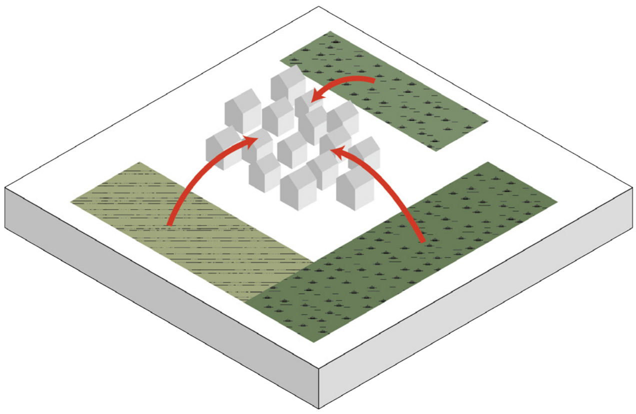




Hydro power
A widely applied means of power generating is with the use of reservoirs. In addition, by using hydro power the water level can be controlled decreasing the risk of fluvial flooding. Unfortunately, these reservoirs have a negative impact on the environment.

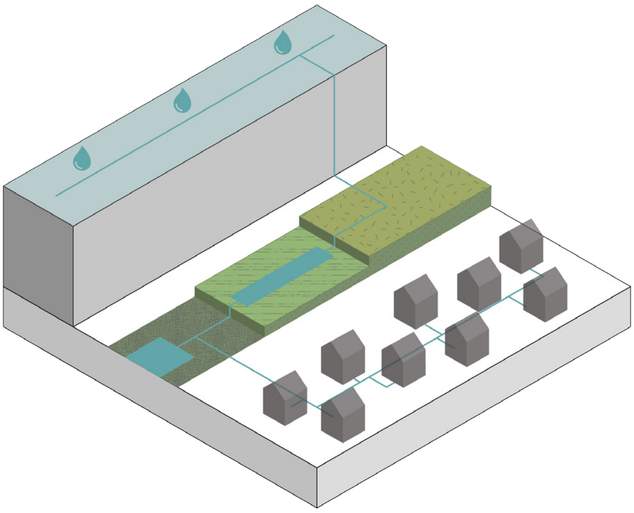
Solar power
Using solar power as a source of renewable energy is one of the cheapest ways to generate electricity. Solar panels can be integrated in buildings or used in large solar fields.



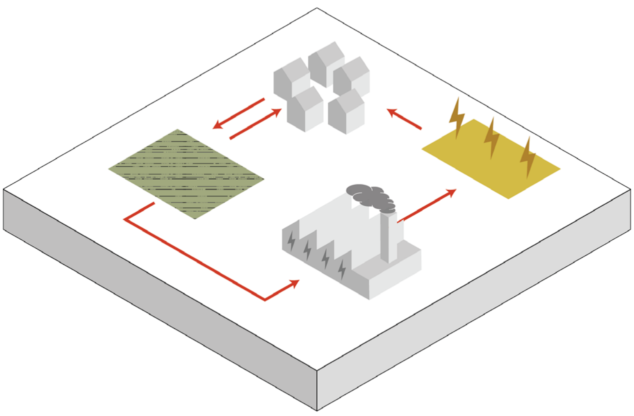


Wind energy
At sea there are many opportunities to use wind generators as a renewable source of power. On land however, they are less effective due to the topographical layout of Japan.

Local food production & consumption
Energy consumption can greatly be decreased when producing and consuming the food locally. This action can be well combined with the community garden action.



Water cleaning system
Japan has one of the highest intensities of precipitation which can be a potential for water treatment and reuse. Having a green water cleaning system integrated in the public space the water can be reused before being discharged in the sewer network.



Circular Economy
Keeping products as long as possible in the chain of usage greatly decreases the consumption of energy and resources. It is a very complex system to establish and will take time to deploy. However, when functioning it will have a long lasting positive impact.

figure 74. Renewable energy actions. Author


Sendai
Natori river
Yuriage
118
LEGEND
1 : 25000
N
Elevated ground
Industry
Agriculture
Embankment
Roads
Shiproute

Current Situation

Yuriage

The test case Yuriage is chosen to apply the actions and develop the concept of Modern Urban Renewal. Before the actions can be translated to the physical environment the current situation is of Yuriage is analyzed, figure 74. After the village got completely devastated by the tsunami a set of policies was applied to the location. Three categories that are categorized by the number of inhabitants, economic activities and flood characteristics associated with the defense measures were defined. The first category has a high disaster risk and it is therefore not allowed to build any housing or industry. This area is now designated for agricultural purposes. The second category allows building, but only industrial functions. Because of the strong historical relationship with the sea Yuriage decided to rebuild their harbor and develop fishing industries. In the third category it is allowed to build housing. To guarantee extra safety, the surface of the housing area was elevated with 5 meters. These policies caused Yuriage to these building restrictions. The number of inhabitants dropped from 5.686 to just 1.025 after the disaster because of casualties and relocation (Natori City council, 2018). However, statistics show a growing population in the municipality Natori of which Yuriage is part. This will give opportunities for future developments.

As a first response to the tsunami disaster an embankment of 4 meters high was built along the coast together with breakwaters. Furthermore, first attempts were made on replanting parts of the mitigation forest, however, the process is going slow and financing relies heavily on crowd funding. The Teizan canal, parallel to the coast, connects all the coastal villages together of the Sendai Bay. The canal is used as tsunami mitigation measure where it captures the approaching water and directs it away from the village. Additionally, the canal can be used as trading route or for leisure purposes. In order to meet the requirements for more renewable energy sources a solar field is constructed south of Yuriage. Furthermore, a waste treatment plant is located next to the energy facility. This forms a potential for an energy cluster where the waste treatment plant and energy facility can collaborate.

The next two pages show images of the current developments in Yuriage. This gives a clear idea on the approach that the village is taking. In figure 75 the position of Yuriage in the recovery process is illustrated which shows that Yuriage currently is in the Traditional Urban Recovery phase. Yuriage has been evaluated according the six themes from the criteria hexagon to determine the position of the village towards Modern Urban Renewal, figure 76. This also decides the starting position of Yuriage for the Dynamic Adaptive Policy Pathway (DAPP). Yuriage put a lot of effort in tsunami mitigation measures, but lacks a more nature based approach. Furthermore, the physical living quality and community oriented themes are mediocre. This illustrates where the focus should be in order to reach Modern Urban Renewal. The gathered knowledge and developed actions will be implemented in the DAPP which will form the main strategy for Yuriage.

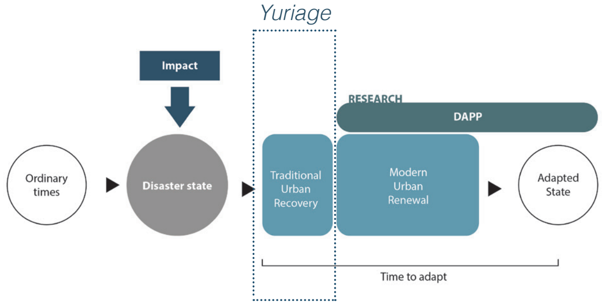


figure 76. Current situation of Yuriage. Author

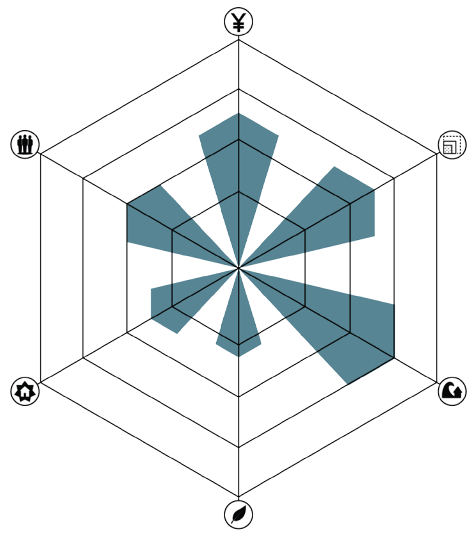


figure 77. Assesment of Yuriage on the six aspects. Author

figure 75. Current situation of Yuriage. Author

figure 78. The four meter high embankment at the coast of Yuriage. Yusuke Miura

figure 79. First developments of the harbor of Yuriage. Yusuke Miura

figure 81. Development of housing. Author

figure 80. Tsunami resilient apartments keep the ground floor free of housing units. Author

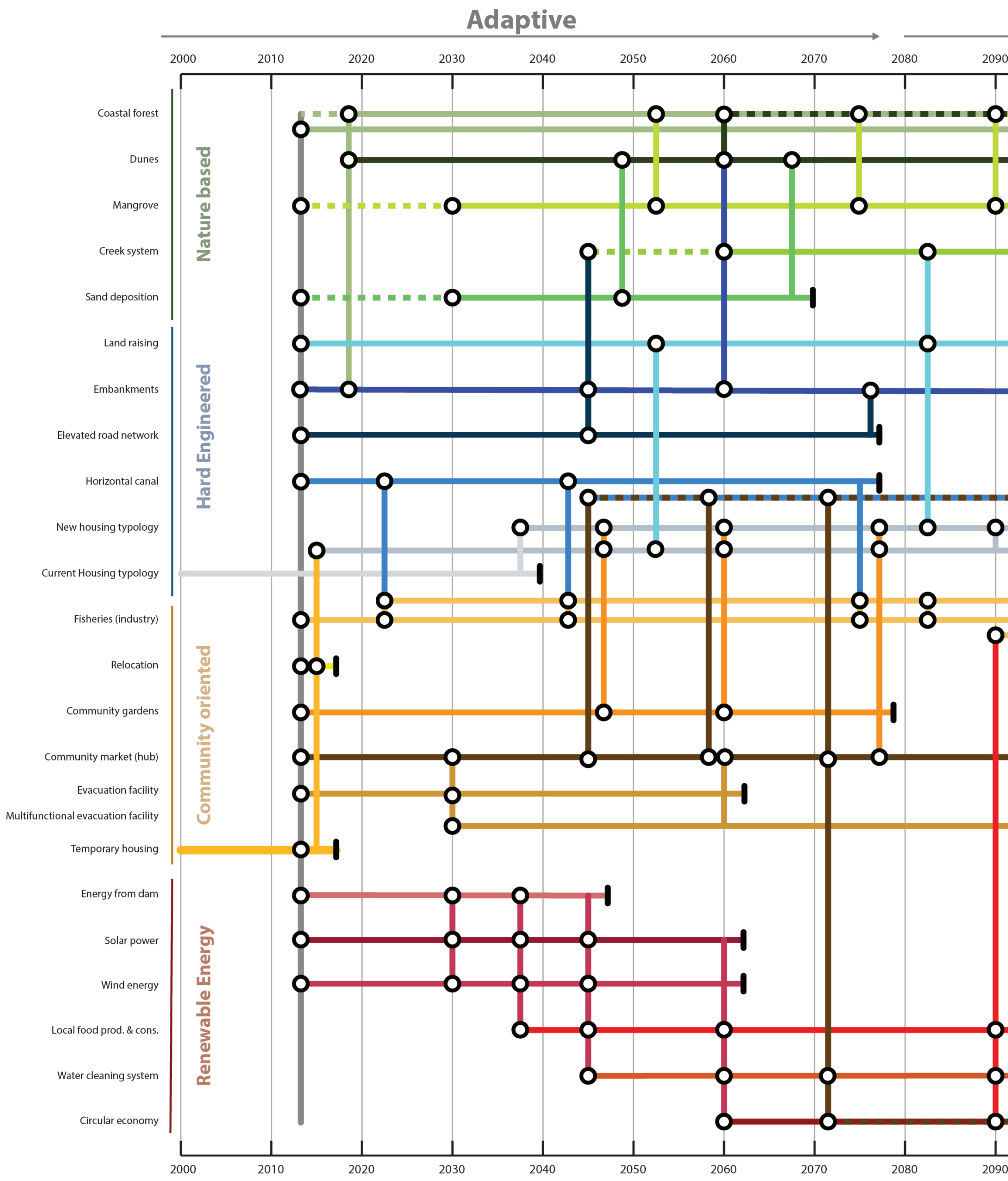
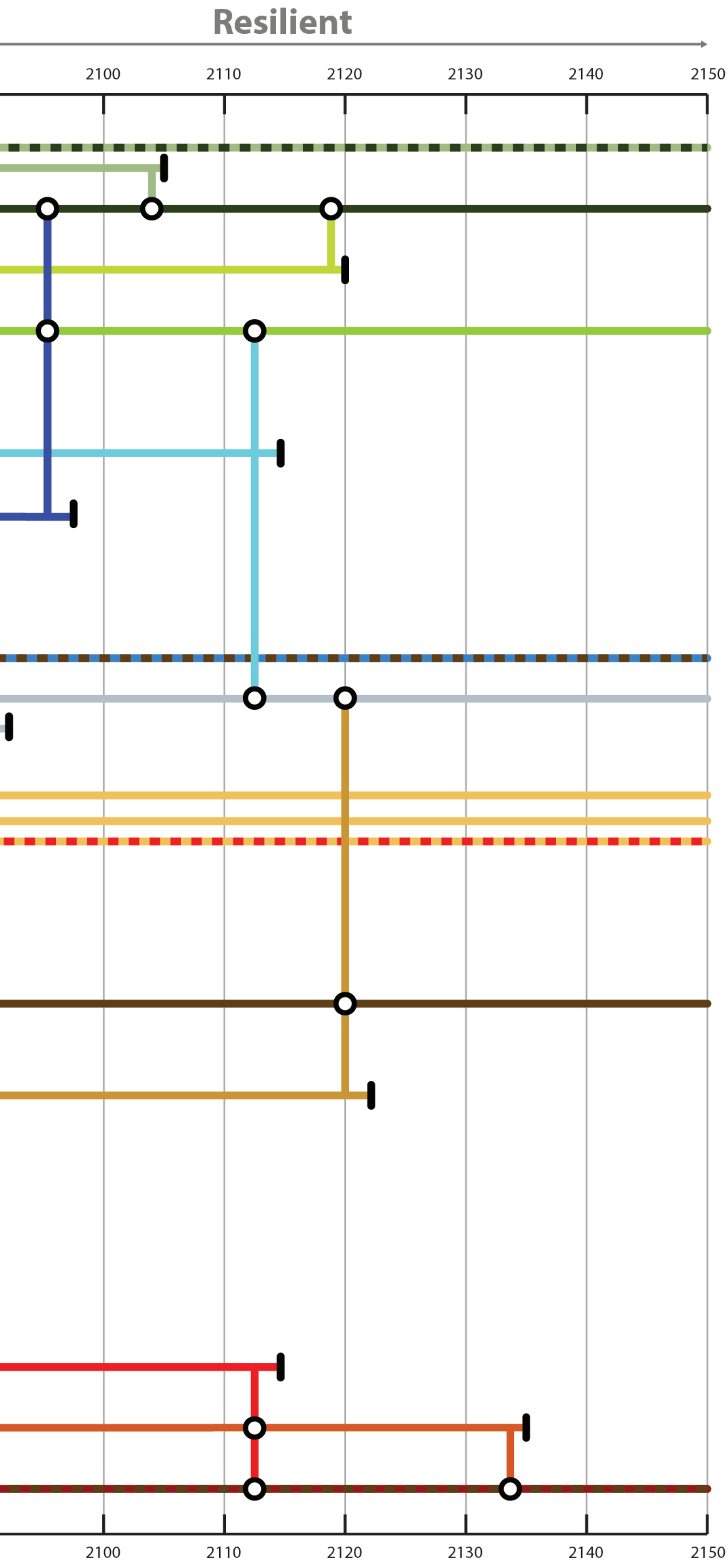


figure 82. Dynamic Adaptive Policy Pathway Map. Author

Dynamic Adaptive Policy Pathway



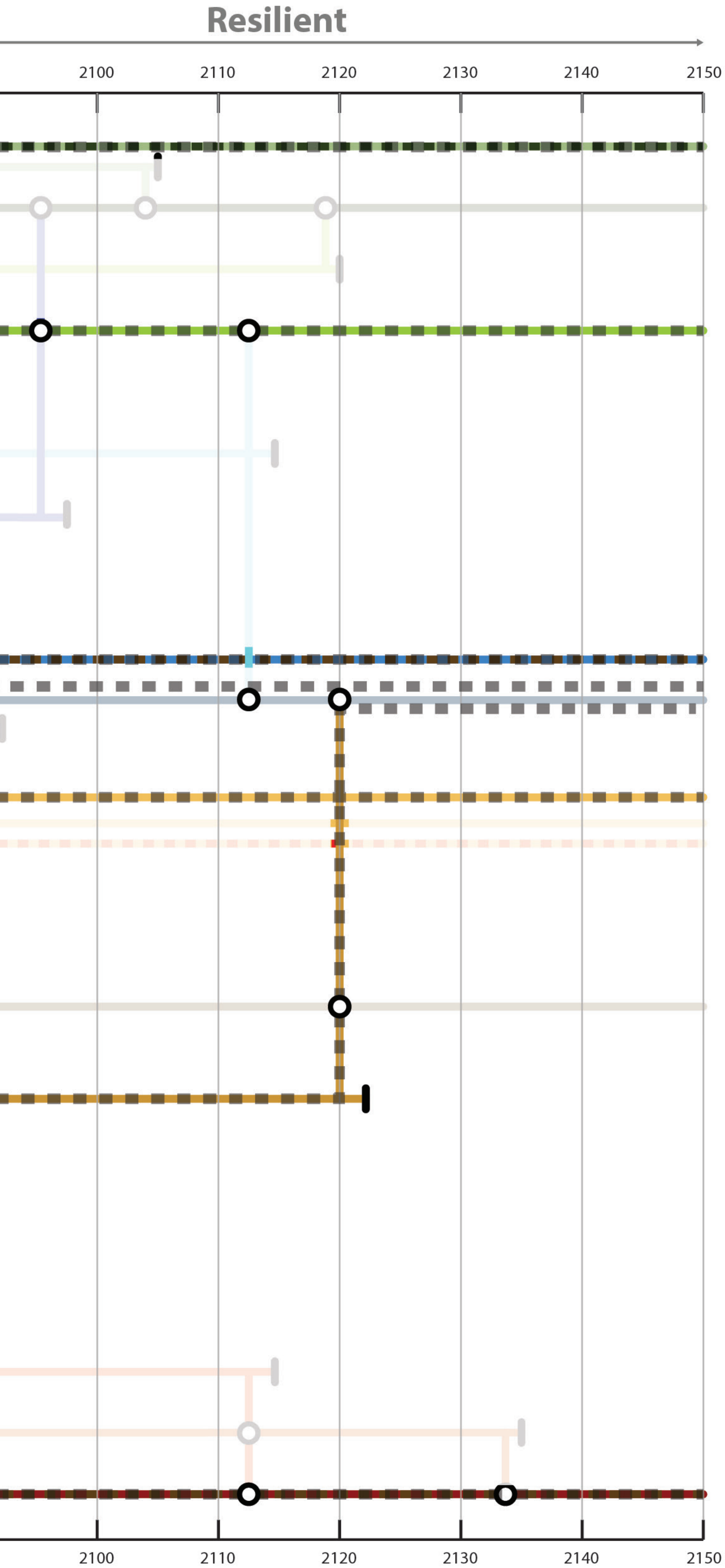
Introduction

After defining the starting point of Yuriage the developed actions can be added to the pathway map, see figure 81. Due to the fact that multiple actions can be taken simultaneously the Dynamic Adaptive Policy Pathway (DAPP) is categorized in four themes: Nature based (Green), Hard engineered (Blue), Community oriented (Orange), and renewable energy (Red). Each theme has its own pathway increasing the resilience of Yuriage with the goal to achieve Modern Urban Renewal (MUR). Adding the pathways creates a complex scheme with many paths to follow. However, there are two conclusions that can be taken by examining the pathway map. Firstly, is a clear difference between the first and second half of the pathway map.

The first half consists of adaptive actions that are used as a quick response to the disaster and are very short term oriented. The second half of the pathway map shows which actions are the most resilient, the pathways extend the furthest. Therefore, it is important to develop a strategy where there is a transition from adaptive actions towards resilient actions. As time moves passes, the higher the risk will be on an even more destructive tsunami or other disaster. This means that the further goes time, the more sustainable and diverse measures should have been taken. Secondly, the pathway map shows that the hard engineered solutions are not resilient and by only implementing these measures Yuriage will fail to reach MUR. Therefore, the hard engineered actions should be used as quick response to the disaster, but transition towards more resilient actions.

In the current situation of Yuriage mainly hard engineered solutions implemented. The current recovered status is taken as the strategic position and because of that the strategies will start at the hard engineered actions and make their way towards more resilient actions. The actions will be implemented in a sequence, which means that previous actions are not discarded when moving to another action. This can create interesting combinations such as hard engineered actions and nature based solutions. The pathway map is used to illustrate potential connections between actions and where a sequence of two different actions can strengthen it and become more resilient (double colored and dashed line). Some actions have a dashed line before the actions starts. This means that the action needs a certain amount of time before it has the desired result. For example, before a mitigation forest is functional it needs to grow for at least 15 years to have enough strength to mitigate a tsunami impact.

figure 83. Dynamic Adaptive Policy Pathway Map with chosen strategies. Author



Strategy

Each strategy is a set of tactics that leads towards the end goal, Modern Urban Renewal. Two conditions were important in the choice of paths. The first is that a pathway should always move towards an action that has the opportunity to become resilient. Secondly, the paths should have the possibility to be combined with other actions. The more actions that can be combined the higher chance of success and the more flexible the pathway. The strategies start from hard engineered and will be transformed in order to achieve Modern Urban Renewal and create balance between nature and construction. Flood management needs to be developed with a long-term perspective (e.g. 100 years or longer) because climate change and disaster are provided for the long term.

Each pathway theme (nature based, hard engineered, community oriented, and renewable energy) has its own partial goal, where all four strategies combined result in Modern Urban Renewal:

1. Nature based: sequence natural processes for stronger resilient power;
2. Hard engineered: receive the first hits from stress on the system + transform the structures towards MUR;
3. Community Oriented: create identity and strengthen the community + creating a hub;
4. Renewable Energy: from accommodate energy needs towards reduce energy consumption and finally circular economy.

The result of the chosen pathways is shown in figure 82. Each of the actions and their potential combination will be elaborated on in order to understand the decisions that were made.

The coastal forest needs time to be fully grown and effective against a tsunami impact. However, the forest remains weak during earthquakes where liquefaction can occur. In order to strengthen the roots of the forest this action can be combined with the dune landscape and provide stability during an earthquake. The dune landscape can be created relatively fast and over time forest growth can be accepted in order to create the mitigation forest.

Sand deposition is used to strengthen the beach and create more distance between sea and land. It takes time to have effect and the sell-by date (the moment a solution no longer meets the requirements to achieve MUR) depends on the amount of sand that can be provided. A dewatering system can be implemented as a short term solution to increase the sand deposition on the beach. This is a system that refers to the drawdown of the water table under the beach foreshore by a network of perforated pipes and pumps (Keenan & Weisz, 2016). The porosity of the beach is increased by lowering the water table allowing water to percolate down through the sand. Any sediment that is being carried by the water will deposited on the beach.

The embankments function are the first defense against the tsunami impact. Due to the fact that these are already built they should be integrated with more resilient solutions. A good combination of actions is to create a dune landscape behind the embankment of the same height. This creates a closer relationship with the ocean. In addition, the raised ground provides a stable foundation for the mitigation forest.

The creek system is a solution for the long term by changing the landscape on a larger scale. Before it can function properly other actions need to be implemented in order to provide a safe environment. The elevated road network can provide evacuation routes further inland. This system of elevated roads should be strategically implemented in the region. This will guarantee that the network will be sustained for the long term and give room for developments alongside this network. These developments will strengthen this network even further making it more resilient and safer in case of a disaster in the future.

Temporary housing can be transformed into flood resilient housing, but the sell-by date will be less than when they are newly built. This decision depends on the funds that are available. New housing typologies that can cope better with floods and earthquakes can be built in areas around the elevated ground where Yuriage is currently developing on. Currently the life span of buildings is around 20 years in Japan due to the disposable-home culture of Japan (Koo & Sasaki, 2008). The government updates the building code every 10 years due to the earthquake risk. With a result that people just build new homes rather than spending money on expensive retrofitting (Braw, 2014). By investing in new building typologies that are earthquake proof and more sustainable the life span can be increased with many years.

Land raising accommodates the old housing typologies the best, however instead of raising land new housing typologies that are flood resistant could be an alternative option.

In the first years solar fields can meet the energy demand of the people living in Yuriage. However, when the number increases there will be a need for other means of energy production or ways to reduce energy consumption. The community market can function as a hub which provides a potential for the Circular Economy where goods are sold such as recycled products by the waste treatment plant or food that has been produced locally.

The hypothesis is that following a pathway for each of the four themes from adaptive actions to resilient actions Modern Urban Renewal is reached, figure 83. It is important to include the current trends of climate change and population decrease/increase. These will have an influence on the success of the chosen actions. Therefore, there are two phases that the strategy will go through: adaptation and resilience. During the adaptation phase the population will stay the same due to the fact that there is still a massive population decrease in Japan. However, by the time that the resilience starts the population will increase again. Both phases follow the trend of rapid climate change which causes an increased amount and intensity of storms. The next chapter explores the translation of the strategy from the DAPP to the physical environment.

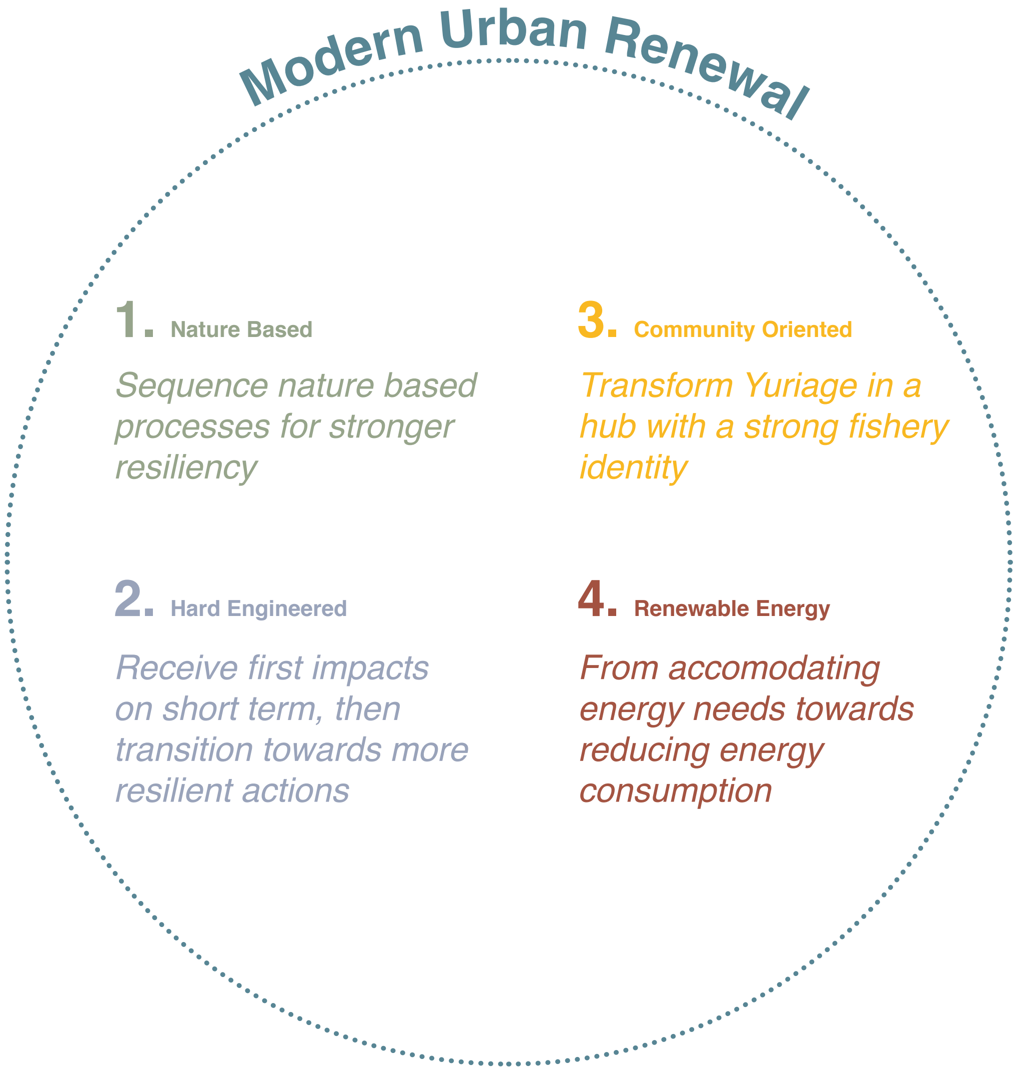


figure 84. The four strategies combined that will lead to Modern Urban Renwal. Author

IMPLEMENTATION

水一

Development Phases
Landscape
Energy
Community
Industry

一国

Development Phases

Phase 1 - Adaptation

The first phase starts from the current situation of Yuriage where some hard engineered solutions have been applied such as elevated ground, horizontal canal, and the coastal embankment, figure 84. In addition, the adaptation phase provides a foundation for the shift towards more resilient solutions. The design can be divided into four sections: the coast, the harbor, the housing area, and the energy hub. Each of these areas has their own specific goal and set of actions which together forms Modern Urban Renewal.

Coast
Dune landscape is formed in combination with the embankment to create a better transition from land to sea, and thus improving the visual relation with the sea. In addition, the elevated land will provide stability for the coastal forest that is planned for phase 2. In order to strengthen the coast a method is used to lower the groundwater table under the beach foreshore by using a system of perforated pipes and pumps. However, the effectiveness depends on the reliability of the pumps, availability of sand, and the maintenance of the pipes. This can result in a very costly solution for the long term and should therefore be replaced with a more sustainable solution in phase 2.

Harbor
Historically the fisheries are strongly tied to related industries and play an important role in terms of local economy and employment. The harbor area is the representation of the identity as a fishery village. A promotion and cooperation between fishery industries and private sector companies will utilize local tourism and enhances the potential for tourism in the area. On the evacuation hill south of the harbor a disaster museum will be located that has a panoramic view on all the four sections of the design. These elements combined create an interesting setting that functions as a hub for tourists.

Housing area
In the first phase there are two types of housing built to accommodate the current population. These two typologies are built on the flood measure of elevated ground which offers extra protection. The housing closest to the sea are more robust than the housing further away. Robust building blocks are built that also function as evacuation towers. In order to strengthen the community in these complexes there is a communal garden in the center. In addition, these complexes are suited with solar panels and water retaining reservoirs. These are used to reduce the energy consumption of the residents in a collective way. The relation with the water is created by integrating a set of canals that flow through the elevated land. Because of the height differences there is a need for a pumping station which will be placed at the school and can offer extra educational purposes. The park at the center of the housing area is also an evacuation facility and is programmed as a restaurant.

Energy hub
In the adaptation phase the focus lies on providing as much renewable energy as possible. Therefore, a solar field is developed next to the waste(water) treatment plant. This will create an energy hub that stores excessive energy created by the waste(water) treatment facility. This energy hub will be the first step towards Circular Economy as it can offer various ways to treat waste and generate energy.

◂ *figure 85.   Phase 1 - Adaptation. Author*

Phase 2 - Resilience

In phase two the transition from adaptive solutions towards resilient solutions is supported, see figure 85. Most of the hard engineered solutions are replaced by natural processes. However, in some cases the civil constructions and nature based solutions strengthened each other and were therefore combined to increase resilience.

The dune landscape is transformed into a mitigation forest by natural forestation. A creek system is created that can capture excessive water and discharge it in the lake. In case of a large flood or tsunami this river system can function similar as the Natori river where the water is captured in the river. Multiple sources of renewable energy, such as wind energy, provide power for the residents of Yuriage. By creating a smart system with the 3R concept energy consumption is reduced.

The harbor area is expanded as the industries grow and tourism increases. In order to meet the requirements for water capacity an excessive network of canals runs through the harbor area connecting all parts together through land and water which is ideal for transporting goods or leisure purposes. The balance between the system of canals and the hard paved materialization enhances the harbor identity.

New housing typologies are built in the lower areas of Yuriage. These are able to withstand the earthquake impact and smaller floods. However, in case of a tsunami the elevated road network provides a safe evacuation route. The new urban morphology will settle alongside this elevated road network. This will ensure that the elevated route will be maintained in the future and is embedded in the urban fabric.

All of the evacuation towers and main functions in Yuriage are connected through a pedestrian & bike only route. This will encourage people to evacuate by foot or bike instead of taking the car and create congestions during a disaster and during normal situations. To further promote this, the route runs through all the different sections of the design and connects the town and harbor to the coast.
Phase 2 aims to find a balance between the hard engineered solutions from the first phase and use these in combination with nature based solutions to increase the resilience of Yuriage. The plan translates the core idea of Modern Urban Renewal which is the integration of four aspects: physical living quality, environment, energy, and tsunami resilience. Where these four aspects are stimulated and strengthened by the community all in the context of a balance between land and water.

◂ *figure 86. Phase 2 - Resilience. Author*

Panorama

Each action has a specific place in the design where it performes the best. In figure 86 an overview is shown of where these actions are implemented and how they relate to each other spatially.

figure 87. Panorama illustrating where the actions are applied. Author

Miltifunctional Evacuation Facility
Fisheries (Industry)
Coastal Forest
Wind Energy
Teizan canal
Sendai Bay
Disaster resistant building typology
Horizontal Canal
Sand Deposition
Dune Landscape

Landscape

Section

In figure 87 a section of the coastal area is illustrated that shows the multi-layered defense system where hard engineered and nature based solutions are combined. Because of the sweet water flow from uphill and the salt water flow from the beach a brackish environment is created in the middle. This gives a great boost to a specific biodiversity in the region and is the habitat of the famous Japanese Seaperch. The trees that will be used for the mitigation forest are the black pine trees together with Rhizophora mangle trees. By using multiple species the flexibility to cope with an impact is increased.

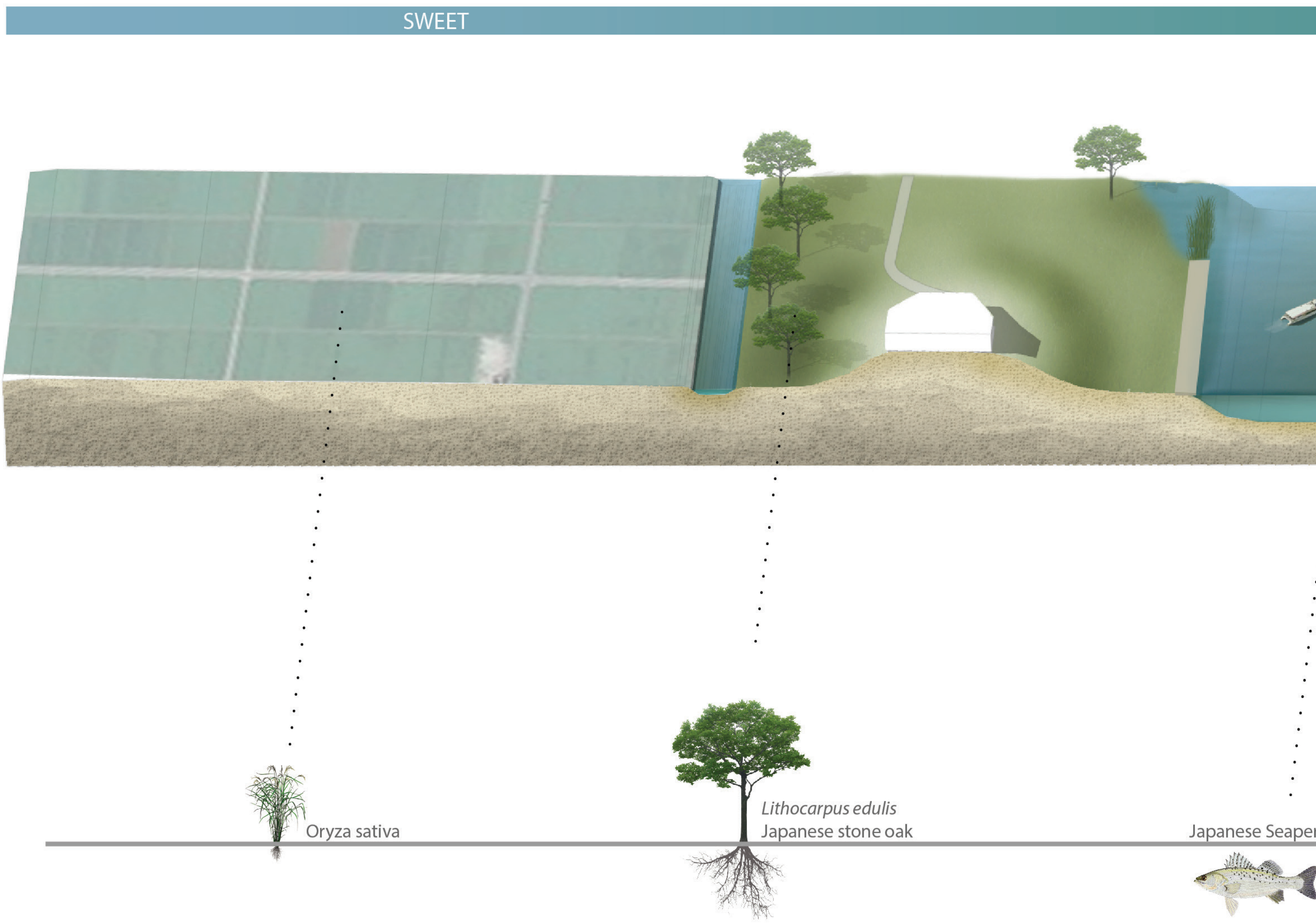


figure 88. Section of the coastline with the species that live in these coastal environments. Author

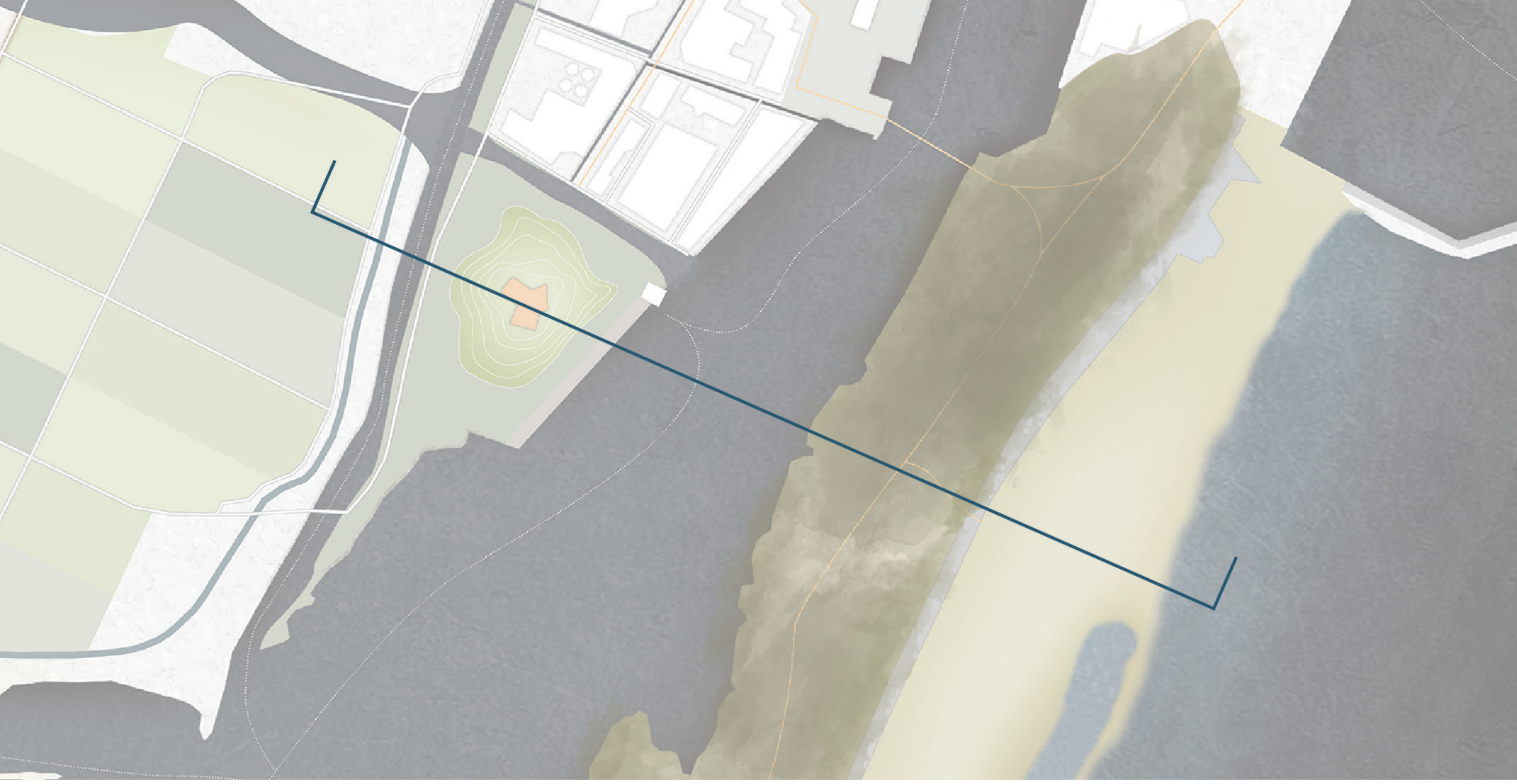
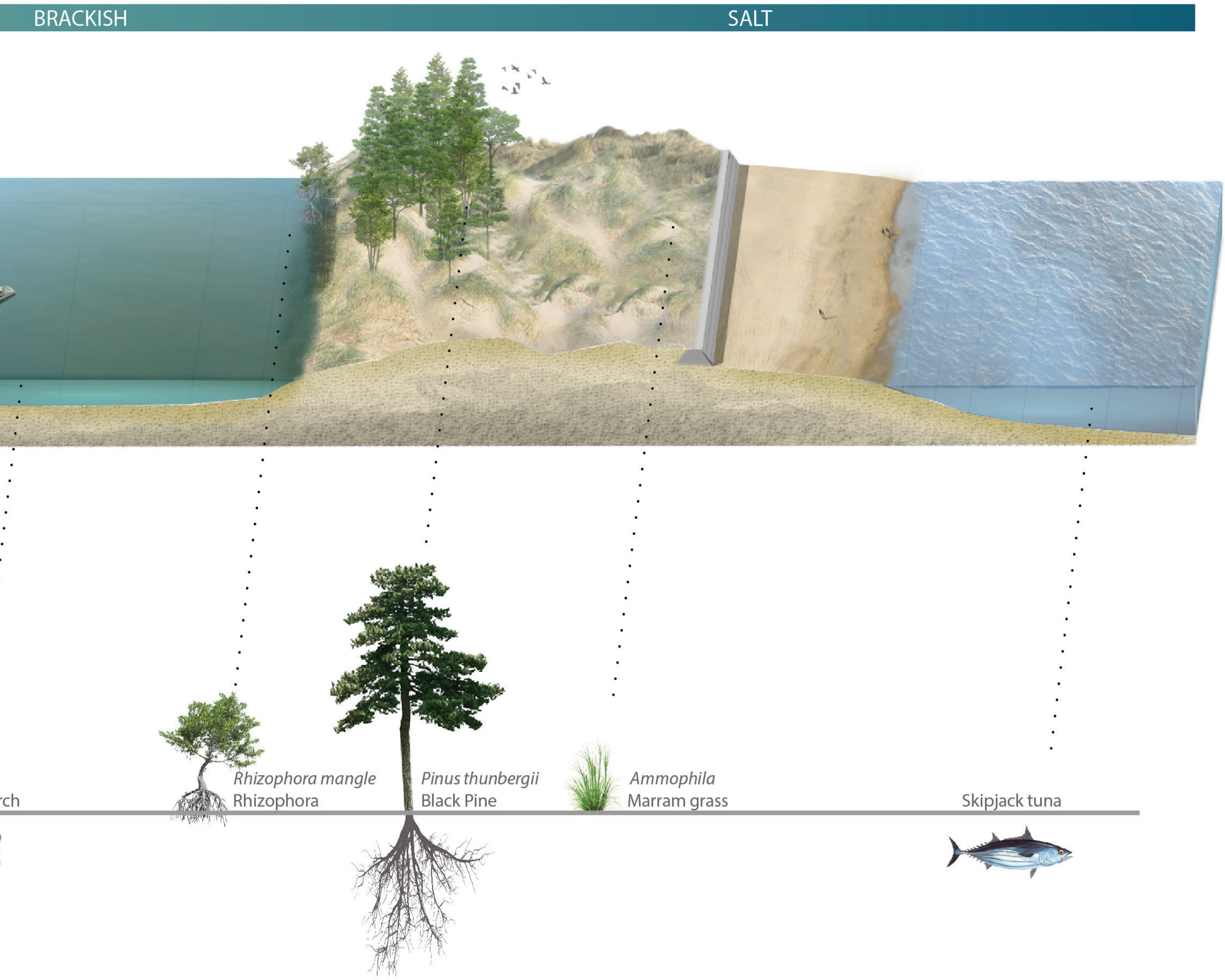


figure 89. Location of the section. Author



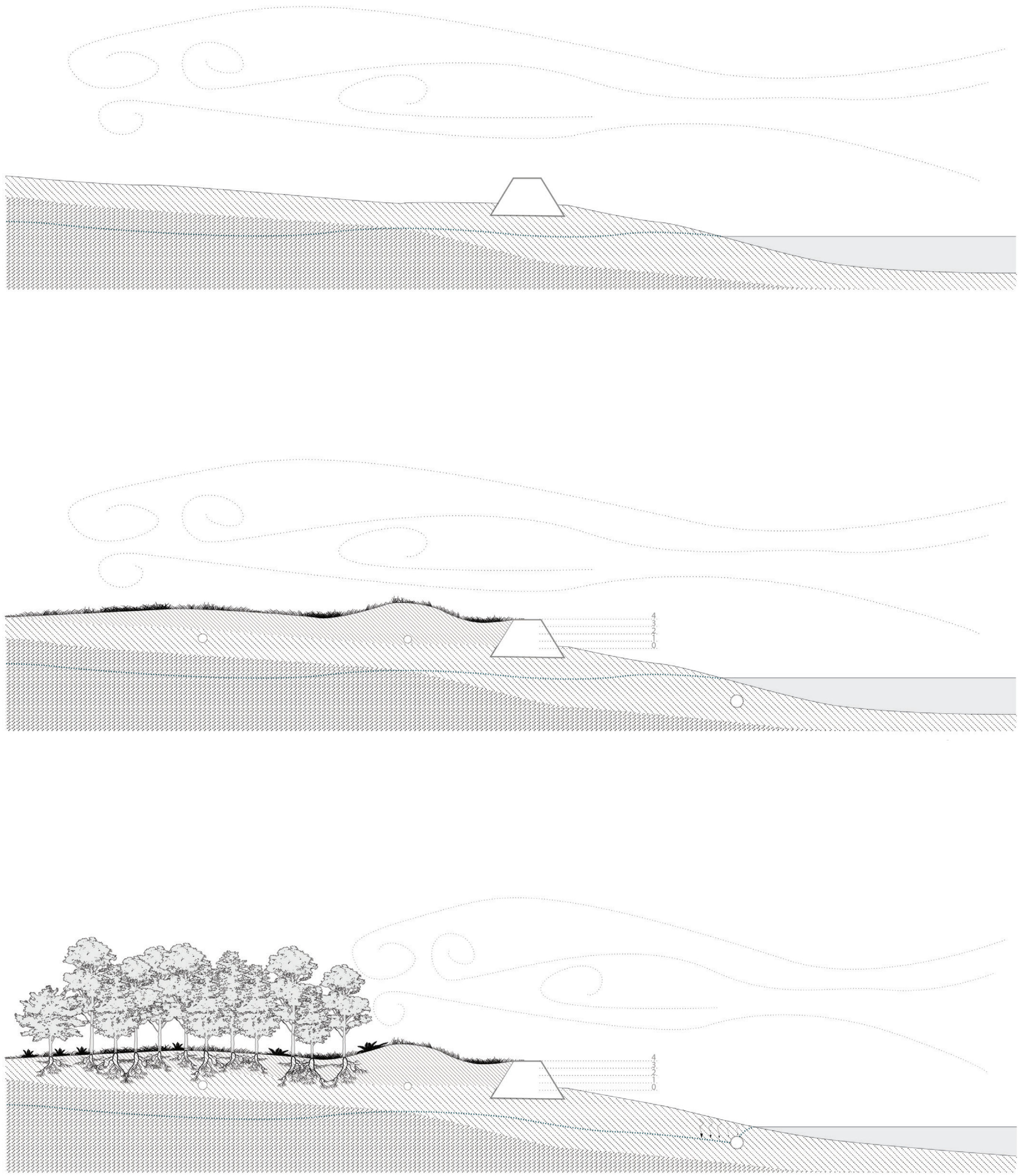


figure 90. Transformation of the coast. Author

Transformation of the coast

The sequence in figure 89 shows the transformation of the coast. The first section shows the current situation where the coastal embankment is built. In the second section the dune landscape is added together with the short term solution of the drainage pipes at the shore line. The drainage pipes will increase the sand deposition on the beach which helps the growth of the beach and dunes. The dune landscape is elevated to the same height as the embankment (4m) to enhance the visual connection with the sea. Through natural forestation the mitigation forest will grow on the dune landscape. By leaving a space open between the dunes and mitigation forest sand can be captured by the trees that strengthens the dune landscape. One of the issues that mitigation forests had to cope with was liquefaction caused by the earthquake. This resulted in trees being unable to stay in the ground due to limited root-soil structure. The forestry Agency advised to raise the ground with 3 to 5 meters to ensure stability for the trees (Renaud & Murti, 2013). By raising the ground Salt spray from the sea is a problem that affects the agricultural fields inland. The mitigation functions as a natural barrier that blocks off the salt spray in the air and protects the fields. A good balance between nature and land is found by combining hard engineered and nature based solutions that strengthen each other.

- Filling (sand)
- Sand
- Gravel
- Civil construction
- Ocean
- Underground drainage
- Salt spray
- Ground water table
- Infltration

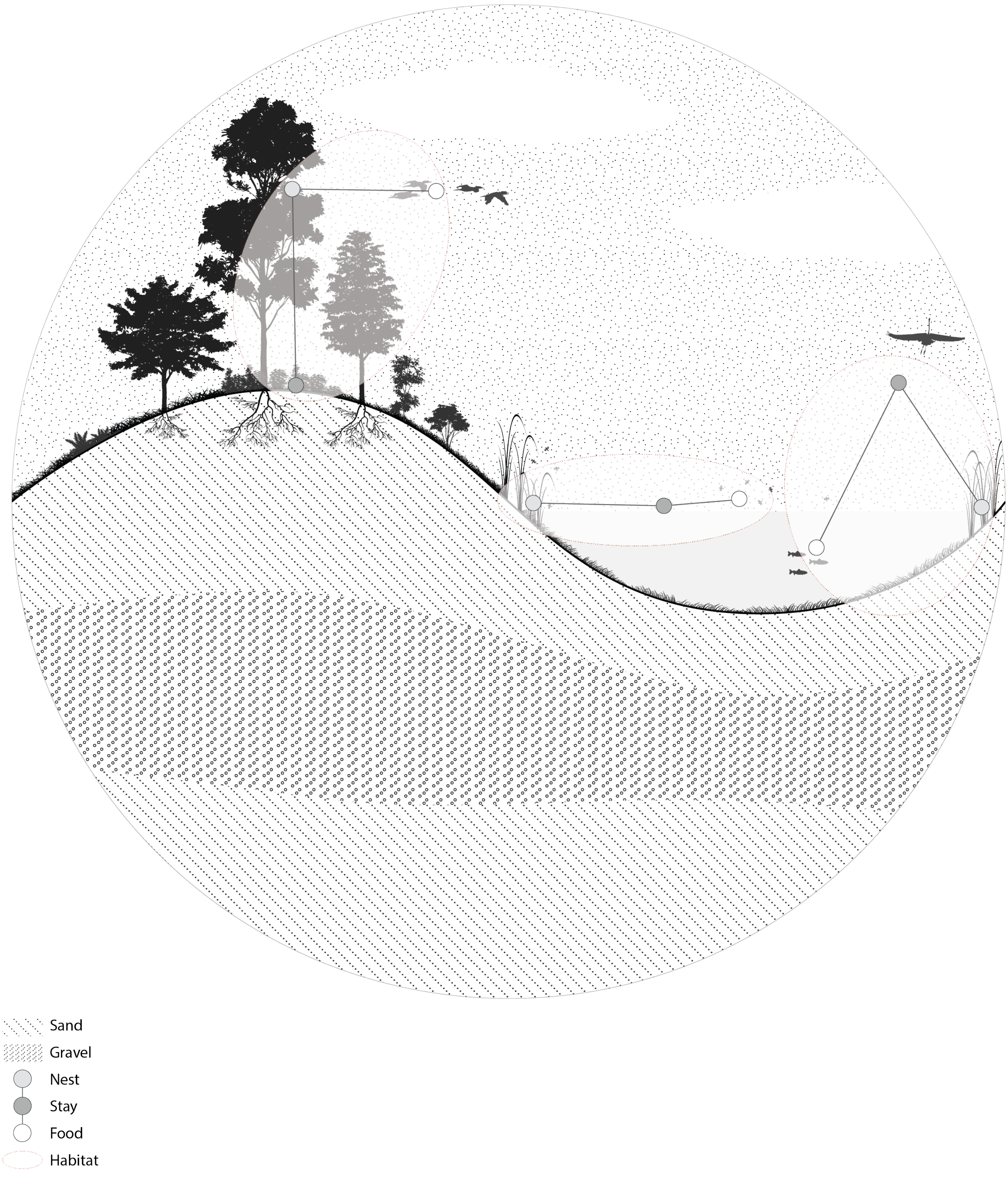
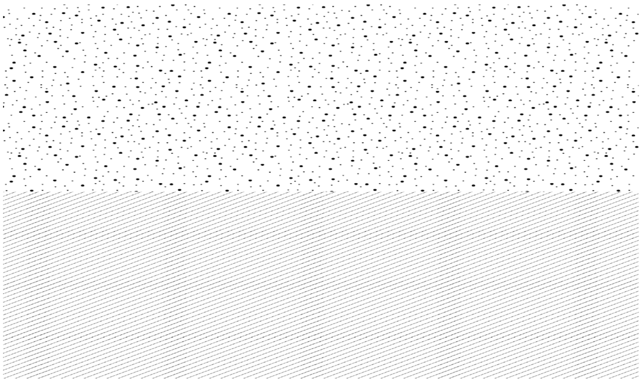


figure 91. Increase biodiversity by providing habitats for the species. Author

Biodiversity

There are three requirements for a habitat to function properly: a place to nest, stay, and find food. If one of these nodes is missing a species cannot settle (Heuvelman, 2017). The coastal regions of Yuriage will have three main habitats because of the water types that are salt, brackish, and sweet. In these habitats grow various plants that attract different species that thrive in these environments. By providing a layered system of grass, shrubs, small trees, and large trees multiple habitats are created illustrated in figure 91. Biodiversity can be increased even more by interconnecting the habitats as shown in figure 91. The first image show two habitats meeting in a normal situation. However, by increasing the surface area here habitats meet as shown in the second image the interaction between habitats also increases and thus increasing the biodiversity (Heuvelman, 2017).

Little biodiversity



Increased biodiversity

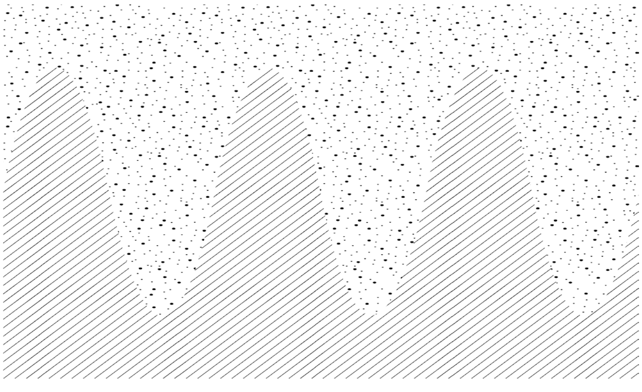


figure 92. Effect on the biodiversity by interconnecting the habitats (top view). Author

Energy hub

Section

In the section of figure 92 the energy system is illustrated. The agricultural land and housing will provide waste materials for the waste treatment plant which recycles or incinerates the waste. The power that is generated can be stored in the energy facility next to the wastewater treatment plant. In cases of fluctuations in the energy supply, the stored energy can be used to prevent the lack of energy.

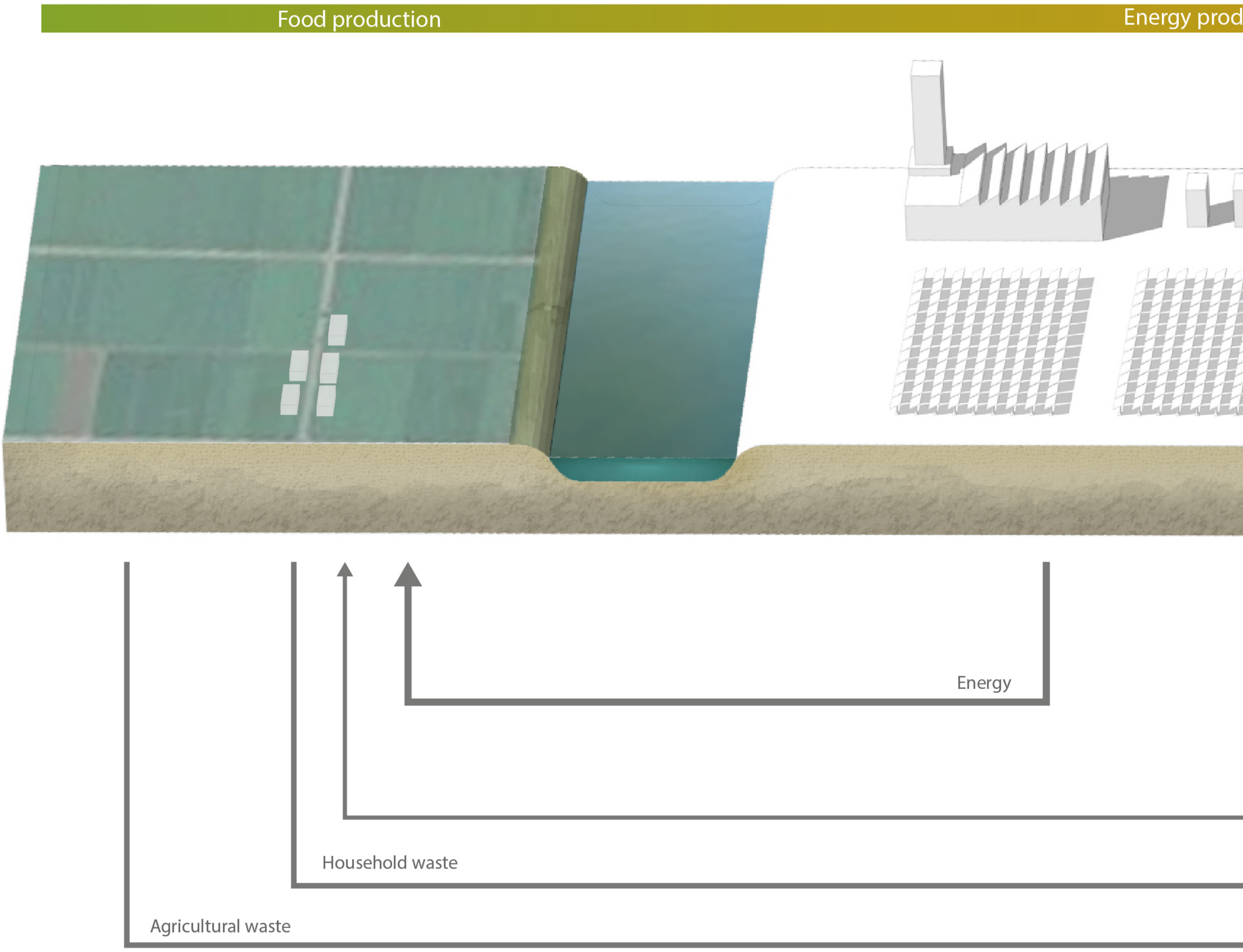
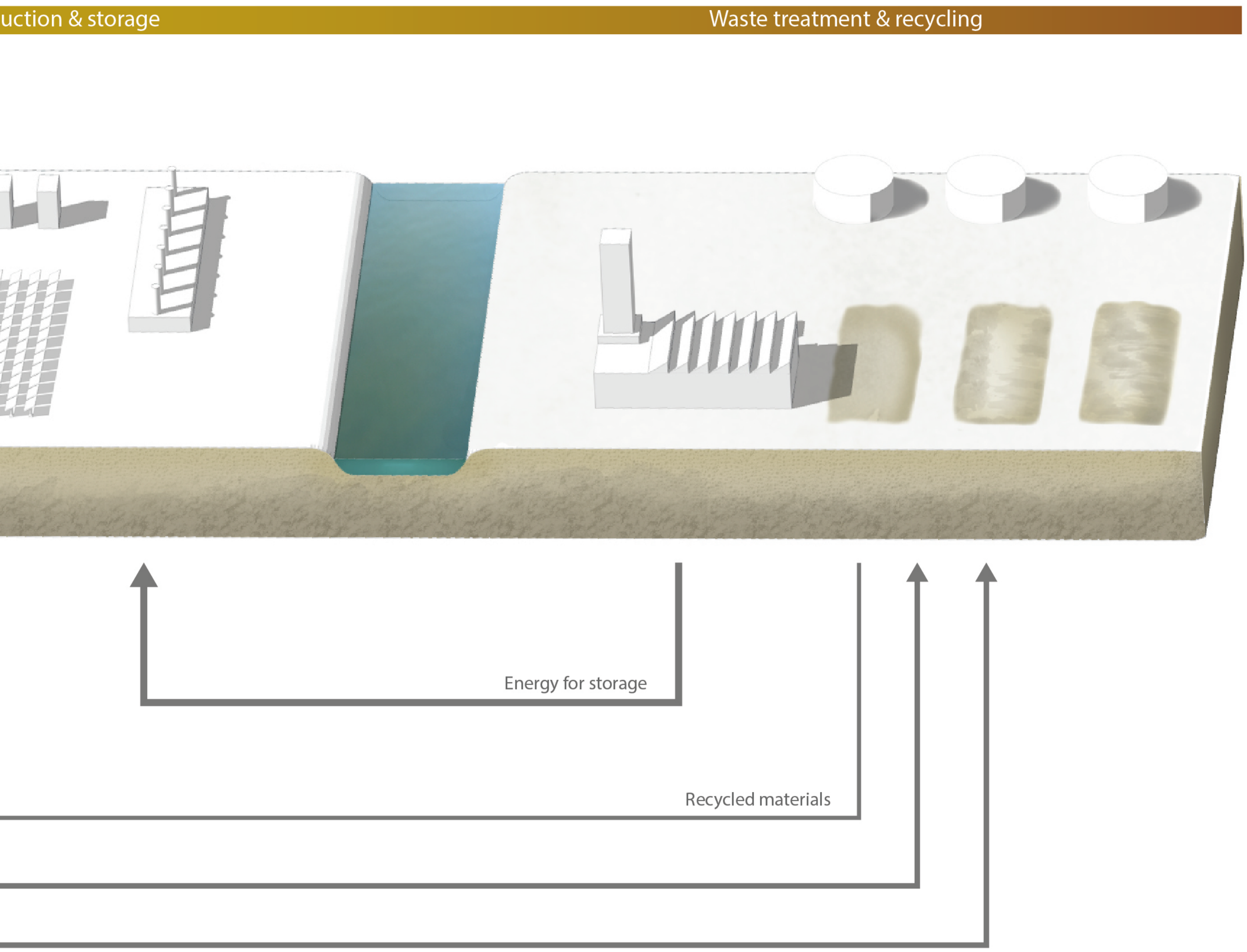


figure 93. Section of the energy hub. Author

figure 94. Location of the section. Author

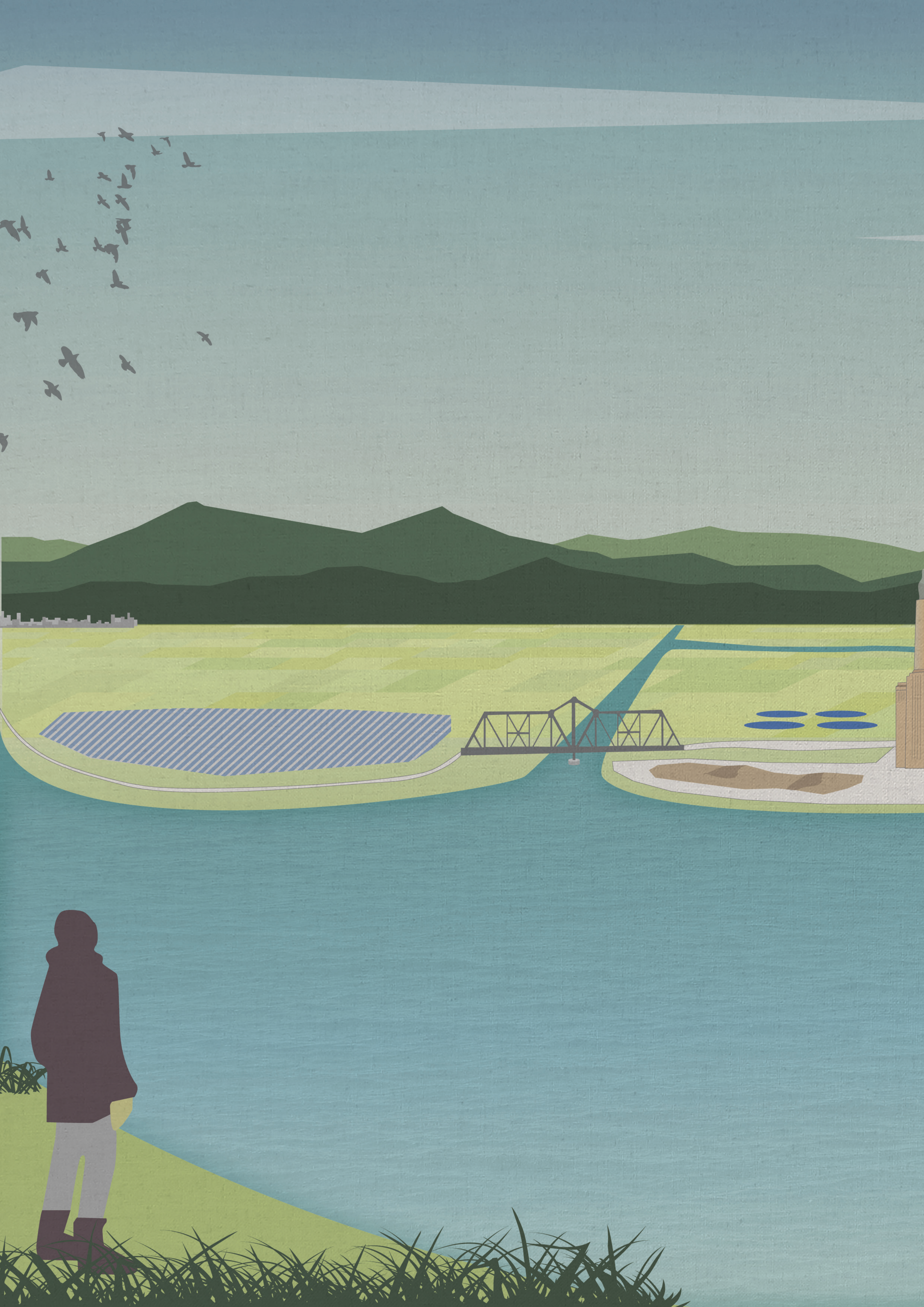


LEGEND
1 : 25000
N
Fishing industry
Housing
Waste treatment
Evacuation fac.
Energy production
Pedestrian route
Food production

Function System

The function system shows how each of the sections of the design are connected together. By creating a circular system on the small scale the step towards Circular Economy is easier to make. Housing and industries provide waste materials to the waste treatment plant. The received waste gets recycled and stored for later use. The agricultural land provides resources such as food for the residents of Yuriage. This will create a more self-sustaining village and reduces the energy consumption.

◂ *figure 95. Function system of Yuriage. Author*



Housing area

Housing

The housing area consists of three main parts: the buildings, the water system and the park. The built environment is made of two typologies of housing, see figure 95. The first is the standard Japanese housing but with improved foundation and isolation. This will ensure a longer life span for the dwelling. The second typology is the community evacuation apartment. This apartment complex is a transformation of the current apartments of Yuriage. Apartment complexes in general are very anonymous and lack the sense of community. Therefore, these new apartment blocks are focused around community involvement where each community can have their own specific element at the hearth of the apartment, the inner court. A water system is integrated on the raised land to enhance the relation with the water and provide quality to the public space. In addition, the housing area aims to capture and hold as much water as possible by integrating green patches between the housing clusters. A pump station is placed at the school and functions also for educational purposes. A river side park is created east of the elevated land to create a smoother connection between the housing and water.

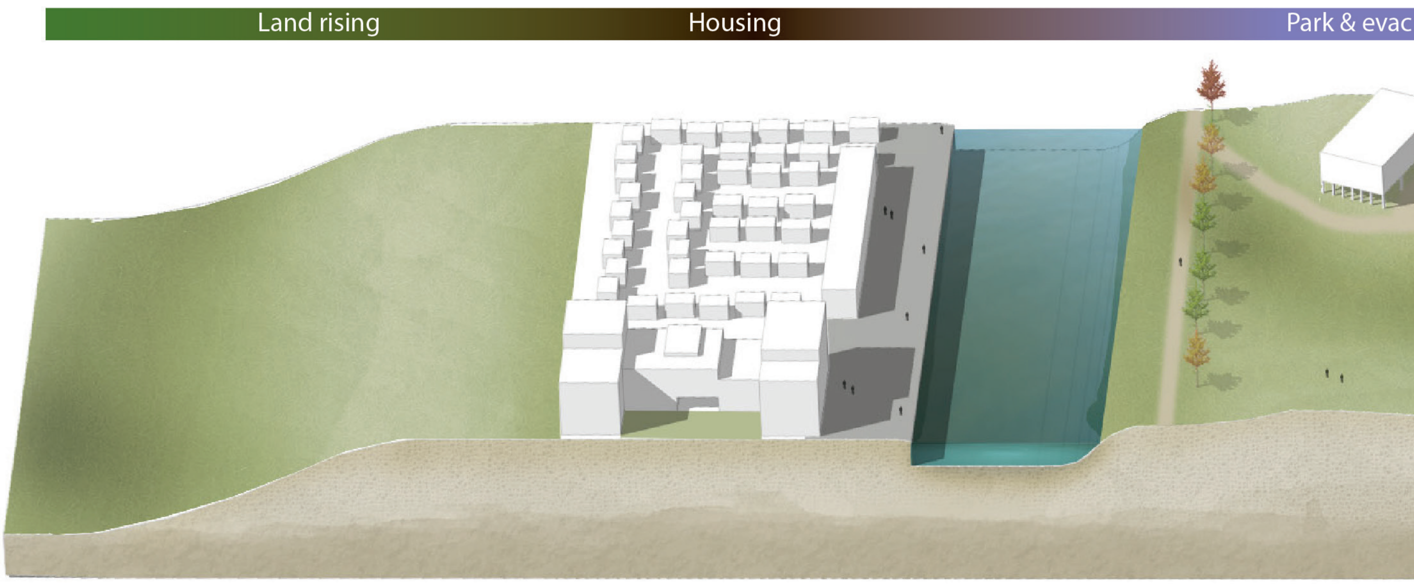


figure 96. Section of the energy hub. Author

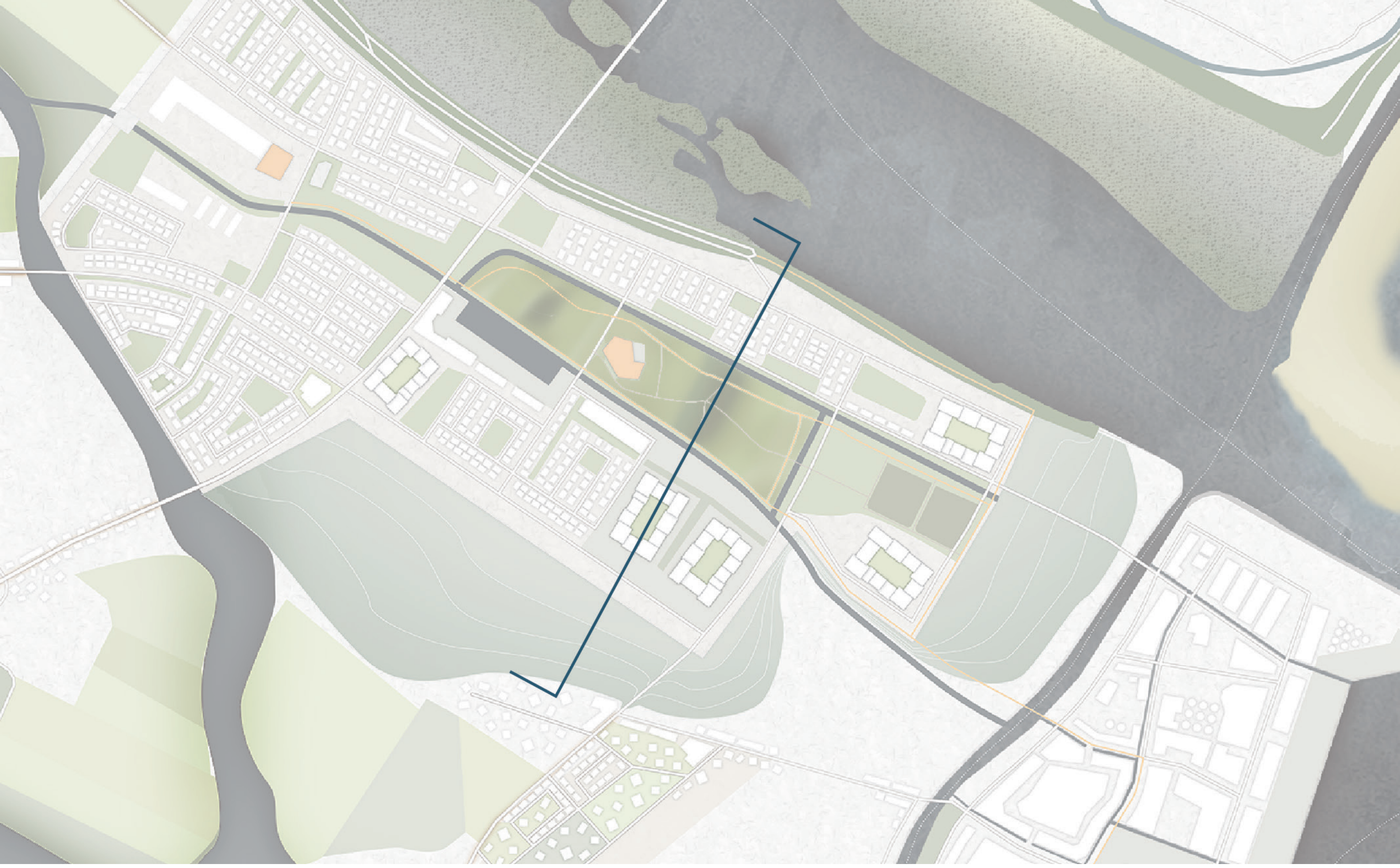


figure 97. Location of the section. Author

Apartment blocks

The apartment block is illustrated in figure 97. The complex is a combination of all the elements that form Modern Urban Renewal. Typical Japanese design principle is the use of an inner court (Graaf & Hooimeijer, 2008). This principle will be applied for the apartments where in the center food or flowers are planted that can used by the community themselves or sold through the shops that are situated on the ground floor. On the roof are solar panels and water reservoirs to provide the apartment with energy and water. However, there should be enough space on the roof left for people to evacuate during a disaster. The apartment has an informal layout which encourages community involvement. The inner court can also be designed to store water in case of heavy rains. Extra storage capacity is achieved by creating height differences in the center that can fill with water during excessive rain. During normal situations the space is used for leisure activities.

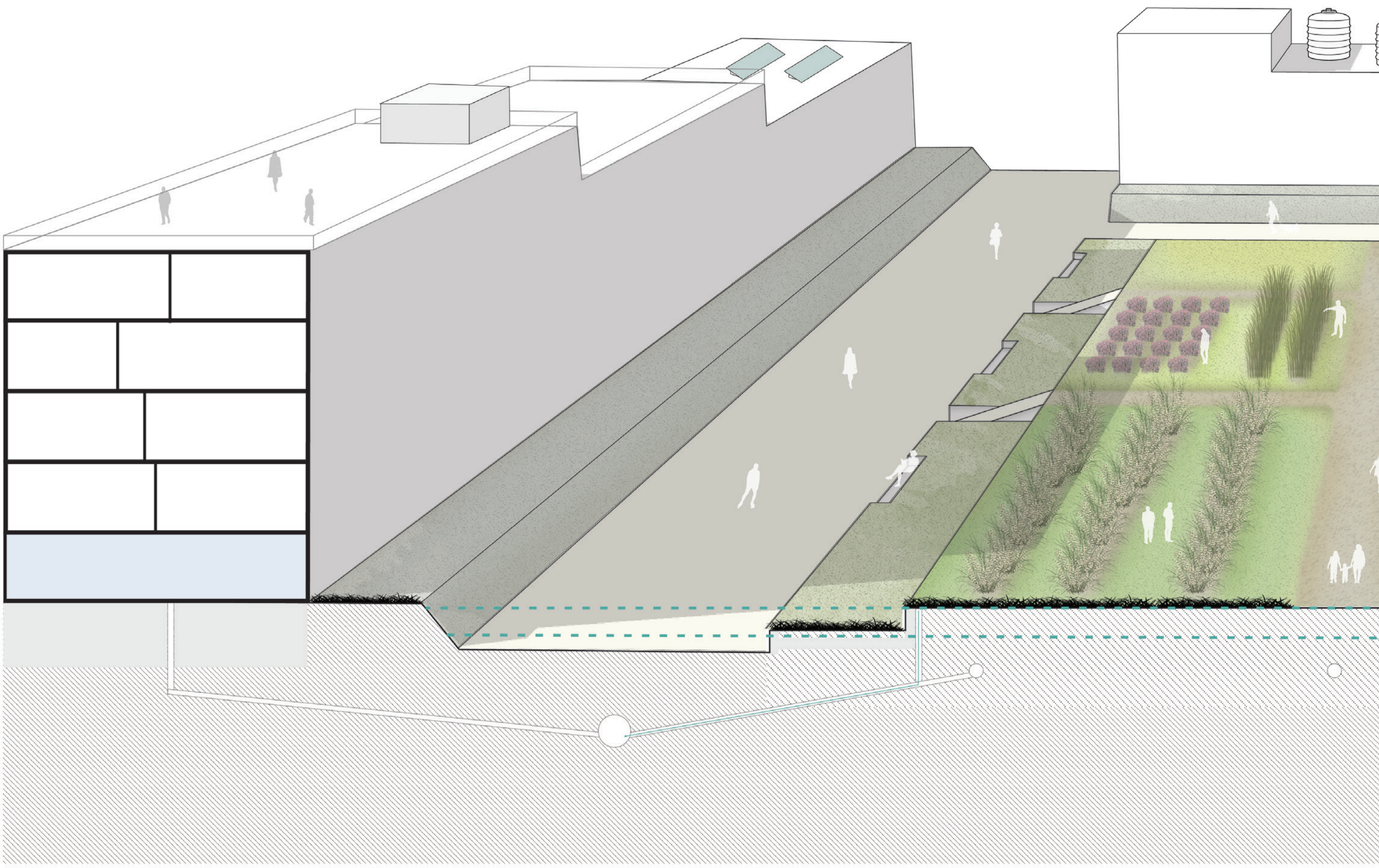
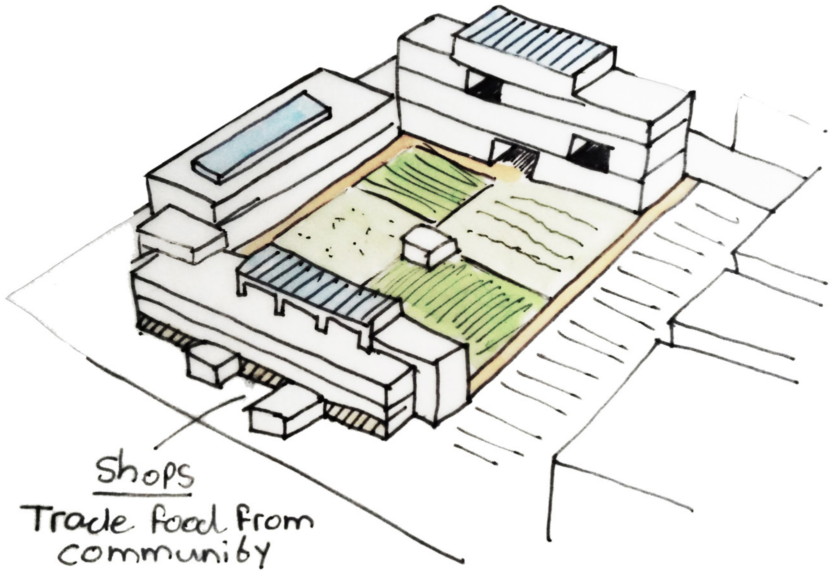


figure 98. MUR apartments. Author


Shops
Trade food from community

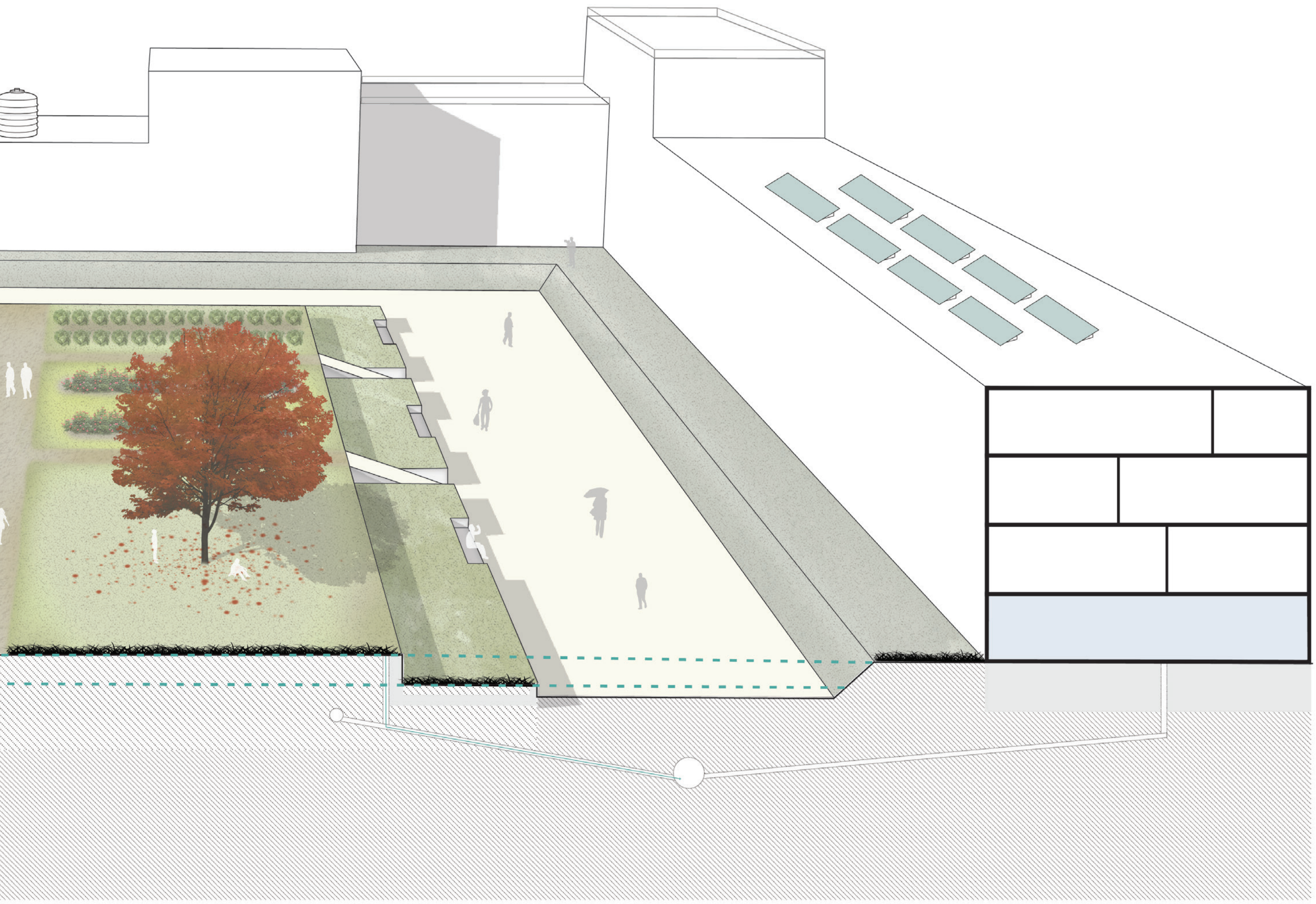


figure 99. Traditional Engawa. Emzett85

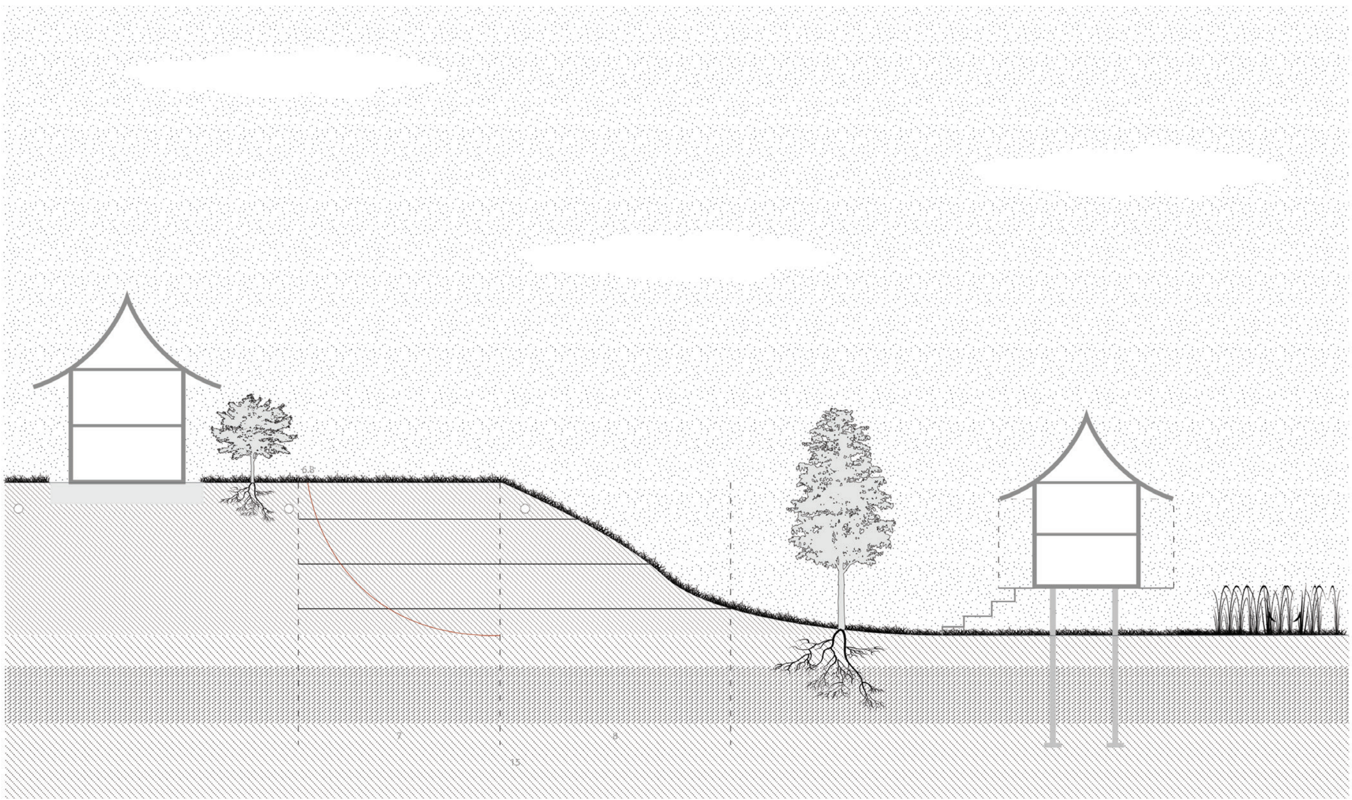


figure 100. Section of the elevated ground with integrated geotextile. Author

Housing typologies

The section of figure 99 illustrates the use of new housing typologies and the use of geotextile in order to maintain slope stability. Due to the stable ground of the elevated part the buildings can use concrete slabs. In the low-lying areas there is a need for wooden pile foundations for stability. Elevating the building above the ground will provide extra safety during floods from the nearby river system or during heavy rainfall. This typology is derived from the traditional engawa which is a typology that is used in Japanese architecture, see figure 98. It was common to have a small terrace around the house that was lifted from the ground. From this area the garden could be experienced. The same principle can be applied in this scenario, only the garden is replaced with the public space.

The geotextile that is used prevents the collapse of the slope during an earthquake with the same intensity as the GEJE. Geotextile is a new technology that is put into the soil to stabilize the ground. The red line shows the critical zone that will collapse during an earthquake (6.8 meters from the edge of the slope). By applying the geotextile 7 meters from the edge of the slope it will prevent the collapse (Mustaqim, 2018). Geotextile is permeable so it has no influence on the ground water table. However, no buildings or trees can be built or planted on top of the geotextile because they will penetrate the textile. Therefore green open spaces are designed at the location of the geotextile.

Filling (sand)
Sand
Gravel
Building
Concrete slab foundation
Wooden pile foundation
Underground drainage
Geotextile
Critical point land slide

Industry

Section

The harbor area is used for fishery industries and tourism. In order to maintain the harbor identity many hard materials are used in the public space. However, in order to be able to store and discharge water from peak rainfalls a system of canals is integrated in the design. In addition, where possible permeable pavement is used to maximize the water infiltration capacity. The next two pages show examples of the integration of water in the harbor area. This network of canals link all the different parts of the harbor together and can be used for leisure purposes. The square in the center is the main area for market stalls or events that can take place during festivals. The square has a direct connection with the ships that enter the harbor. The harbor area forms the main attraction of Yuriage for tourists that wants to visit a fishing village with a strong cultural identity.

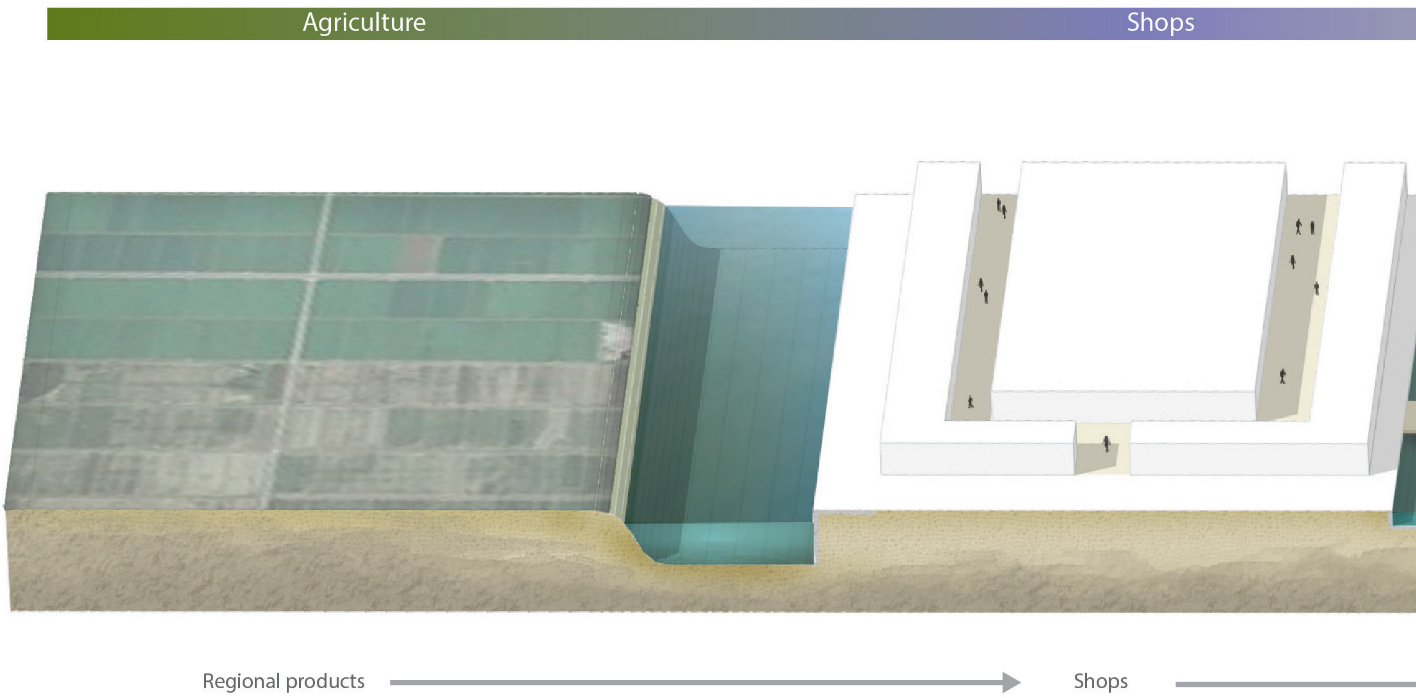
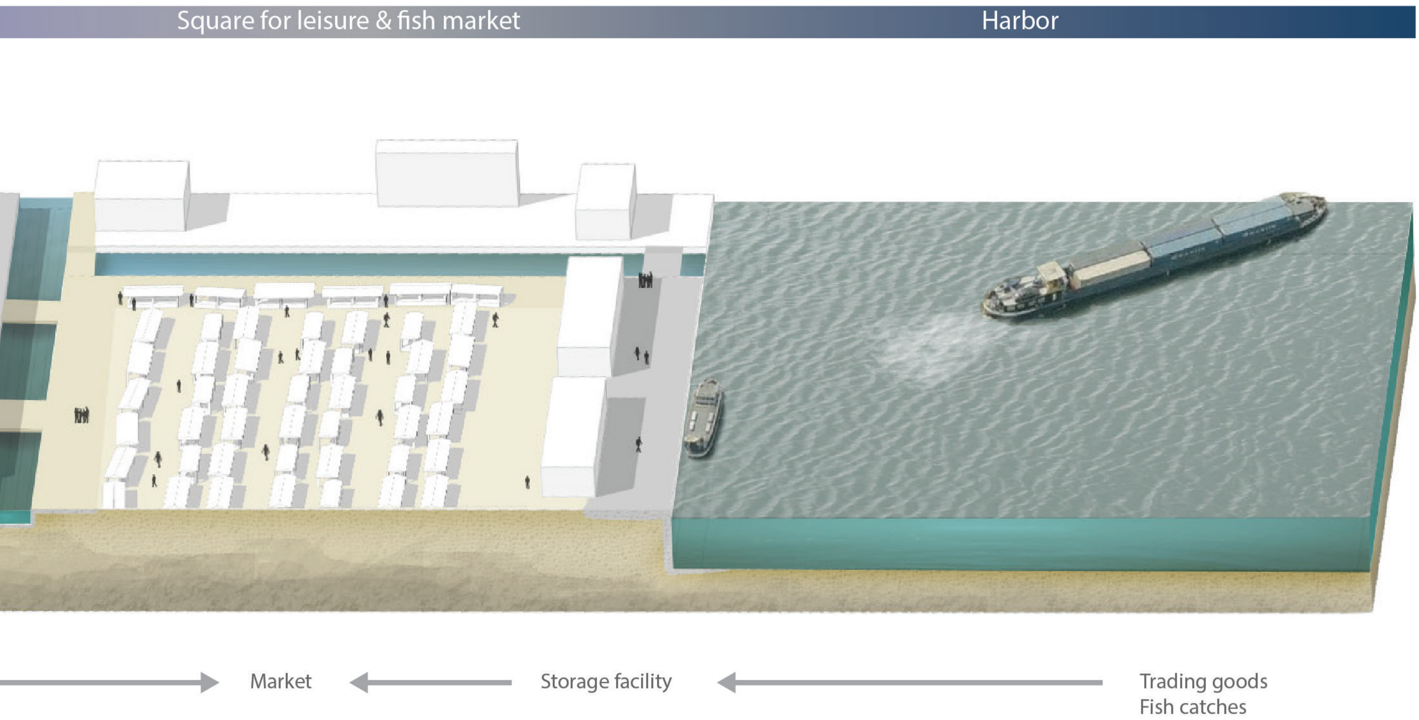


figure 101. Section of the harbor area. Author

figure 102. Location of the section. Author



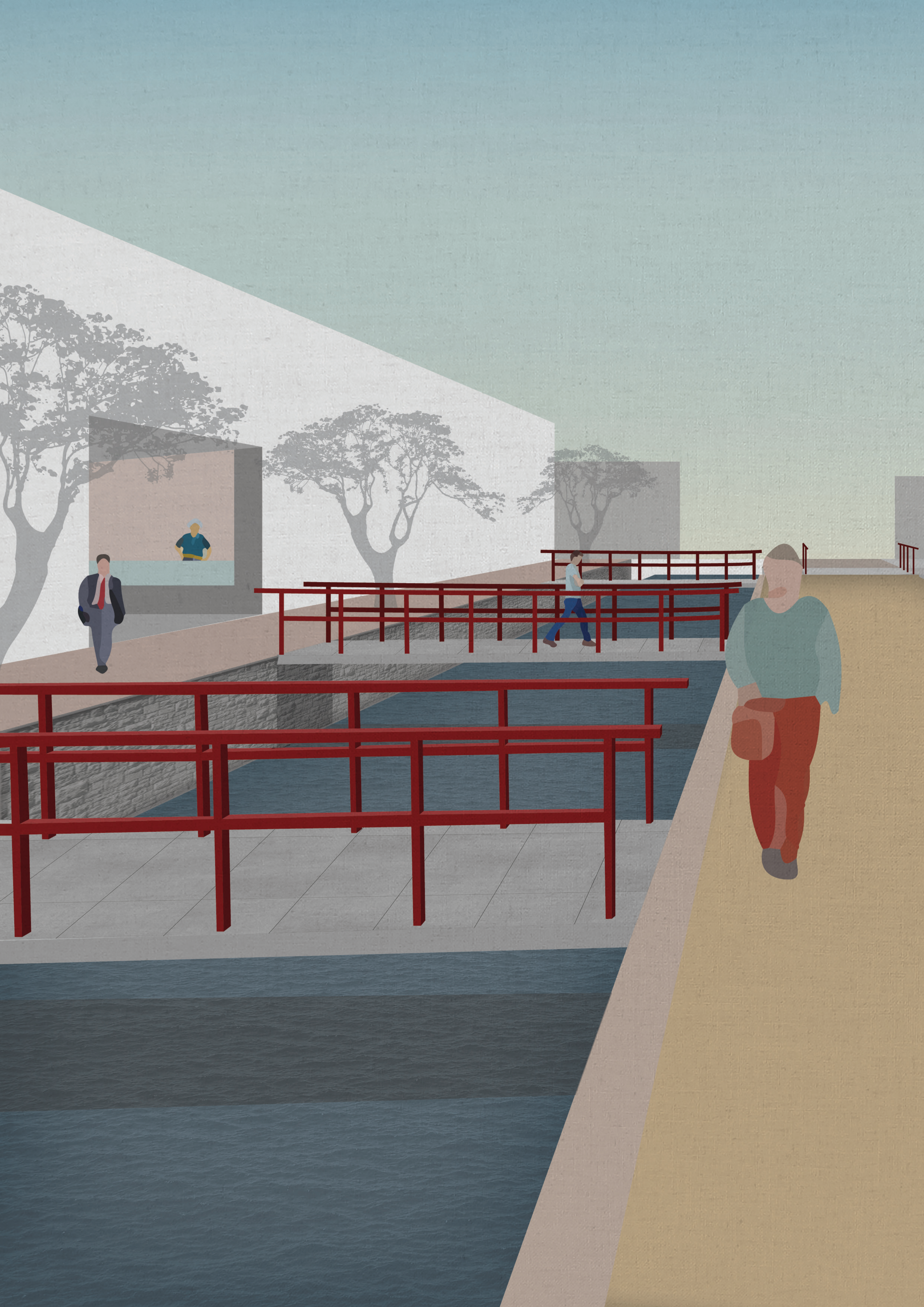
Integration of water in paved areas

figure 103.   Undeep water causes sound and visual effects. Author

figure 104.   Multifunctional use of the canals. Author

figure 105. Bridges to acces buildings. Author

figure 106. Above surface drainage of rainwater. Author



CONCLUSION

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Conclusion

Reflection

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Conclusion

Japan has a vast history of earthquake and tsunami disasters that Japan had to cope with, the country can be defined as a disaster society. The most recent disaster, The Great East Japan Earthquake, resulted in a tsunami which had a devastating effect on the coastal regions of Tohoku. However, these crisis situations also offer a potential for implementing innovative concepts and strategies regarding disaster recovery. Developing for the future comes with many uncertainties which requires the strengthening of the capacity to adapt. Therefore, long term planning is crucial where one should keep in mind that disasters cannot always be prevented. After the 3.11 tsunami the road to recovery started in the affected regions. Currently, the reconstruction process can be defined as Traditional Urban Recovery (TUR) where the focus lies on recovering what was there before as a result of trauma among the affected people. When taking surveys by the government they mainly aimed to find out what people needed rather than what they wanted. This shows that there is a very practical approach towards the recovery process. In addition, during the recovery process mainly hard engineered civil constructions were used to protect against the water, which again is a practical approach to the opposed problems.

There are multiple governmental documents about the policies for after the 3.11 disaster. However, most of these documents lack visual representation which makes it more difficult to communicate the policies to the involved parties. Furthermore, there is a missing link between layers of governmental bodies. Most of the decision making is done top-down from the national government. This creates For example, the national government already implemented construction works such as the sea embankment before municipalities could react to these plans. This resulted in the construction of the sea embankment in places that were not necessary. To prevent this in the future a transition is made towards municipality driven reconstruction because it is the residents who are closest to their communities and understand local characteristics best. However, the national government should set the overall policy for reconstruction, including a vision, ideals, and types of assistance.

There is a need for change from Traditional Urban Recovery to a new concept, Modern Urban Renewal (MUR). MUR in the context of Japan is defined as a combination of multiple concepts and topics that are systematically integrated together and strengthened by the community providing balance between water

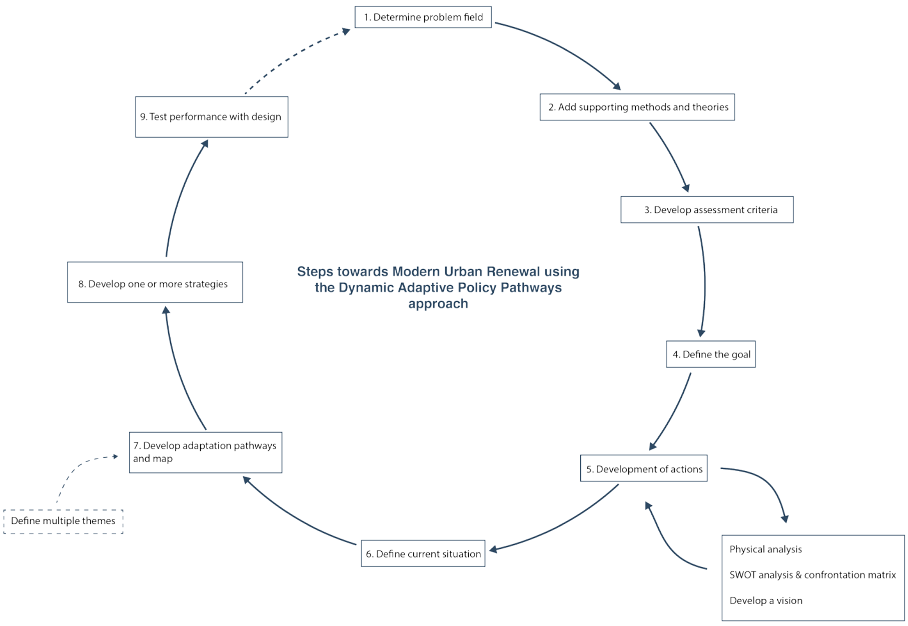

figure 107.   Steps to reach Modern Urban Renewal. Author

and land. These include four topics: physical living quality, environment, energy, and tsunami resilience. Although each of these concepts alone could be innovating when used during the reconstruction process, only when combined together and providing a balance between land and water MUR can be achieved. Defining MUR alone is not enough to be able to shift from TUR towards MUR. And with the increasing amount of uncertainties a guiding framework is needed which results in the research question of this thesis:

How to shift from Traditional Urban Recovery towards Modern Urban Renewal after a tsunami disaster in coastal cities of Japan?

The research project is using the Dynamic Adaptation Policy Pathway (DAPP) approach as guiding method in order to shift from TUR towards MUR or learn how to directly implement MUR after a disaster. In order to strengthen this approach a set of supplementing methods is chosen. Two methods in particular proved to be very useful in this process. The first method is the multidisciplinary approach. By using the expertise of the various disciplines more substantiated information could be integrated in the process. The second method is the SWOT (strengths, weaknesses, opportunities, and threats) analysis combined with the confrontation matrix. This method is used in order to translate the information from the spatial analysis to a vision for Natori and the development of actions that help reach MUR.

The DAPP approach is developed for dealing with uncertainties in the field of water management. When testing this method to the case of Yuriage it appeared to be not possible to directly apply this method for two reasons. Firstly, the complexity that is involved in the process requires sub-goals that combined reach the end goal, which was MUR. This resulted in having four themes in the DAPP map each with its specific goal. This difference can be illustrated by comparing the process with a water management project. For example, the problem of water pollution. In this situation there are multiple actions that can be taken in order to clean the water, but only on action is needed to reach the goal which is clean water. When looking at the problem field in Yuriage, many different problems occur of which each has their separate solutions. This brings us to the second challenge when using this method in the field of Urban Design, the sequence of actions.

The DAPP approach is used to get a clear overview of the actions that can be taken and is using one action as starting point. When that action cannot meet the requirements of the goal there is a possibility to shift to another action which in those new circumstances is still able to reach the desired goal, resulting in a sequence of actions. However, as a spatial planner it is more likely to initiate multiple actions simultaneously which will accelerate the path toward the final goal. This is reflected in the DAPP map developed for Yuriage. Multiple pathways were established that could run in parallel with each other in order to reach MUR.
By making changes to the approach, but still using the core principle of the DAPP approach it proved to be useful as a tool in the decision making process and to get a clear overview of the various strategies that could be applied. Furthermore, the DAPP map gave clear insights about potential links between different actions and as a spatial planner using the DAPP in this manner helped finding connections where actions could strengthen each other. The changes made to the approach from the urban design perspective resulted in a new step by step guide how to apply this approach illustrated in figure 106.

Although the DAPP approach was slightly changed for this project it would be interesting in further research to develop this method in a way that it can be directly applied in the field of other disciplines. This will enhance the decision making process and create bridges between multiple disciplines when using the same method. Furthermore, the research project focused mainly on physical solutions rather than policies that can be used to reach the end goal. This is an important layer in the development of a successful strategy and in should be a part in the research process.

Reflection

Relation between graduation project topic, the studio topic, master track and master programme

The master track Delta Interventions is a multidisciplinary research program of the Department of Urbanism. The studio explores the possibilities to combine flood protection and water management strategies with urban design, landscape design and spatial planning. In addition, the studio develops design and planning approaches and methods which contribute to make urban delta landscapes more sustainable, attractive and adaptive (D-I, 2018). The above text is from the introduction manual of the master track Delta Interventions and explains what the focus is of this studio. There are three main categories that can be derived from this: Delta landscapes, multidisciplinary working and sustainability. My research project also has these three focuses integrated through the whole process. The 2011 tsunami hit the east coast delta region of Japan which is the area of research for this project. In order to get good understanding of the problem field and possible solutions a multidisciplinary approach is used. The five disciplines involved are Transportation, Hydraulics, Geotechnics, Water Management and Urbanism. Due to the increased amount of uncertainties in the future it is important to use a sustainable strategy that can cope with changes or unexpected events in the future. For this the Dynamic Adaptation Policy Pathway approach is used in this research project. This approach helps to develop an adaptive strategy that can cope with unexpected changes in the future and therefore, becomes more sustainable.

The relation between the methodical approach of the graduation lab and the chosen method in the developed framework

The Delta Interventions studio covers a few theories and methods to work towards a sustainable future for delta regions. A strong focus is put in the relationship of landscape and urbanizing the delta. In the case of Japan the relationship with nature is broken by the response on the tsunami which has a negative impact on the adaptive capabilities of the delta. Therefore, theories such as Dynamic Adaptation, Landscape Urbanism, Water Sensitive Design and flood risk management that are covered in the graduation lab are used in the project. The first main method that is used in the research is the Dynamic Adaptation Policy Pathway approach (DAPP). The theories and methods from the graduation lab are used in two ways. The first one is to supplement the DAPP with the theories of the graduation lab. Secondly, in order to develop the content that is put into the DAPP theories and methods such as the SWOT-analysis, system thinking and site specificity are used. The second main method is the multidisciplinary approach. Multiple disciplines form the foundation in for a recovery project after a tsunami or any other water related project. Topics such as the subsurface, evacuation strategies and tsunami mitigation measures will be discussed because of this set of disciplines. It is then the challenge to integrate the combined knowledge in a strategy. Working with experts that have views and backgrounds substantiates the decisions that are made throughout the research and increases the chances of a successful strategy. Therefore, a workshop was organized that took place in Japan with the five disciplines mentioned above. This workshop set the starting point for this thesis and was the place where Modern Urban Renewal was mentioned for the first time. Furthermore, the workshop provided a clear indication what your relation was with the other disciplines and how they could help you and how you could assist them further in the research process.

The relationship between research and design

The developed research framework proved to be a strong tool for the translation to the design. The analysis of the dynamics of Japan provided the first insights of the problem field and the ongoing trends in Japan. In addition, two important elements were found that set the first requirements to which the design should meet. The first was the strong identity that every region of Japan has, and in the case of Miyagi fisheries were an important part. Secondly, the balance between water and land that got broken by the measurements taken against the tsunami. By exploring the Miyagi prefecture through the scales, the processes of reconstruction and the physical characteristics of the prefecture were researched. Whereas the larger scale had the focus on processes that were happening in the prefecture (potentials and threats), the lower scales put the focus on physical strengths and weaknesses. By using the SWOT analysis these findings were linked together and formed the input for the main method, the Dynamic Adaptive Policy Pathway approach. This became essentially a collection of all the research that had been done. And by choosing the most suitable pathways in order to reach the desired goal, the phasing and design components were decided. Therefore, the DAPP is a translation of the research, and the design a translation of the DAPP. When performed correctly, the goal of Modern Urban Renewal is achieved.

Transferability of the project results

Due to the fact that the outcome of the DAPP is very site specific the results of the project itself can only function as an example or inspiration for other projects. But, as mentioned in the relationship between research and design, the research results provide a clear step by step framework that can help guide a project when dealing with uncertainties. For this project a selection of methods was chosen that complement the setting of the research. With projects not related to uncertainty or a focus on a balance between land and water the choice of methods could be different. However, choosing the proper methods to strengthen the DAPP can be implemented in the framework as one of the steps to take.

Societal and scientific relevance

As sea level rises the need for protection against the water rises with it. There is an increased amount of storms and cloudburst which causes more floods. These trends caused climate change to move to the forefront of the global agenda. Therefore, it is important to plan and design delta cities in ways that increases their water resilience and tsunami mitigation capacities. This thesis project contributes to the relation between engineering, design and ecological studies in a systematic framework for reconstruction approaches.

Many studies exist in the field of urban resilience and adaptivity. However, research on how to implement these concepts in a flexible design process is still limited. The future is unpredictable and in many occasions differs from the constructed scenarios. The Dynamic Adaptive Pathway (DAPP) approach is a newly developed method to provide a systemic framework for future developments. By providing multiple timelines and actions to reach the desirable future chances that a project will succeed is greatly increased. In addition, this research explores other methods to supplement the DAPP approach in order to create a robust framework for redevelopment after a tsunami disaster.

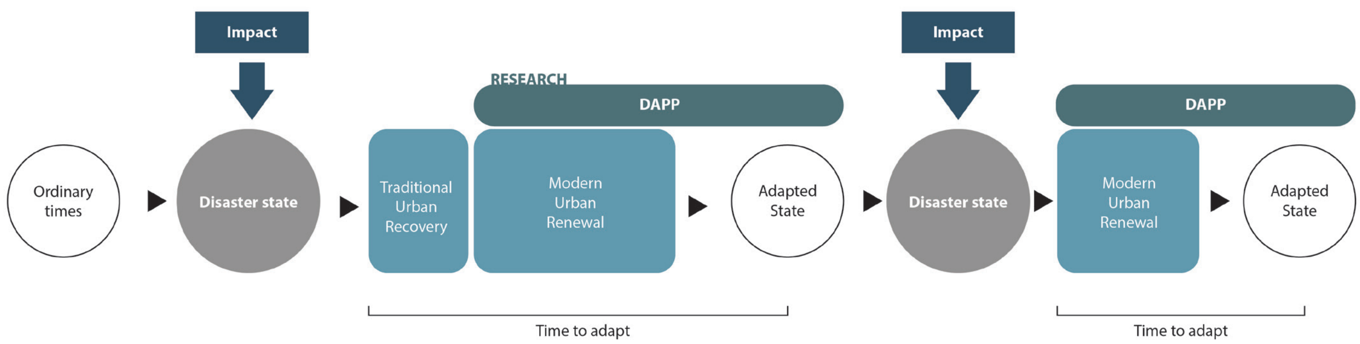

figure 108. DAPP can be used to reach MUR more effectively.author

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APPENDIX

水一

A. Maps
B. Case studies
C. Interviews
D. Workshop

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A. Maps

appendix A figure 1. Soil of Japan

SOIL

The main soil types of Japan are shown in this map. The plains in the Miyagi prefecture consist mostly out of fluvic soils which received fresh material from the sea over time. Interesting to see are the soil temperature differences in the south (warm) and the north (cold). This can effect the way the soil is used.

appendix A figure 2. Sedimentation

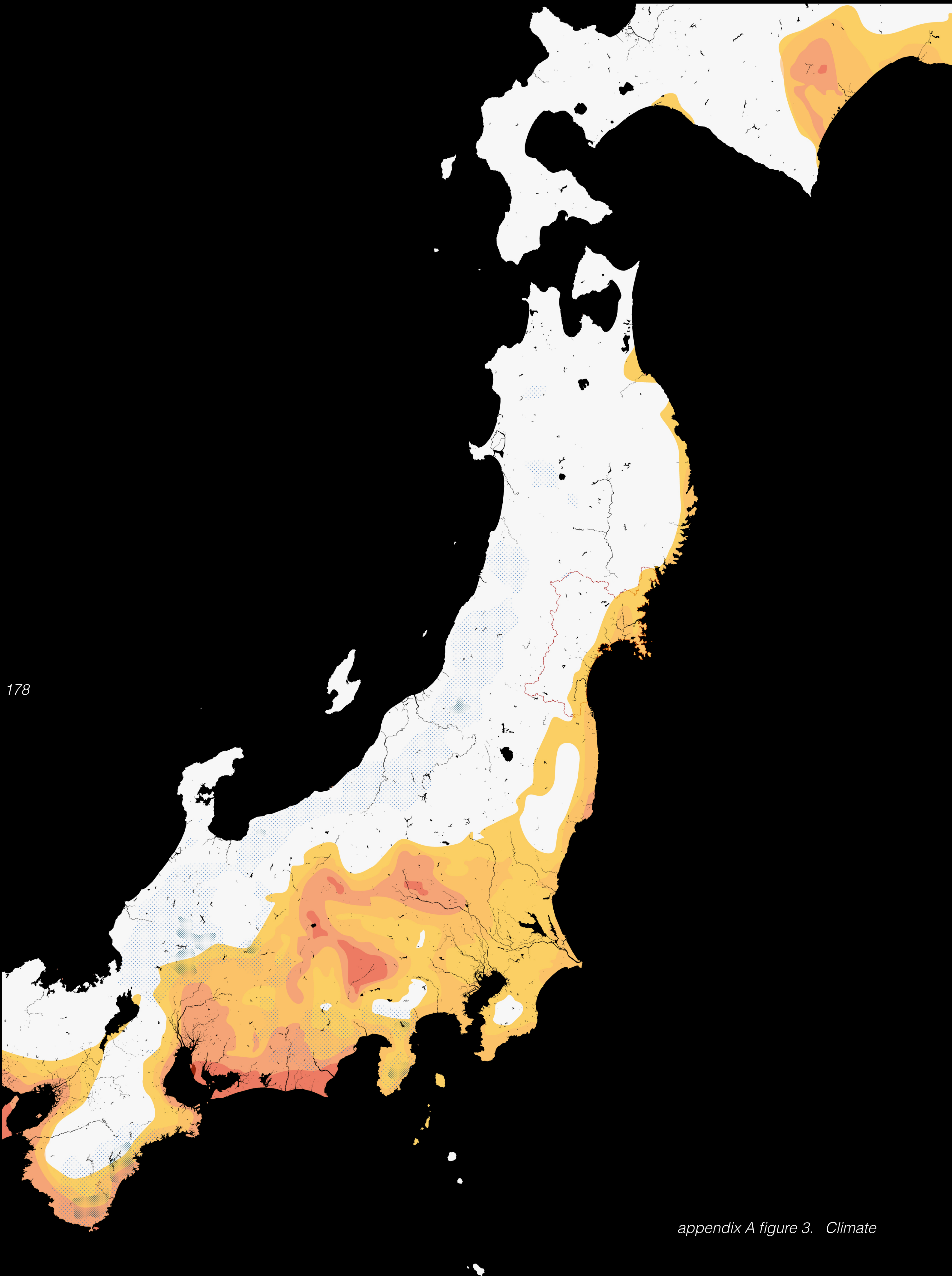
Sedimentation

The Sendai Bay is mainly filled with layers of sand & gravelly sand. Due to the rocky characteristics of the Ria Coastline north of Sendai there is more gravel and rock sedimentation at the northern part of the Sendai Bay. The coarsest sediments are mainly on the pacific side, whereas the finer are on the inland.

Type

- Muddy sand - Silt
- Gravel & rock
- Sand & gravilly sand
- Sand, gravel, mud, calc. ooze
- Brown, red-brown mud
- Sand, gravel, mud, rock
- Gray, green, blue mud
- Muddy sand & gravel

100 KM



appendix A figure 3. Climate

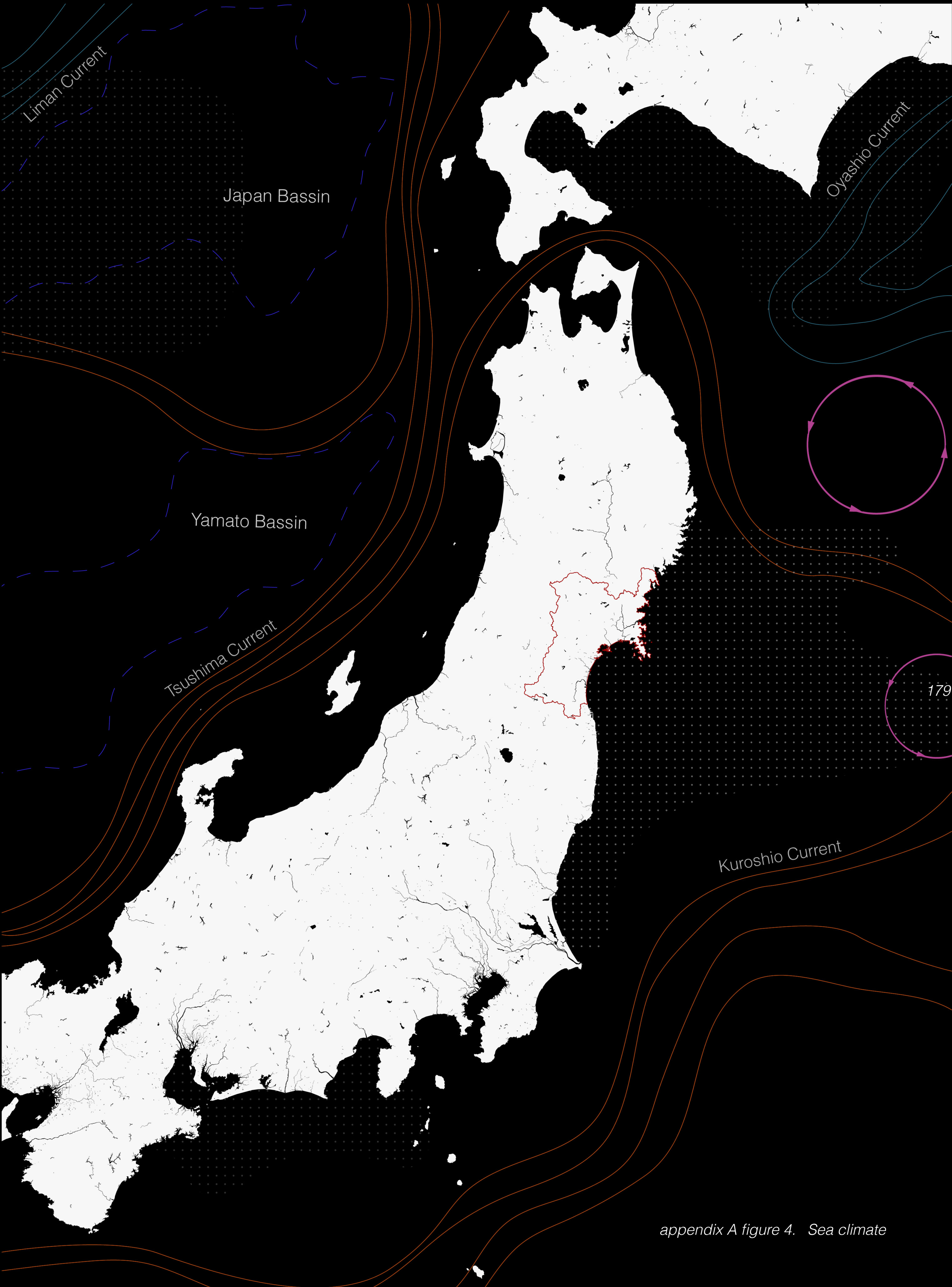
CLIMATE

There is a clear distinction between the climate of Japan. The west of Japan receives the most sun hours and reaches the highest temperatures. Whereas the east side of Japan receives the most precipitation. At some points even around 4000 a year which is almost double of the world average.

Precipitation per year
- 3500 - 4000
- 3000 - 3500

Sun hours per year
- 2200
- 2100
- 2000
- 1900

100 KM



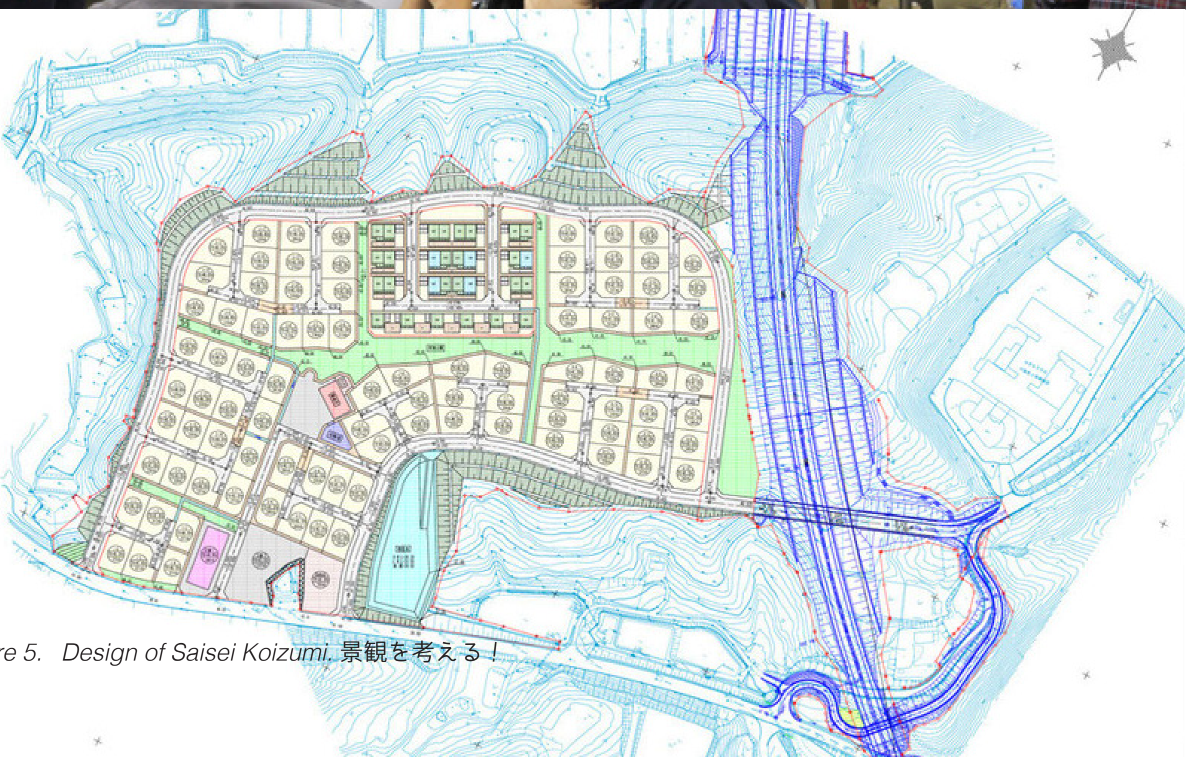
appendix A figure 4. Sea climate

SEA CLIMATE

Warm and cold ocean currents collide off the coast of Japan, creating a wide variety of temperatures. The result is a series of different marine communities. Where the currents collide, nutrients from cold water feed warm-water phytoplankton. Resulting in a eutrophic body of water that attracts lots of fish.

Currents
- Warm current
- Cold current
- Eutrophic area
- Eddy

100 KM



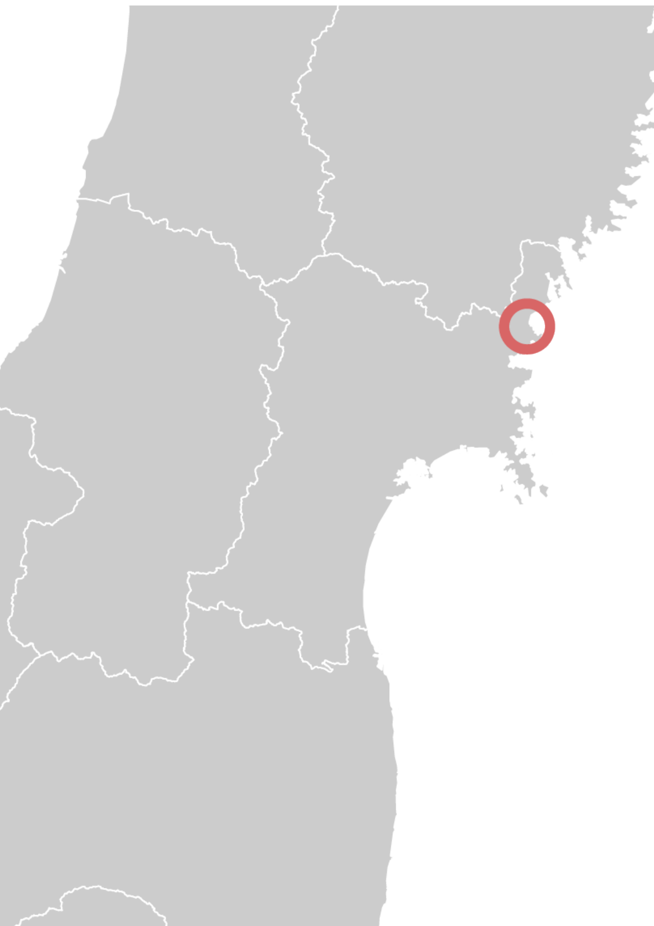
appendix B figure 5. Design of Saisei Koizumi. 景観を考える！

B. Case Studies

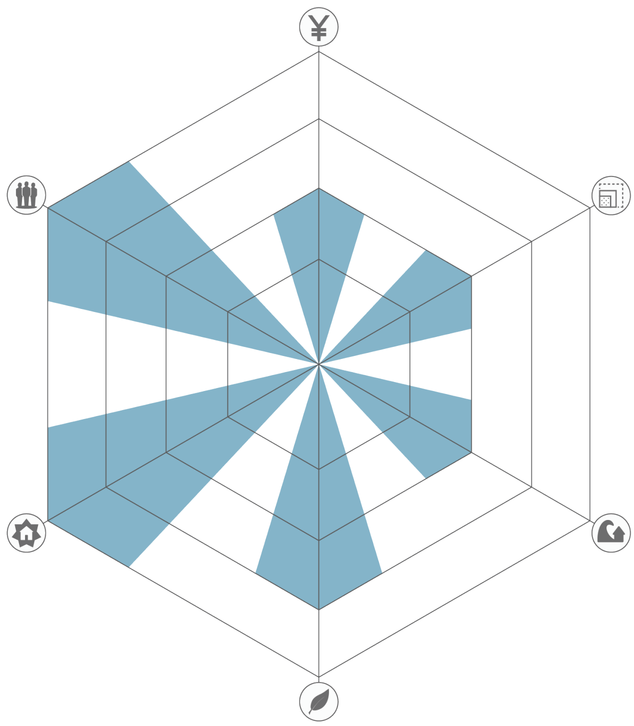
Saisei Koizumi

People - Town - Nature

Residents in a disaster-struck Koizumi district of Kesennuma submitted their own relocation plan to the local municipal government, an action that could become a model for other affected areas. Residents in the city's Koizumi district completed the plan based on many discussions and study sessions. A total of 20 sessions were held each with a specific theme such as 'land revival!', 'Think about the landscape and 'creating an attractive city!'. During these sessions the needs from the participants were discussed together with professionals. However, different from traditional surveys that only ask for the needs of people, the meetings of the Koizumi also took the wishes of new residents into account. Topics like secure energy network during emergencies, promenade that functions as a refuge, a child's playground to make the city a place where children can play were discussed. The design took the 'New Town Development' as leading concept where car and pedestrian flows are separated and roadways are kept to the minimum. The town will have meeting places, community spaces and public housing in the center of the plan. The layout of the design has a clear evacuation route for in case of an emergency. In addition, land is added around the town to increase safety. Apart from these measures no other tsunami mitigation measures were taken here. This makes sense because the main strategy was relocation which already minimized the risk of a tsunami disaster. Only threats such as earthquakes, flooding by heavy rainfall and landslides pose a risk to the town. After two years of preparing construction started and three years later the first houses were built. With the intensive collaboration with future residents a design has been made that strengthen the sense of community and is very people oriented. However, this approach also caused a long and extensive process forcing a lot of people to live in temporary housing for many years. A lot of attention was given to the living quality of the people and the relationship with nature. In one of the meetings with the theme 'Think about the Landscape!' topics were discussed regarding tree species, unification of flowers and materials used for buildings and street furniture. Al these sessions resulted in a thorough design of a New Town Development with a strong community ("こいずみブログ").



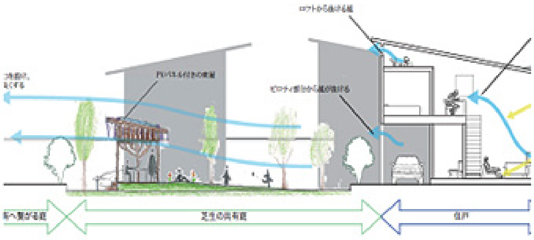
appendix B figure 6.   Location of the project. Author

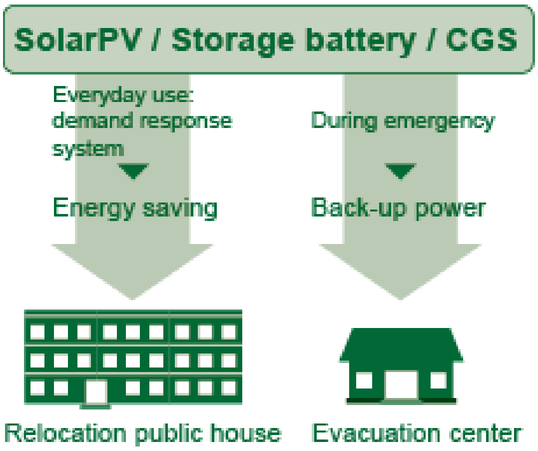


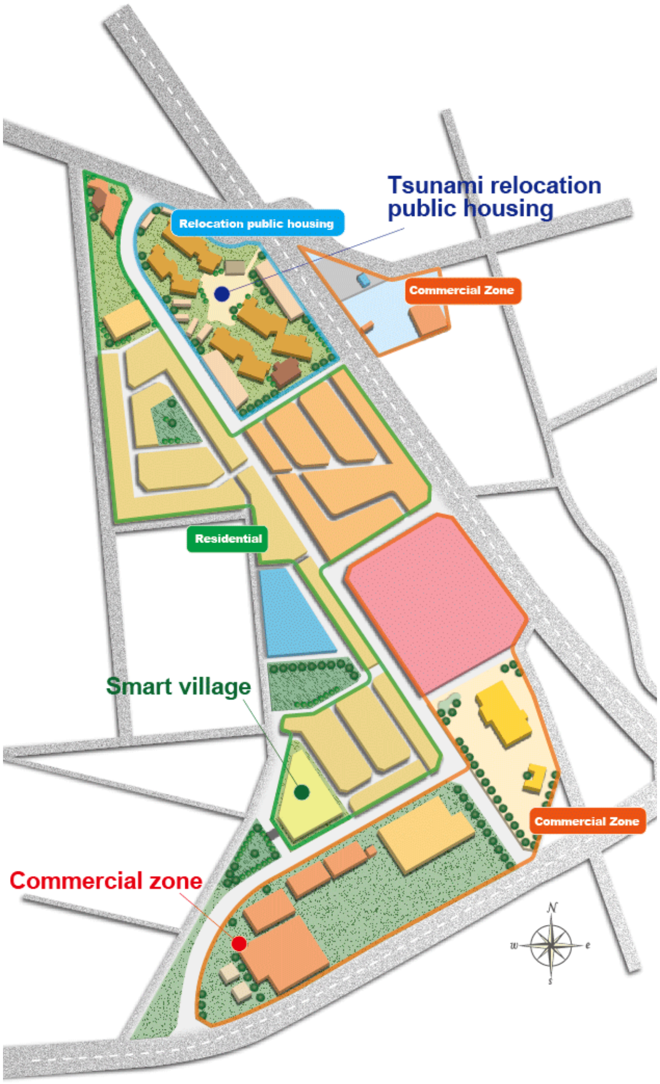
Actors

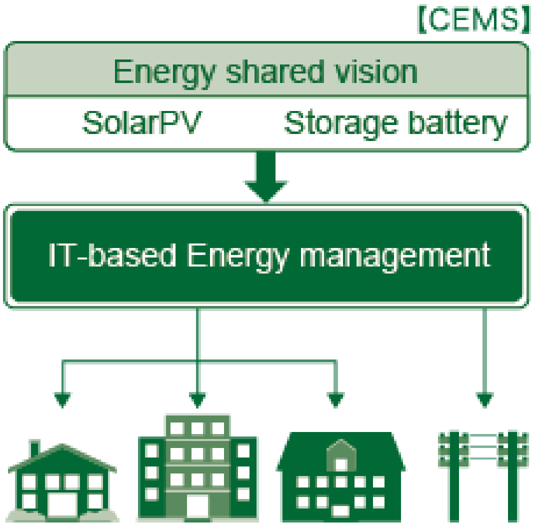
Suguro Mori
Hokkaido University
Future residents

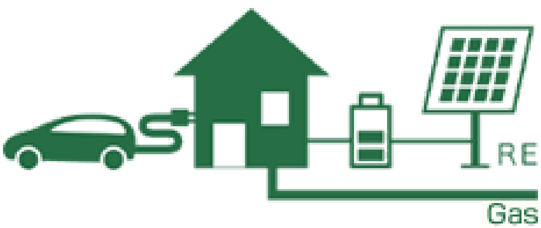
appendix B figure 7.   Assesment on themes. Author











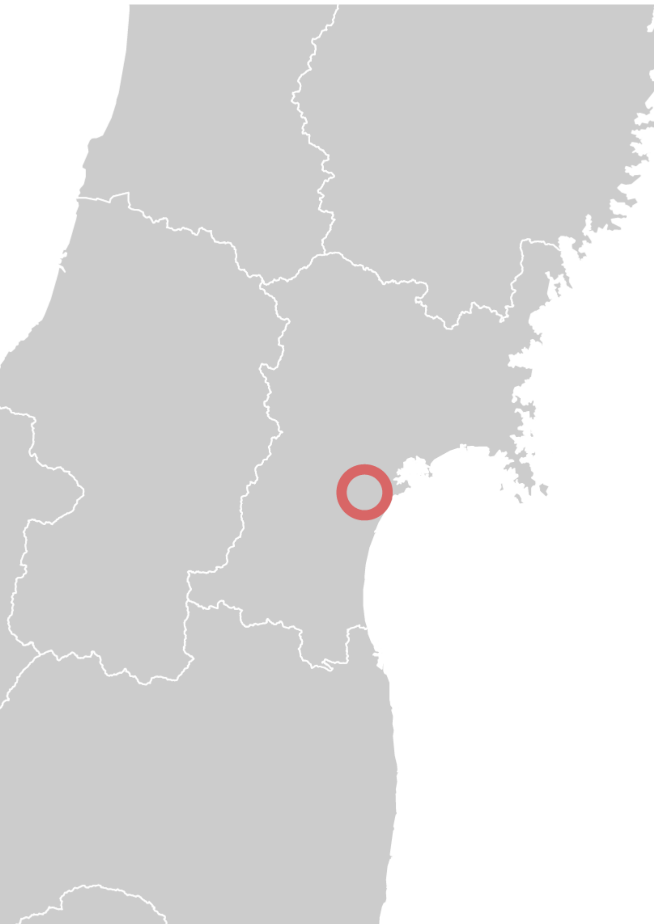
appendix B figure 8. Design principles of the Green community. Green Community TAGONISHI

Taganishi

Green Community

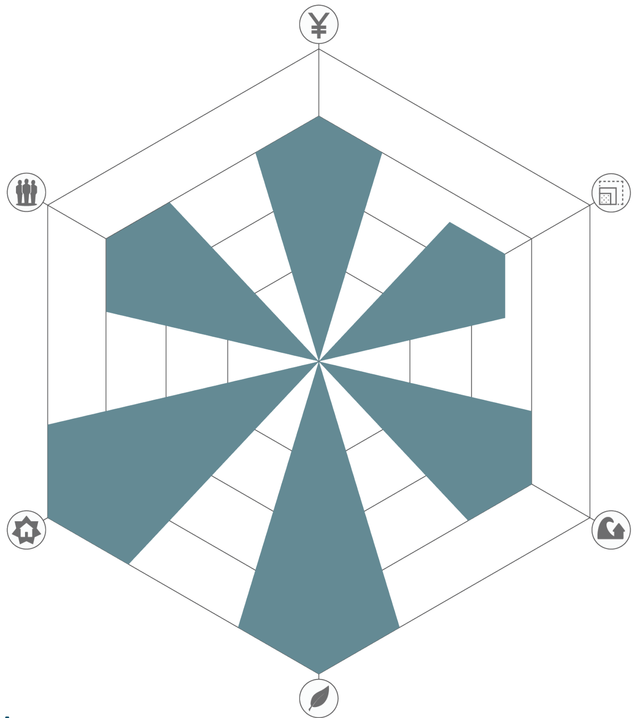
The green community project already started before the 3.11 tsunami as an Eco-Town city with the aim to maximize energy efficiency and bringing a new level of comfort to the living experience. Due to the evens of the tsunami they added a new perspective to the design, making the community disaster resilient.

The design is based on four concepts that aim to bring comfort and safety to a new level. The four concepts are 1) reducing energy consumption, 2) setting the stage for safe, secure and comfortable living, 3) harmony with nature, and 4) disaster resilient urban infrastructure. Although the town was not affected by the earthquake, tsunami or through liquefaction they were still included in Sendai City's Earthquake Disaster Reconstruction Plan as a model town. This means that this project should form an example for other projects in Japan. The north part of the plan will develop tsunami relocation public housing for the people that got affected by the 3.11 tsunami. These will be four medium-rise blocks that are centered around a green inner court. The blocks will be connected with pathways and public spaces to a network of houses.



appendix B figure 9. Location of the project. Author

The public space and blocks are designed in a way that communication in the community enhances. The common areas have a lot of greenery to increase the physical living quality of the city. The project integrates advanced renewable energy systems that combine solar power and gas cogeneration systems. Through a collaboration with multiple companies and the Tohoku University an environmentally-friendly and technologically advanced community is developed. The tsunami relocation blocks will have storage batteries to create a consistency in energy supply and provide energy in case of an emergency. Two research projects were established to explore the possibilities for a sustainable smart city. The first research team, Sustainable Urban Redevelopment, investigate innovative solutions for disaster-resilient, low-carbon community development. Concepts such as electric bike- and vehicle sharing are implemented and create buildings that make the most of nature by implementing greenery and making use of wind and natural light. The second research team, Dissemination of the Smart Community Concept, will work towards advanced communities by researching environmentally-friendly smart housing and systems that use storage batteries ("Green Community TAGONISHI | Kokusai Kogyo Co., Ltd.").



Actors

Kokusai Kogyo Corporation
Miyagi Prefecture
Sendai City
Tohoku University
Land owners

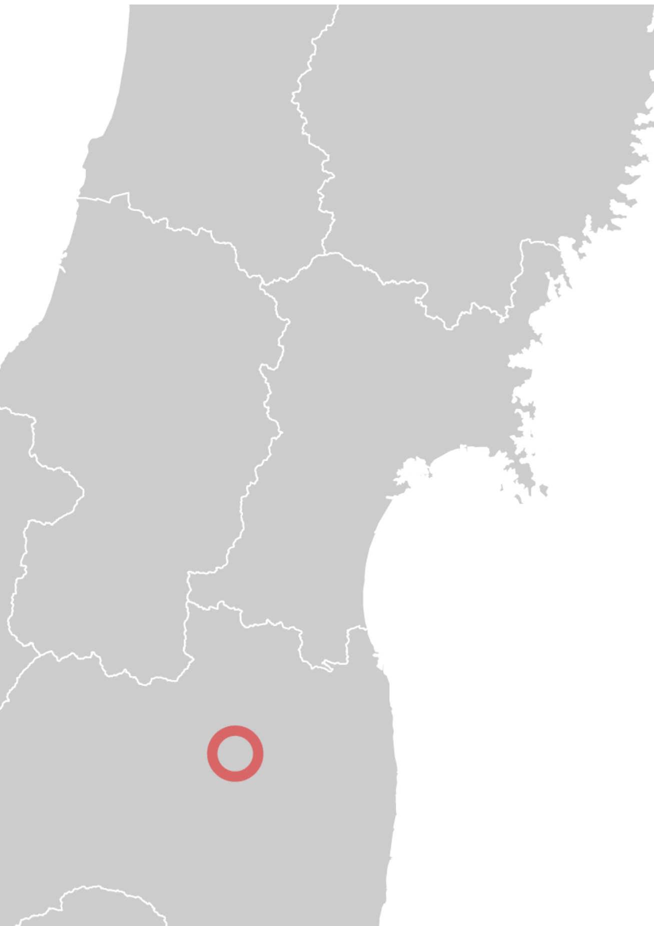
appendix B figure 10. Assesment on themes. Author

appendix A figure 11. Design of the Koriyama Project. 級建築士事務所はりゅうウッドスタジオ　郡山プロジェクト

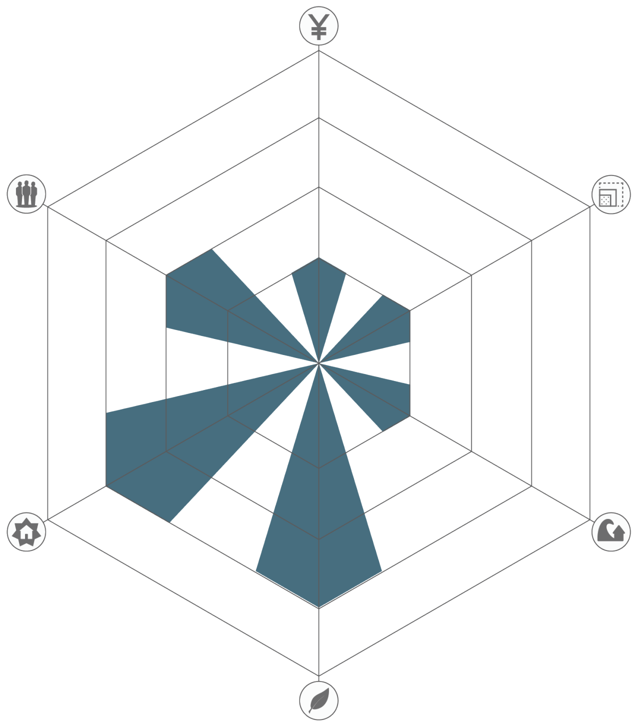
Koriyama Project

Wooden housing

The city of Koriyama recently put focus towards a transition from a city of power generation to a city of renewable energy and medical devices. Since Koriyama is one of the biggest cities in the Fukushima prefecture it was dependent to the Daiichi nuclear power plant. After the disaster the urge to develop towards a more sustainable source of energy and environmentally approach was therefore started. With this new development multiple good practices were developed of which the wooden reconstruction housing was one of them. It is a small scale project that aims to create inexpensive, environmentally friendly reconstruction housing. The plan consists of three buildings each designed by a different design studio. The Nanba Building, Shimakage Building and Studio building were completed exactly two years after the disaster. The buildings had to meet four conditions: 1) It had to be made of wooden materials, 2) the house is easy to disassemble and transport to another location, 3) the buildings have to be inexpensive, and 4) the building is based on an environmental friendly philosophy. After the construction they will serve as an exhibition hall on how to construct cheap and sustainable housing and form the base for the "NPO Fukushima Daimyo Town Planning Network". The main purpose of this organization is to provide support for the town planning of municipalities within the Fukushima prefecture to rebuild housing for evacuees. As a model for disaster public housing the small detached houses were seen as most fit. The reason for this is that the studios state that many evacuees are seeking detached houses that with low maintenance. In the future the three buildings will be used for housing when the concept is implemented at more locations in the city (" 一級建築士事務所はりゅうウッドスタジオ　郡山プロジェクト").



appendix B figure 12.　Location of the project. Author



Actors

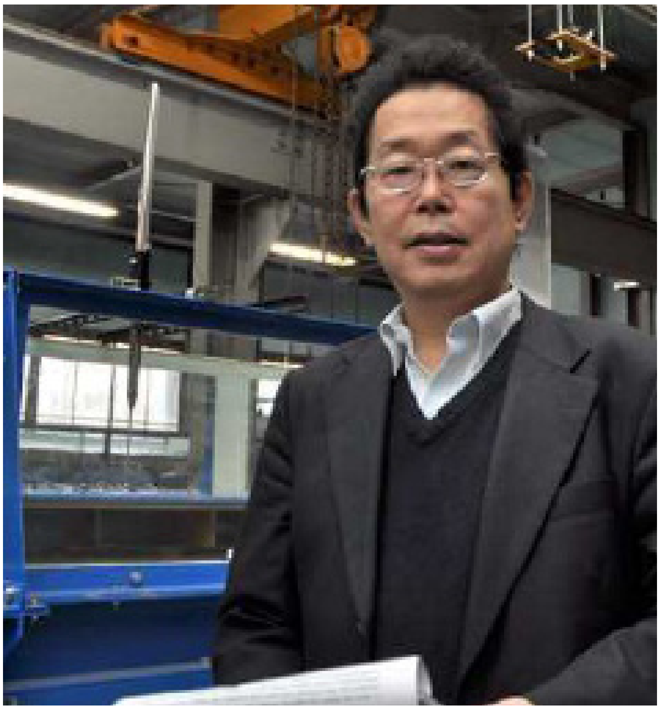
Kazuhiko Namba + Kai Kosakusya
Kenichi Shimakage / Kenchiku Koubou
Sachiko Yagi / studio Nasca + Nihon University
Urate Tomoyoshi Lab + Haryu Wood studio

appendix B figure 13.　Assesment on themes. Author

C. Interviews

Norio Tanaka

Profession: Landscape and Ecological Engineering
Specializes in bioshields in tsunami prone areas.
University: Saitama University
Date of interview: 7 november
Location: Tokyo



URB/ HYD: In tsunami defence there is a balance in hard and soft solutions. What is your opinion in the current situation and future plans for the Miyagi?

Japan had to cope with tsunami heights of 30 meter. As it happened in the past it will also happen in the future.

Two categories:
lvl 1 tsunami 1 - 100 protect houses etc
lvl 2 tsunami 100 - 1000 -> needs mitigation

Even with the walls the tsunami will have the same effect and result as the last tsunami. Therefore there is the need of sand dunes with coastal forests behind the embankments.

When the tree crown is too high the trunk will break and become a projectile. But when the tree crown is low, the tree will stay put in the ground and not break, therefore not becoming a projectile.

At the moment Norio works on a project in Hokkaido about the height of tree crowns and the effect during a tsunami. Together with this project there he investigates how much the forest width should be for optimal mitigation and utilize trapping functions.

As a reaction on the Great wall of Japan:
Hokkaido project-> They want to increase green belt, but don't have an embankment for second protection. The forest only functions to hold back the salt air from the sea. A better solution is to create a hybrid system with an embankment and forest together.
URB: It has been pointed out that the ability of communities to prevent disasters has declined as nuclear families increased, traditional communities declined and solitary, live-alone old people increased. How do you see the role of communities in mitigating tsunami impacts when this trend continues?
shifts more towards government role -> help increase the appeal of the mitigation forests.

URB: Lots of defence methods affect the natural functioning of an landscape. (Raising soil in a flat landscape affects the natural functioning of such land introducing foreign trees to forest is affecting the natural habitat) What is your opinion the connection of Japanese methods and their connection to nature?

Different species is important for biodiversity. Right now they only use (Rhizophora).
Natural forest can provide the right resistance -> and only use species from Japan

GEO: We can conclude that the soil has been affected (salty) by the tsunami how should this be restored to create a good base for the forests?

Heavy rain causes salty ground to clean up. Salt spray in air is a more urgent problem for creating healthy forest.
you need to combine forest with embankment to protect forest
Use embankment to protect forest if the forest gets too much salt damage 4-5 meters in Hokkaido. Sendai maybe 7-10 meter

Transport: When looking at the reconstruction of the area in its entirety, what had the highest priority? (Is a lot of research done prior to the rebuilding?)

It is a question on how to reduce exposure to the dangers of a tsunami. Japanese have high risk areas appointed in coastal areas to make road as second embankment in Sendai.

Transport: What is in your opinion the most effective strategy to reduce risk in the area? (So if you have all the money in the world, what would you do in the region?)
big natural forest at coast and make paddy field a lagoon again, and have embankments at the end. At the shore only natural zone

Overall: What will be the biggest challenge/change for the coming years the Japanese coast have to deal with?
discuss more about compact city, make more natural buffer zone (because of shrinking)

Overall: Our group is handling this challenge interdisciplinary, how is your experience in your field? And what disciplines do you tend to work with often?
Work together with forestry, but outside japan or other projects only with civil engineer
Gives better result when working together because generates more ideas
Norio works with hydraulics, geo, forest in the Hokkaido project

Makoto Okumura

Profession: Human and Social Response Research
Specializes in bioshields in tsunami prone areas.
University: Tohoku University
Date of interview: 7 november
Location: Sendai

The first part of the interview consisted of professor Okumura explaining more about the disaster and the area. The second part consisted of more specific questions and answers.

Natori
Immediately after the GEJE, there was congestion between the location shelters. Due to the relatively large amount of people who drowned in their cars, the government has put a ban on evacuating by car when a tsunami warning is issued.

Natori is a commuting town, people live here, but work in Sendai. It is very car based, there used to be a special bus service before the GEJE to bring people to the city center and the shopping mall. The service was cancelled after a relatively short time. Yuriage is the nearest port in the area, people who live their either work in the fishing industry or also commute to Sendai. Traffic is also generated in the other direction by the fishing market in Yuriage. Natori was also damaged by the earthquake and tsunami. The reconstruction of this area focuses mainly on connecting Natori with Sendai. It is also possible to use different modes, Natori has a JR connection.

The increase in population in this area can be partially explained by the fact that people who were active in the fish industry in Fukushima became jobless after the nuclear power plant disaster, because no one wanted to eat the fish caught around Fukushima. These people moved to Sendai to live for jobs, but didn't want to cross the river, so they settled in Natori. The daily number of commuters increased as well, however congestion is not a problem since the roads were designed initially for larger numbers of people. The traffic mainly goes from north to south. The soil used for land elevation is coming from the west. The large and heavy vehicles are causing some traffic problems.

The area doesn't have a lot of heavy industries. The main industries are fishing and agriculture. In 2009 Toyota opened a new fabrication location north of Sendai. The local government promised good conditions and an expressway. They use the Sendai port for transport within Japan.

Impact of the disaster.
The earthquake damage was limited, the railways were already strengthened. The only problematic thing were the power supply lines hanging over the rail tracks. This was difficult to repair because it was hard to reach and there was a shortage of construction vehicles. The impact is also larger, because you cannot operate the network when part of the rail network is still destroyed. People in Tokyo were also affected by this and had difficulties getting home. Some railway stations had their power supply underground, they suffered damage from the water. It took until the end of April before everything was up and running. Also tunnels suffered damage either because of inundation, or because the tunnel blocks were slightly moved and had to be realigned.
Due to the power outages, it wasn't possible to process crude oil in order to make gasoline which caused a fuel shortage.

How long does it take to implement changes to the network/service structure?
It takes a long time. After the disaster the local offices had money from the national government, but they have sort of run out.
What is the relation between local and national governing and transport reconstruction?
Many small towns were affected by the tsunami. In these local governments not enough knowledge is available to plan all the reconstruction by themselves. Land use planning regulations/plans are made for a city scale, not for towns. The land re-adjustment plan was used for towns. The Ministry of Land, Infrastructure and Transportation sent specialists to different towns to make a plan on a local level. Also, the National agency of reconstruction implemented a policy which led to a tax raise for the coming years of 2 percent to fund projects for the rebuilding.

Another phenomenon that can be seen is the merging of towns. This already happened before the disaster. This has to do with the shrinking populations. Towns need to have enough people living in there in order to receive enough taxes. Towns already started to prepare for the shrinking trend before the disaster happened but there's no specific or nation wide policy for this. The local policies are based on the myth of increasing demand. Local governments believe that if they make their village attractive enough, the people will soon come to live there. However this doesn't happen and each town competes with each other for funding for projects.

In the rebuilding process for transportation, is resiliency considered?
Yes, but with resiliency they mean: resilient for the next tsunami. They plan everything in such a way that it should be able to withstand the next incoming tsunami. Other types of resiliency are not taken into account.

Is that the best way of planning in your opinion?
It's definitely not perfect but you cannot say you're against tsunami resiliency. However, the overall planning could be more efficient.

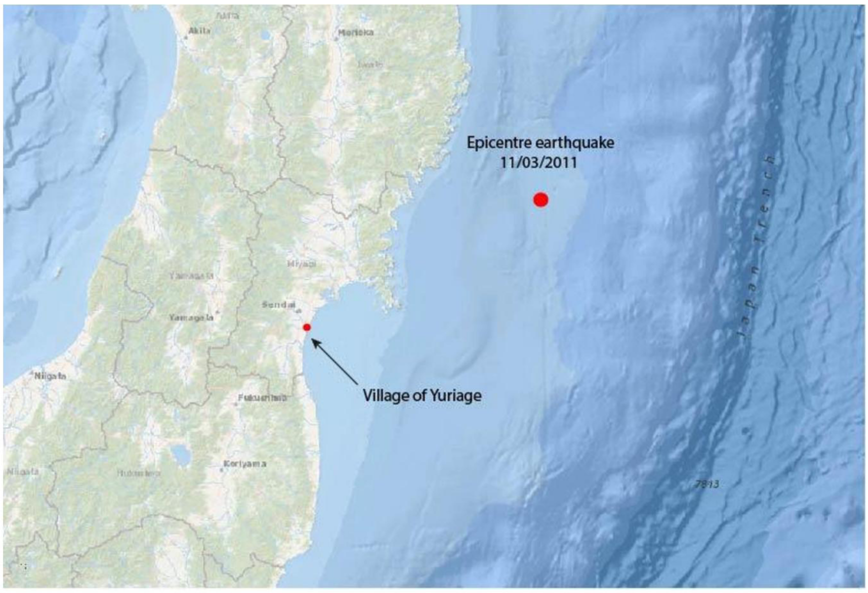
Do you think it would be possible to decrease the dependency on cars in the villages?
Yes it's possible, but it's extremely difficult. When the density increases it's easier but in reality the people in the villages live too widely spread. On top of that, the elevation differences in the land makes it difficult to plan certain transportation modes. In the past the local governments received subsidies in order to operate for instance a bus service, but this isn't the case anymore.

Do you think the overall mobility will decrease? (taking the reduced mobility of the elderly and the aging population into account?)
Yes. When planning for rail and bus services the access of the stations is often not taken into account. Elevation or simply the distance itself can be a problem for elderly. Automated driving vehicles could be a solution between station and home. But it could also run on the alignment of the former railway. AV is seen as a solution towards transport poverty.

D. Workshop

Introduction
Anticipating on the future is becomes more and more complex due to increasing uncertainties. How can we keep our communities resilient towards these unknowns? Working in a multidisciplinary set we can challenge these future prospects in an intertwined and comprehensive matter. It represents a new process for collaboratively researching, developing, and implementing ideas for a more resilient future. This is question also applies to our case we use in the workshop.

At 2:46PM Japan Standard Time (JST) on 11th March, 2011, an earthquake occurred in the Pacific, just off the coast of Japan. The earthquake resulted in a giant tsunami which caused a lot of damage in eastern Japan. The coastal communities especially in Iwate, Miyagi and Fukushima Prefectures were totally devastated. Next to the damage the earthquake and the tsunami created, the largest power plant of the east coast started to melt down causing a correlated triple disaster of an incomprehensible magnitude. Our workshop focused on the reconstruction of Yuriage, one of the coastal communities in the Miyagi prefecture. In our workshop we will be working in a group of 2 different faculties (Architecture and Civil Engineering) within these two faculties we introduce 5 departments : Hydraulic Engineering, Geo-Sciences and Engineering, Transport Infrastructure and Logistics (TIL), Urban Drainage Engineering, and Urbanism. All the students will be working from their own specialty on the same location with the theme of Tsunami resilience in Yuriage.



Workshop location (source: Author)

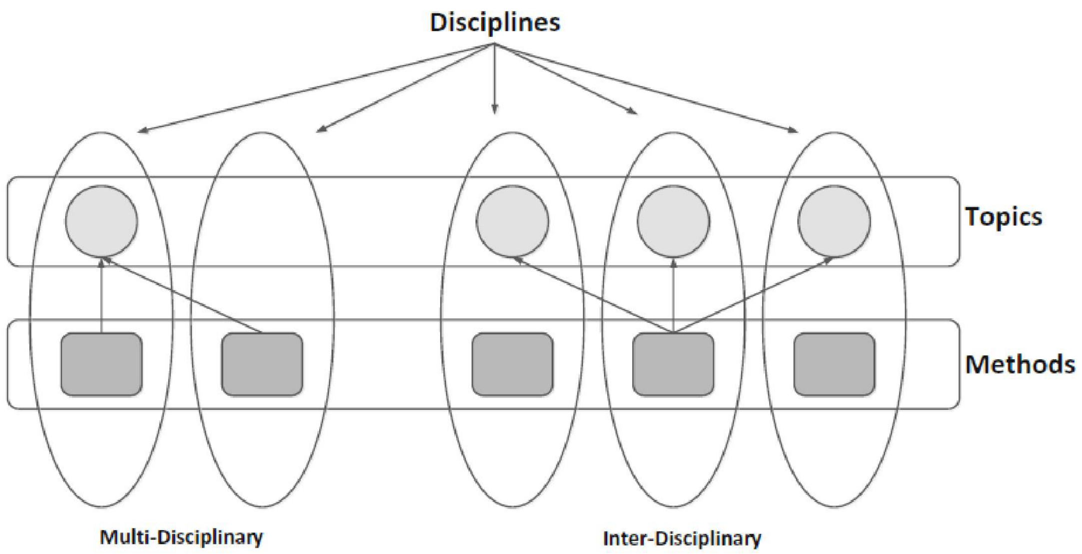
Students that participate: Xenofon Grigoris (Hydraulics); Jesse Dobbelsteen, Nasiem Vafa (Urbanism); Mustaqim and Femke van Overstraten Kruijsse (Geotechnics); Marieke van Dijk and Robert Moehring (Transportation); Sven Suijkens and Ainoa Areso (Water Management).

Professors that participate: Jeremy Bricker (Hydraulics), Fransje Hooimeijer (Urbanism), Adam Pel (Transportation) and Frans van de Ven (Water Management)

Damage of the tsunami in Yuriage (source: http://digelog.typepad.com)

Aim of the workshop:
Each discipline that joins the workshop has its own research topic, however, they share a common theme which is tsunami resilience in Japan. Each discipline perceives the opposed problems in a different way and implements different approaches due to their backgrounds. In order to benefit from each other's knowledge and views it is important to know what the relationship is between the disciplines and what they can offer. This results in the aim of the workshop where we try to develop a framework and workflow on how multiple disciplines can work together on the same case. We hope to get an understanding which disciplines have stronger relationships and in which part of the process they can benefit the most from each other.

Methodology
The students are all involved within the case area based on 2 drivers. One group of students use this case as a part of their graduation thesis. The other uses the location as part of their honours course. Placing the students within this context is a form of ''goal integration''. By giving the student each their chance to look at the location from their own perspective you provide them the chance to examine and learn several methods from different specialists within one topic/location. Resulting in a multidisciplinary workshop instead of an interdisciplinary one where the focus lies on transferring methods from one discipline to the topic of another discipline (Crowder, 2015). Buanes and Jentoft (2009) state in their research three main pillars in which aspects of a discipline can be categorized. The first is the regulative pillar that lays the focus on rules and standards for what defines a particular discipline. The second one is the cognitive pillar. This views disciplines as containers of knowledge. The third pillar focuses on the basic norms, values and world views that members of a discipline shares (Buanes & Jentoft, 2009). These pillars define the differences between disciplines and how they look at opposed problems.



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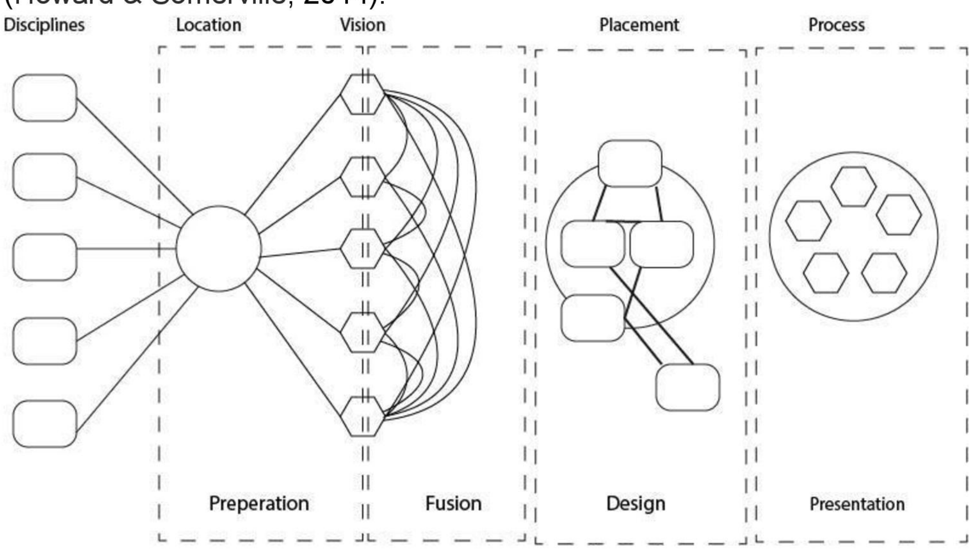
Type comparison (source: Multidisciplinary Systems Engineering (Crowder, 2015))

The other method we use during the workshop is the design charrette method. This method was used by Zhang and Mao (2015) during their case study in Fukushima. Their stages consisted of preparation, fusion, design and presentation. In the first stage the students where required per discipline to investigate the site based on their own methodological background, placing the location in their own perspective. In the second phase was encountering the perspectives in an information sharing setting by combining the disciplines in several group settings. The goal of this phase is to integrate and understand the wide scope of viewpoints and focuses of the disciplines. Maximizing the amount of group combinations insures that every student is aware of the demands and ideas of every discipline. In the design stage we place one student of every discipline in a group with the goal to fuse the desires of every group into a design that envisions the future of the location. Doing so one must place themselves within this design task to maximize the input of all the disciplines. In the last phase of presenting the groups show their, placements of the disciplines the process of decision making and the main elements resulted in the final design (Howard & Somerville, 2014).



Workshop methodology (source: Author)

Workshop phases

The workshop consists of four phases each focusing on a different part of the methodology described in the previous chapter:

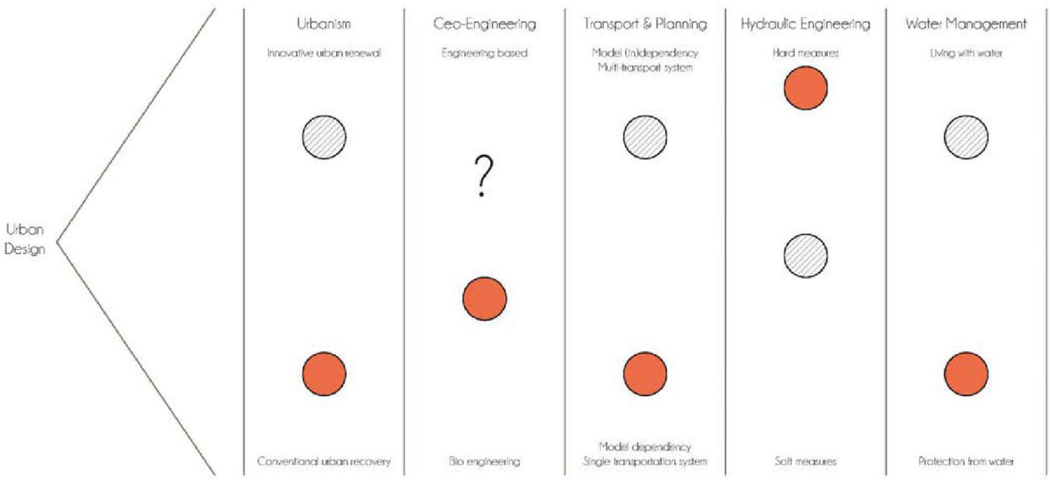
1. Each discipline decides their scope and where Yuriage is located on that scope.
2. Discuss the scopes together to understand each discipline's point of view.
3. Discuss which actions should be taken in order to move Yuriage to the most desirable place on the scopes.
4. Translate the discussion to a design for Yuriage.

These phases will help start discussions between the disciplines and guide them to design implementations for Yuriage. The students are split up into two groups so that the disciplines are distributed evenly. This results in a girls and boys group due to the fact from each discipline there is a guy and girl. In the next part the process of the workshop is described focussing on how the disciplines worked together. This results into two visualizations of the relationship between disciplines. The final part consists of concluding remarks and reflection on how this workshop relates to the thesis.

Workshop Japan - 10 to 14 November 2017

Girls team:

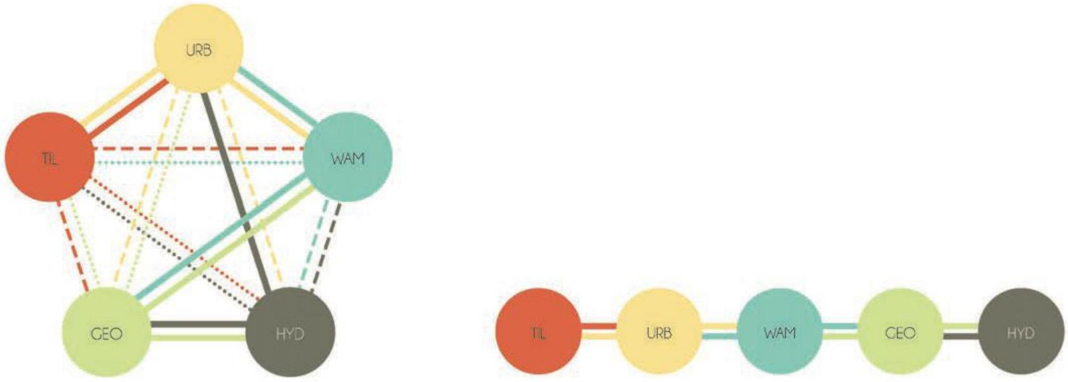
The first step was to create an overview of the scopes each discipline had. Adding color to the place where Yuriage is at the moment in our opinion and where we would like to steer Yuriage towards in order to achieve a more resilient future for the fishing community.



Workshop scopes aligned (source: Author)

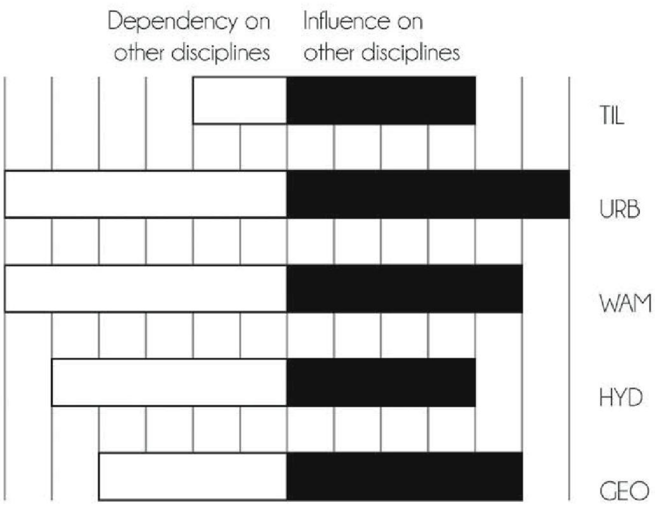
Urbanism, Transport and Water Management had their scopes at either end of the extremes. Concluding that there is a priority to address issues within their field. Understanding the effect that the design wishes have on the future design of Yuriage we can see that there is an interconnection between the disciplines and their choices. So the next step was framing the interdependencies between the students each asking themselves, whose help do I need in order to achieve my maximum scope? Resulting in a "chemical like" double bond between several disciplines and a single or even weak bond between others.

When aligning the disciplines we identified a chain of strong bonds between each discipline.



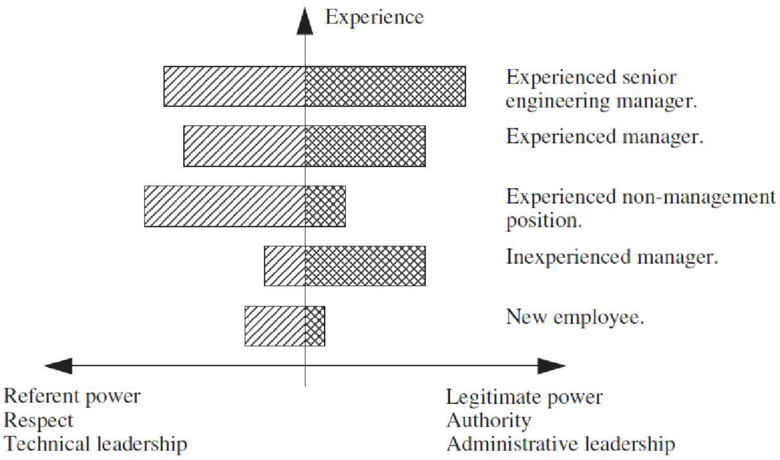
Interdependencies between discipline (source: Author)

When we concluded our position and closest connected disciplines the next step was how to flexible each student was within achieving their goal. This was done by counting the bonds between the model.



Flexibility between discipline (source: Author)

This approach is based on the use of 'power' the more power there gives a certain dependency position between others. The 'power' to achieve your desired goals is a combination of mutual understanding and authority in the spatial sense. When elements within a plan have to be achieved the people look to those with the appropriate type of power (Taura, 2016). Though this does mean per se that disciplines with less influence have less to say in a plan, this is also dependent on the person itself and its positioning within the design team.



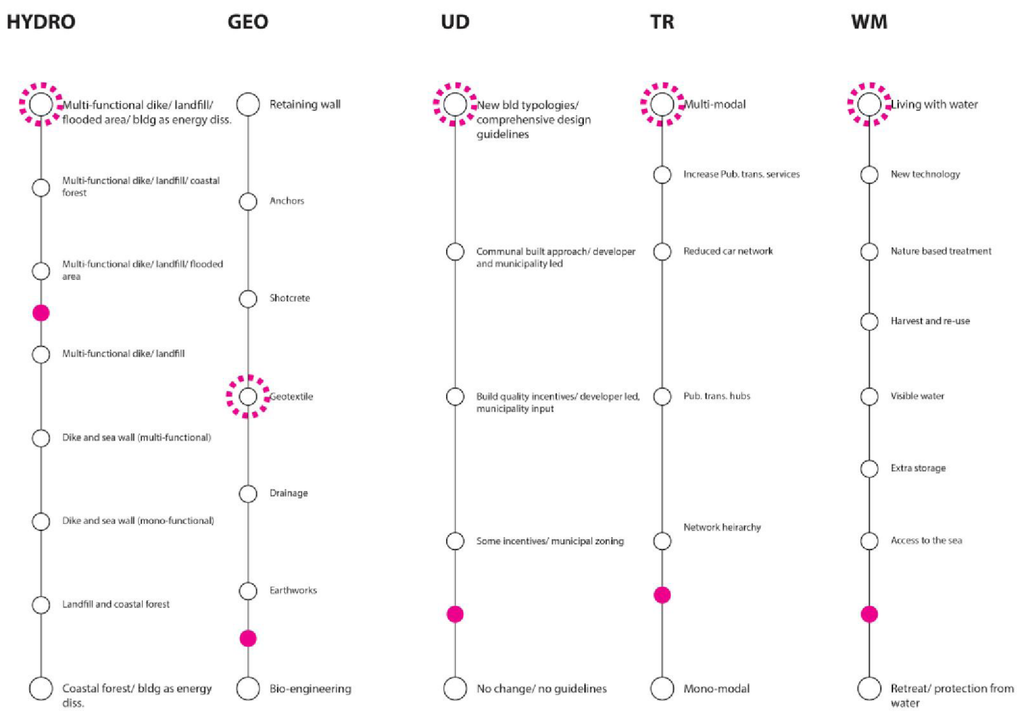
Types of power (source: Creative design engineering (Taura, 2016))

With these two conclusion we could place ourselves for the design phase. Each student designed their own desired scope on paper. Aligning them on the chain of interdependencies we discussed each feature of the design per discipline evaluating if the other disciplines where willing and flexible enough to implement it without it affecting their personal design. During this discussion we found that some demands where recurrent, the safety of the community and the preserving of the original landscape. This ended up being our main concept for the design, a naturally safe Yuriage.

Final design girls team (source: Author)

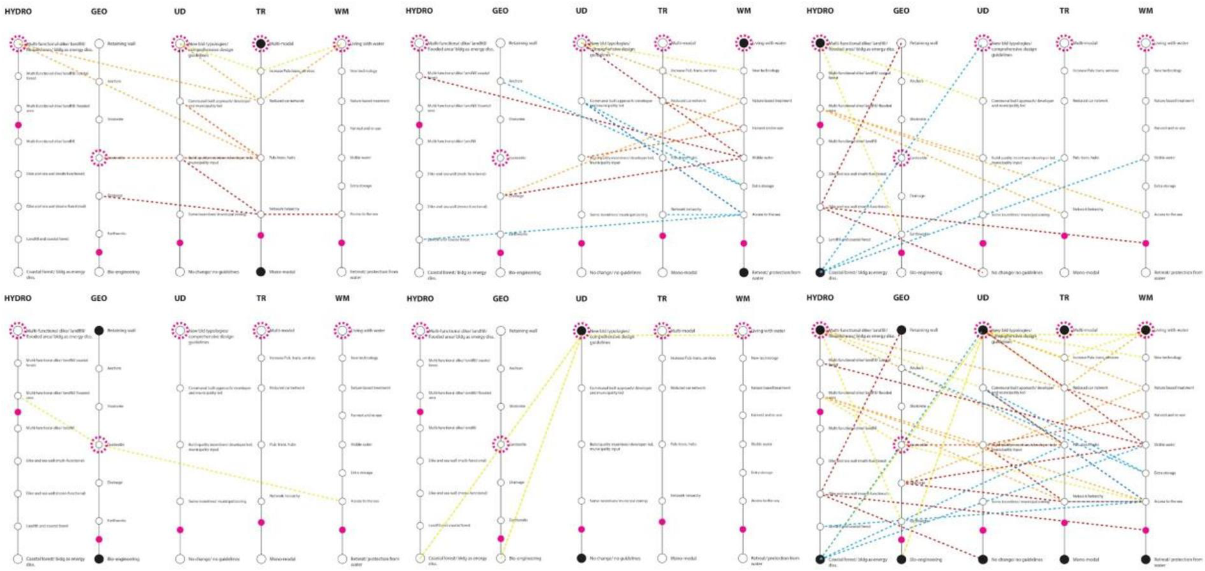
Guys team:

The first phase started off by separating each discipline and develop their scopes and the current position of Yuriage on this scope (pink dot). In addition the disciplines marked their most desired place for Yuriage. This scope consisted of a maximum at the top and the opposite at the bottom. The steps in between were the stepping stones from minimum towards the maximum. For example the scope of hydraulics had a minimum as completely natural solutions with coastal forest as mitigation and the multifunctional dike as the maximum result. After each discipline had created their scopes we put them together to discuss what the reason was behind their choices. During this discussion we found out that the urbanists thought more in processes and the other disciplines more in physical implementations. This caused confusion on how to get from the minimum towards the maximum with some of the disciplines.



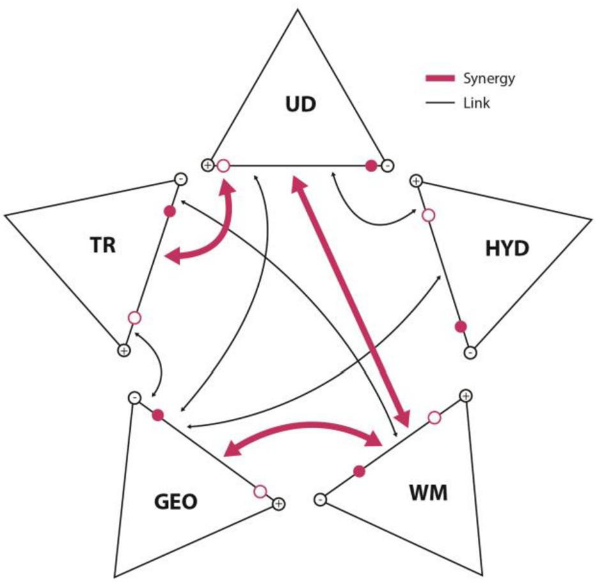
Overview of the developed scopes (source: Author)

In the second phase we tried to find out if the steps taken towards the desired location of Yuriage had effect on the scopes of other disciplines. In addition, we discussed if the steps of other disciplines had a positive or negative impact. This caused a lot of discussions as disciplines wanted to reach their maximum. This process is illustrated in the diagram below for each discipline. And after overlaying each diagram a pattern should become visible with the strongest connections between disciplines (bottom right diagram).



Relationship and effect of actions taken between disciplines (source: Author)

During the discussion we noticed that the students perceived the scopes differently and the maximum and minimum outcome. For some disciplines the maximum outcome was the most desirable solution and for others it meant an extreme. In the case of Geotechnics the direction of Yuriage was in the middle of the scope because that was the most balanced solution. This resulted in failing to see strong connections between the disciplines because the most desired position of Yuriage was at a different position on the scope than the other disciplines. To solve this we made a table where we showed if a discipline had a synergy or just a link with each other resulting in the following diagram.



Synergy and links between disciplines simplified (source: Author)

Interesting to see is that hydraulics didn’t have strong synergies with any of the disciplines. This was due to the fact that the scale and location on which hydraulics was making solutions did not directly relate to the other disciplines.

For the last phase the students had to translate the discussed topics into a new design for Yuriage. This was also the first moment we used a map to implement the steps. We directly found out that we should have used the map in an earlier phase of the proces. Each discipline perceived scale differently with the solutions from other students. So after using the map we could discuss more easy as we could point and draw it on the physical space. This process led to the design of a dike embedded in a dune landscape. This was natural elements were preserved (urbanism) and safety was ensured (hydraulics). Geotechnics had mainly solutions against landslides and disintegrating dikes by applying geotextile. The fishing harbor was recovered and buildings were facing against the water to deflect water. After the harbor there was the dune landscape with a mitigation forest that protects further inland. All the disciplines were mainly on the same line when solutions were presented and did not have much conflict between each other. Almost after every discussion between two disciplines one or the other saw the benefits or they found a middle way to reach their goals.

Final design boys team (source: Author)

Section of new design (source: Author)

Reflections and concluding remarks

Nasiem Vafa

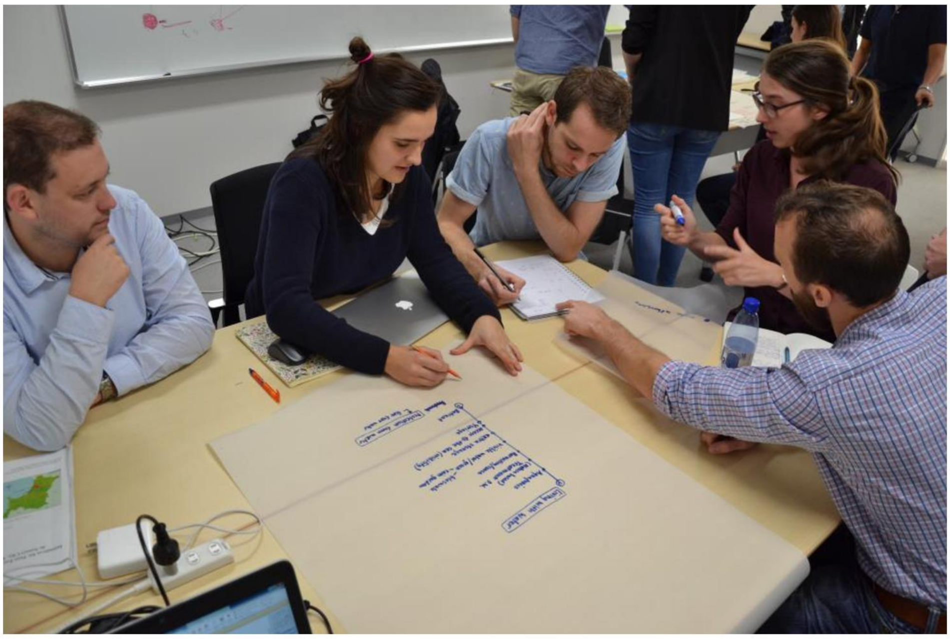
The real challenges of multidisciplinary collaboration appeared during the merging phase of the design as the disciplines had a different aspect within the same theme. The first confrontation was the solution towards the defense mechanisms for the village. The demand from the state that the defense system in place should be resilient towards a tsunami that is similar to the one that struck in 2011, the reoccurrence of such a tsunami is once every thousand years. This appeared to be issue as the disciplines had their own conceptions towards a resilience of such magnitude. Urbanists and Transport students objected that building networks and housings with this timeframe is counterproductive as their systems are efficient between 10-50 years due to a changing society. On the other hand the method of defense was in dispute. Water management questioned the use of elevated land as this might lead to problems in subsidence and other problems in the area and suggested the use of a ‘‘bio shields’’ (use of coastal vegetation for mitigating tsunami’s) instead of land elevation. These discussions lead to the conclusion that there is no consensus between the criteria used in solving the problem and that problems and solutions are dynamic making it an unstructured problem (Pesch & Cuppen, 2016).

The second confrontation regarded the dynamics with working in an interdisciplinary group. The members of the team where all TU Delft students but between their specialisms there where a lot of differences in how the students handled the task. The Geotech and Hydraulic students presented themselves as pure scientist (Pielke Jr, 2007). They held onto the state’s 1000 years tsunami protection demand and did not suggest other possible options unless they were initiated by other disciplines: ’’You request, we build’’. The opposite scientist was to be found in the field of Urban design, the student suggested that elevating the landscape and building high sea walls intervened with the wishes of the community as their livelihood depended on contact with the sea. Deriving from the protection level the Urbanist suggested a mixture of other safety measures to keep the local community close to the ocean. This alignment with the local fishing community shows a political agenda, a key indication of an issue advocate. Other approaches where found in water management and transportation, they both gave suggestions of how the protection could be resolved, but accompanied this with pros and cons. Clarifying and opting for different options are elements aspects of an honest broker (Pielke Jr, 2007). This concludes that every discipline has a different way of approaching a problem. Mapping their place within a project is the first. A second would be a mutual understanding what paths each discipline uses and how to translate this so a mutual one where every discipline can agree with. This workshop will have a positive influence on my thesis progress as I will be able to integrate information of other disciplines more adequately into my project. Knowing where I stand within a reconstitution project will give a better understanding in what phase I need to reach out to disciplines to fill in the 'gaps’ of knowledge. This will end up in a more comprehensive thesis project.

Jesse Dobbelsteen

The workshop proved to be a helpful tool to understand how different disciplines think and approach problems. In addition, it helped finding out which discipline could work together and understand each other's views. As an urbanist we created our scope more process based instead of product based. This resulted in being unable to implement solutions on the map. Therefore, the next time we get in the same phase during the graduation process it is important to have physical solutions to be able to understand each other better. The overall process of the workshop was also focused on discussing how each discipline could reach their most desired position instead of directly trying to implement solutions on a map. This resulted in many miscommunications between disciplines because scales and impacts of solutions were understood differently. However, when the map was introduced most misunderstandings were resolved. Another aspect of the workshop was the approach the students had to work. Because the workshop was organized by urbanists it contained many elements that were familiar for the urban designer but not for other disciplines. For example, when having many unknown factors the urbanist and transportation felt more confident than the geotechnical and hydraulic disciplines.

The workshop helped to establish a framework that could be used in order to receive information from other disciplines. It showed which discipline was useful for your project at certain times in your process. For me this is very beneficial because I need the expertise of these disciplines in different moments during my graduation project. Especially when implementing the adaptation pathway approach it has added value to determine which actions should be implemented after a tipping point has occurred. By working in a multidisciplinary setting you will develop a better argumentation why certain solutions are chosen. Because the disciplines have very specific information, data and expertise they will see problems differently which helps generate solutions other than only an urbanist would come up with.



Discussing the scopes during the workshop (source: Author)

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