PRELIMINAR THESIS P2

Adaptive reconstruction process after tsunami disaster in coastal cities of Japan

水 - 国

Jesse Dobelsteen
Delta Urbanism

Colophon

Author
Jesse Dobbelsteen
4385055
j.dobbelsteen@live.nl
+31 (0)6 1372 4824

First mentor
Dr. F.L. Hooimeijer (Fransje),
Department of Urbanism, Delft University of Technology

Second mentor
Dr. ir. F. van de Ven (Frans)
Department of Civil Engineering, Delft University of Technology

P2 Report
January, 2018
Department of Urbanism, Delft University of Technology

Delta Urbanism Studio
MSc Urbanism
Faculty of Architecture
Delft University of Technology
Delft, The Netherlands

Studio coordinator: dr.ir. Taneha K Bacchin

Keywords:
Redevelopment process, adaptation planning, urban water management, interdisciplinary approach

Summary

Flood risk is expected to drastically due to a multitude of factors. Major consequences of global warming such as heavy storms, floods and sea level rise increases the flood risks of coastal villages and cities. Japan experienced multiple hazards of which the 2011 tsunami was the largest with over 19000 deaths and $4510 billion in damages. Stakeholders and decision makers have to deal with deep uncertainties in the planning process. Two key domains produce the sustainability of coastal areas: a resilience domain and adaptation domain. In order to deal with these uncertainties and work to a sustainable future there is a need for a new planning approach. The Adaptation Pathways Approach provides insight into these problems and help identify action points, tipping points and goals by visualizing it in an Adaptation Pathway Map with corresponding scorecard. Due to the flexible nature of this approach, other methods can be used to strengthen and improve the planning process. The gathered knowledge and strategy is going to be applied to the design of Yuriage, a small coastal village in the prefecture of Miyagi. This results in a design task which takes the domains of nature, people and process into account. An important goal is to find the balance between land and water, between hard engineering and building with nature.

Contents

Project motivation

Since my bachelor I've been interested in designing with water and striving to improve my skills in this field. With the effects of climate change visible all around us, design with and against the water becomes an important factor in future years of development. Especially after recent events such as tsunamis and big floods all over the world. To cope with these deep uncertainties there is a need for adaptive strategies and multidisciplinary working. The Delta urbanism studio has a focus on planning, design and engineering in urbanized deltas. Together with my great interest in Japan since high school forms this graduation studio the perfect condition for my the research topic: Redeveloping areas affected by tsunami disaster in Japan.

Introduction

Through history most of the major settlements were developed along the coast or rivers, that provided trading routes or fertile lands. These lands were low-lying coastal zones or river deltas. This led to a large part of the world's population living in low elevation urbanized areas. However, these areas are vulnerable to flooding due to a combination of storm surges, high tides, river discharges and human induced stresses such as urbanization and subsidence (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 flood plains (Zhai & Ikeda, 2008). Recent events have shown the vulnerability of urban settlements in delta regions and the devastating force of natural events. The largest impact to date is the Great Eastern Japan Earthquake (GEJE) in 2011 which formed tsunami waves up to 10 meters. This resulted in almost 16.000 deaths, and damages estimated around 122 billion dollar (Arm, Vervaeck, & Daniell, 2012). Residents and local governments are still recovering from this disaster. 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. Reconstruction areas devastated by a tsunami is a difficult and complex process. However it also offers opportunities to implement new innovative concepts of building and tsunami mitigation techniques. 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 (van Veelen, 2016). This forms a challenge for the design and planning process as it brings many uncertainties.

This leads to the broad 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.

Fig. 1: Reflection of the city and natural systems. Image: Author

Land - Water

When walking around in Japanese cities there are two realms that keep returning: Water and land. Everywhere water is integrated in the public spaces, connecting the water realm to the land. Each system, function, human or natural process is being reflected in the water, shown visually in the picture below. Lakes and canals are designed in a way that the visitor 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 used for activities such as generating energy, leisure and waste treatment.

Transitioning between the two realms is done through hydrological engineering. It forms the bridge, or pipe, between land and water. It is important that this part is performed knowing about the balance between water and land in order to cause a smooth transition between realms.

LAND

Topography
Soil
Climate
Industry + economy

Dynamic systems of Japan

Many different dynamic systems shape Japan as it is today. As explained in the previous chapter 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. 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.

WATER

Bathymetry
Sedimentation
Climate
Industry + Economy

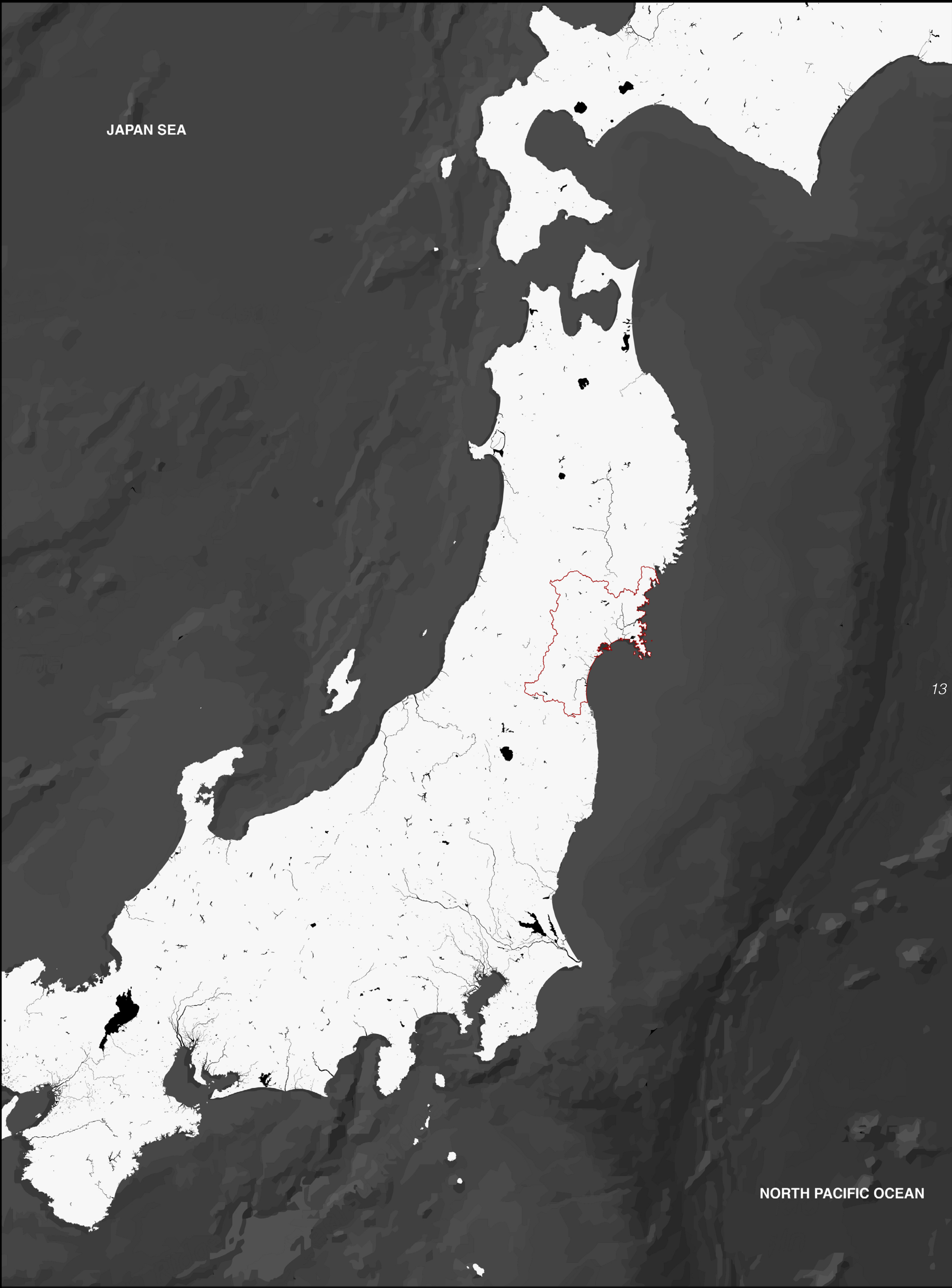
Topography

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

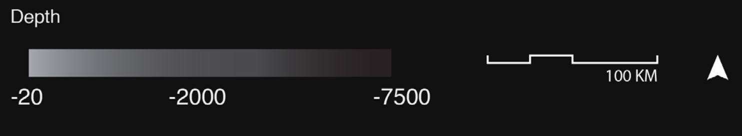
Flat Steep

100 KM



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.



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 is the soil temperature differences in the south (warm) and the north (cold). This can effect the way the soil is used.

Soil type
- Fluvic soil
- Brown forest soil
- Andosol
- Podzolic soil

Soil temperature
- <8°C
- 8°C - 15°C
- 15°C - 22°C

100 KM

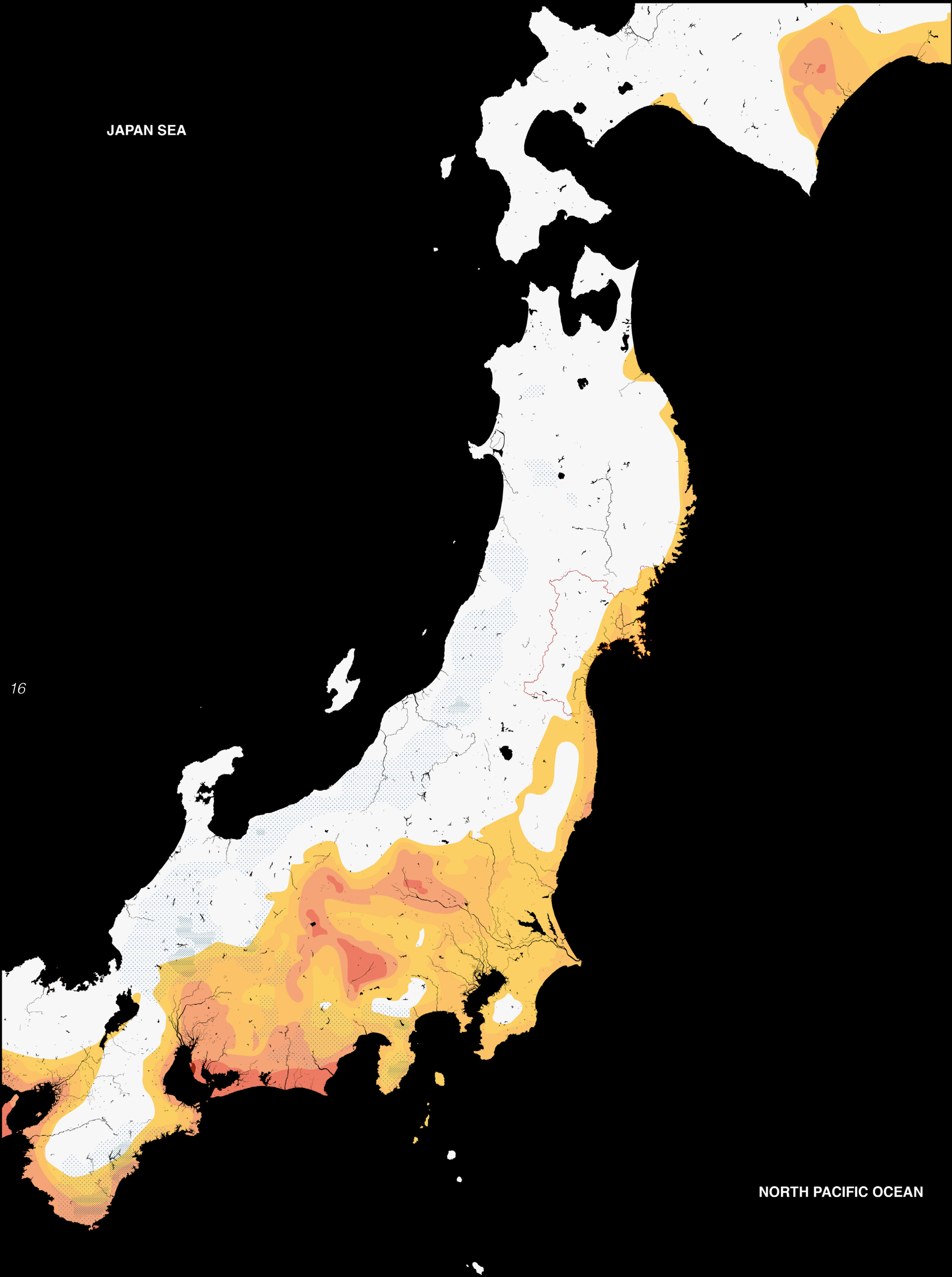
Sedimentation

The Sendai Bay is mainly filled with layers of sand & gravilly 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 Senday 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



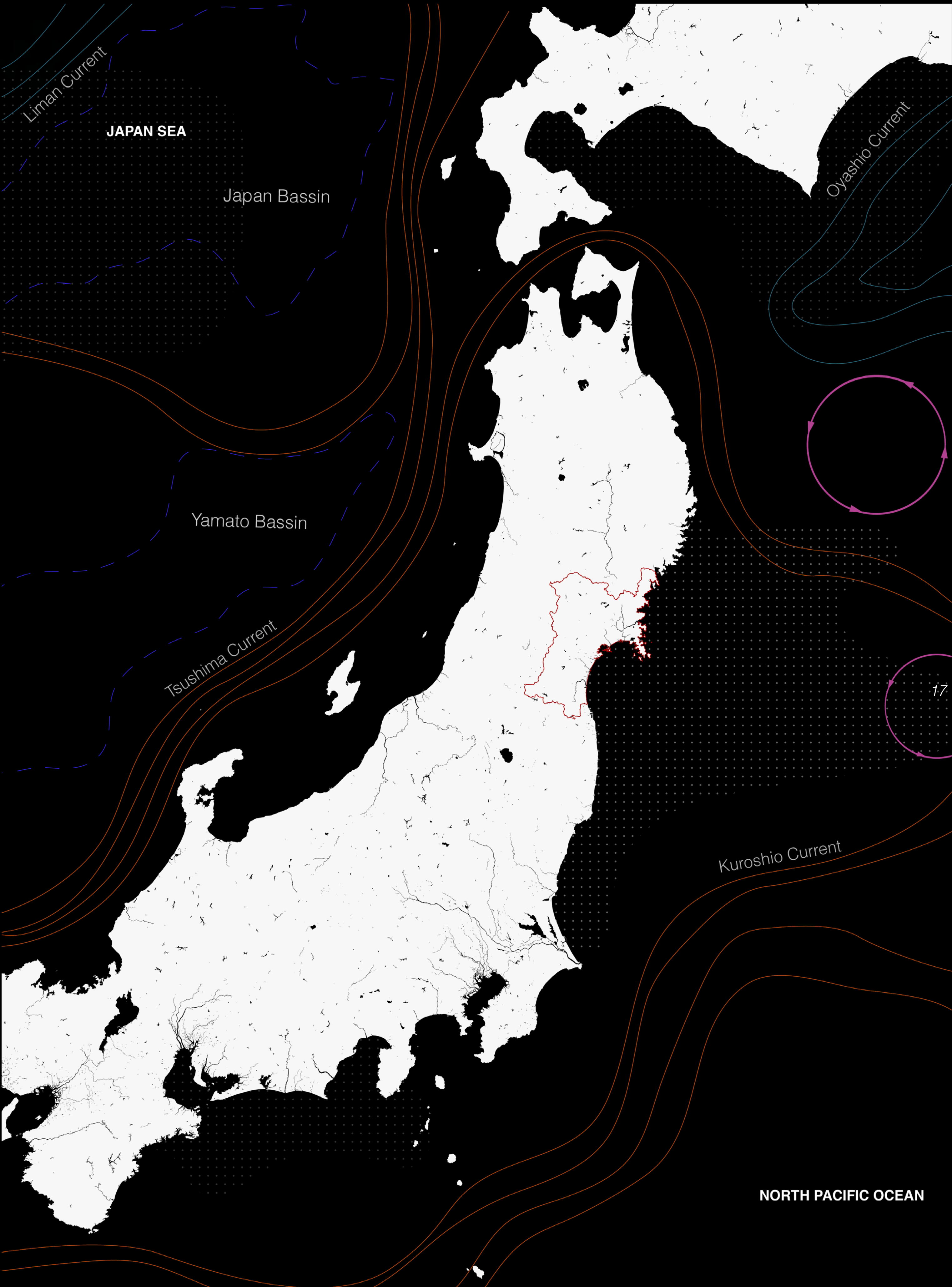
CLIMATE

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

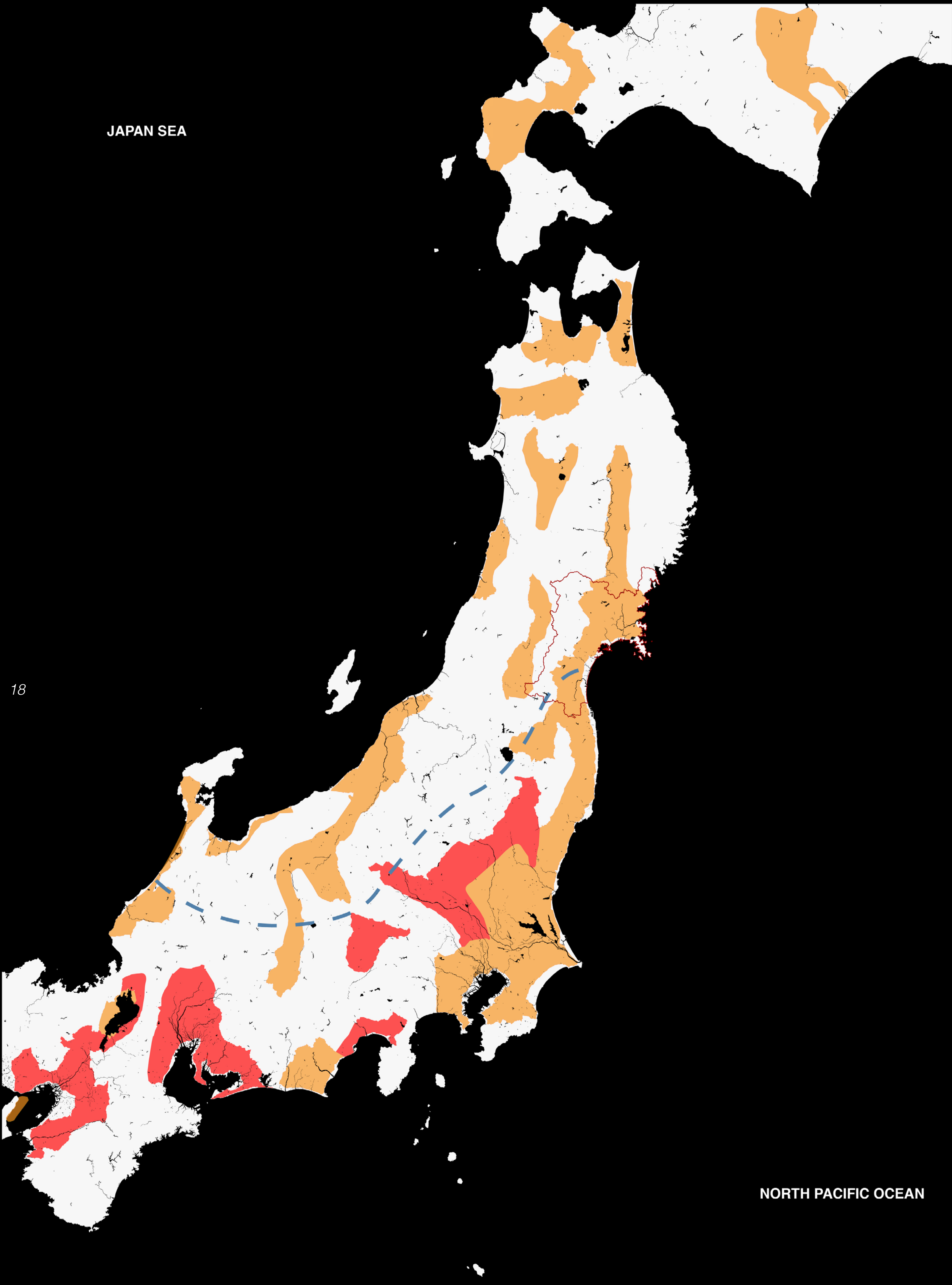


SEA CLIMATE

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

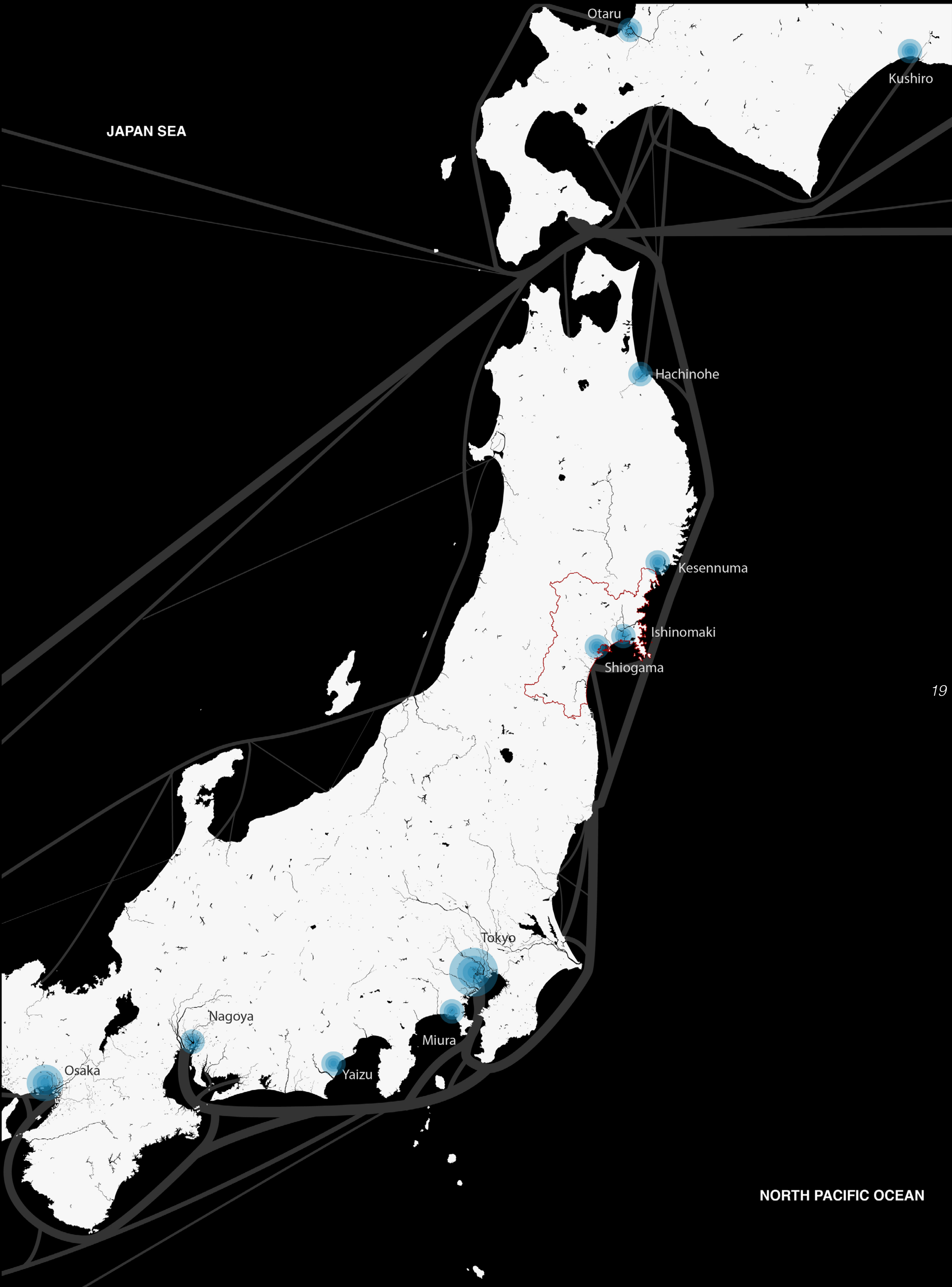


INDUSTRY

One of the main industries of Japan that occurs 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



INDUSTRY

The main industry in the sea-domain is the fishing industry. Noticable 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

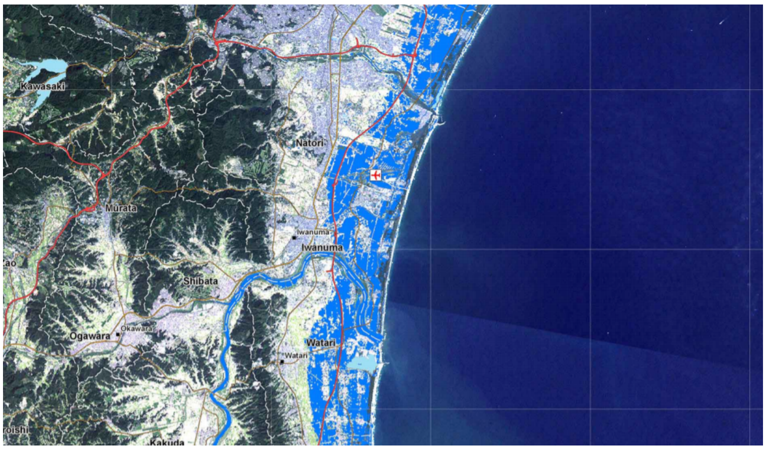


Fig. 2: Flood area of the Sendai plains. Source: City of Natori

Fig. 3: Zoning reconstruction plan for the village Yuriage, Natori. Source: City of Natori

Fig. 4: Population forecast diagram of Japan. Source: IPSS

Problem Statement

The problem statement consists of three main parts: Nature, process and people. Each of these parts play an important role in the redevelopment of cities and villages affected by the 2011 tsunami.

Nature

The past few years sea level rise occurred throughout the whole world, there is an increase of storms and the average temperature has risen by 0.8 Celsius since 1880. 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 and the chance of a new tsunami to happen within the next 1000 years of the same strength as the tsunami of 2011. Although this seems like a small chance of happening, smaller tsunamis can occur in a shorter time span. 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 that has little respect to nature or its processes. Resulting in an unbalanced relation between the land and water domains. There are mixed feelings about the concrete 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. However 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.

Process

To be able to rebuilt in these risk areas a set of laws and budged 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. This resulted in a great variety of different projects with few that managed succeed and Build Back Better (BBB). Therefore 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. Certainly it is important to recover pre-disaster situations, however new 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 former geographical location. To accomplish this, the process relies on major geotechnical and building-site preparation techniques. The land is raised by 5 meters. All of this is developed according a structured zoning plan which results in loss of living quality for the people.

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. The IPSS gave the prognosis that the population diagram will shift from a pyramid shape towards a kite, meaning an aging and declining population. 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. Communities 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 causes original communities to break up and fall apart.

Hypothesis

By shifting from traditional urban recovery towards modern urban renewal recovery programs can achieve more potential in the field of resilience. By taking advantage of designing on an empty slate innovative techniques can be applied for the mitigation of tsunamis and hydrological issues. The adaptation pathway approach can be used as systematic strategy that provides a solid framework for development with deep uncertainties. It can be used by multiple disciplines and supplemented or strengthened by other approaches. Doing so will create a better balance between water and land, a better balance between hard engineering and designing with nature.

This hypothesis act 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.

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 can traditional urban recovery be brought to the level of modern urban renewal?

To help anwser this research question the following sub research questions are formed.

1. What are important elements in traditional urban recovery?

2. How is modern urban renewal defined?

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

4. What is the balance of water vs solid in redevelopment projects of coastal villages?

5. How to integrate designing with nature in the reconstruction process?

6. How can a Japanese village or city prepare against high precipitation that causes pluvial flooding?

7. How are communities involved in the redevelopment process and contribute to tsunami mitigation measures?

8. How can the community be strengthened in the reconstruction process?

Societal 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. Climate change has moved 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. 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 deaths and damages estimated around 122 billion dollar. The damages caused to people's lives and 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. Deep uncertainties caused by climate change make it difficult to plan far ahead. The increased frequency of heavy storms but also higher chances of tsunamis has amplified its characteristic of uncertainty.

Redevelopment processes took off slowly and thousands of people lost their homes. 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. 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. This thesis project contributes to the relation between engineering, design and ecological studies in a systematic framework for reconstruction approaches.

Scientific relevance

There are a lot of studies 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 project aims to explore the concept of building with nature in a context of deep uncertainty. 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 e.a., 2013). The adaptation pathway approach is a newly developed method to provide a systemic framework for future developments. By providing multiple timelines and scenarios chances that a project will reach the desired goal is greatly increased. This research wants to supplement the adaptation pathway approach with other methods in order to create a framework for redevelopment after tsunami disaster.

Urban resilience

The concept resilience is part of a larger group of complexity theories that were developed in the late seventies. These complex theories were used to explain the non-linear processes and behavior of complex systems (B. Walker & Salt, 2012). Originally resilience comes from ecological-system sciences where it was used to research how much disturbance an ecosystem could cope with and then recover (van Veelen, 2016). Van Veelen states that there are three main focuses for 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", z.d.). 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 return to the original state. The ability to transform the system to be able to deal with the difficulties is more valuable than going back to the original state. A good example of this is the redevelopment process for the village Yuriage in the Miyagi prefecture. Instead of incorporating new techniques and ideas the village is rebuild exactly the same as before. The only difference is that they heighten the ground with 5 meters of sand. Therefore the definition of resilience needs to consist of more than the notion of bouncing back.

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)*

In this definition urban resilience is dynamic and provides various pathways towards resilience. Important factors such as temporal scale, general adaptability and a conceptualized urban system are processed in the definition. And therefore gives a more complete definition of the concept urban resilience.

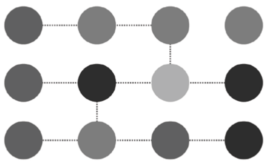
Adaptation

Adaptation is frequently seen as the process of socio-technical or social-ecological system to improve its resilience. In addition adaptation is regarded as 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. When combining these statements one can say that adaptation occupies a crucial central point in the coproduction of development and risk illustrated in fig. 2. 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 or transformation 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 degree solutions such as placing sand bags in front of the dwellings. A higher degree could be improving the drainage system and infiltration capacities. And an even more substantial solution could be to completely heighten the ground. These are mostly technological or physical interventions, but there may just as well be institutional, behavioral or social interventions such as risk awareness projects (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. One of the biggest disturbances or risks that impacts current systems through all scales is climate change. 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. 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 (Castree, 2001).

Methodology

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 Adaptation Pathways Approach (APA) 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 APA.



Adaptation pathway approach

A new paradigm for planning under conditions of deep uncertainty has emerged in the field of urban development. A planner should create a strategic vision of the future, and in addition plan short-term actions. This should be established in a framework to direct actions that will happen in the future (Haasnoot e.a., 2013). The Adaptation Pathway Approach (APA) is an approach that deals with these subject. 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 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 e.a., 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 in fig. 3. The APA 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 deal with 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 APA 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 (W. E. 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 fig. 5. 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	grey	+++	+	0
2	orange, grey	+++++	0	0
3	orange, green	+++	0	0
4	orange, blue	+++	0	0
5	green	0	0	-
6	green, grey	++++	0	- -
7	green, orange	++	+	-
8	green, blue	+	++	- - -
9	blue	+++	+	- - -

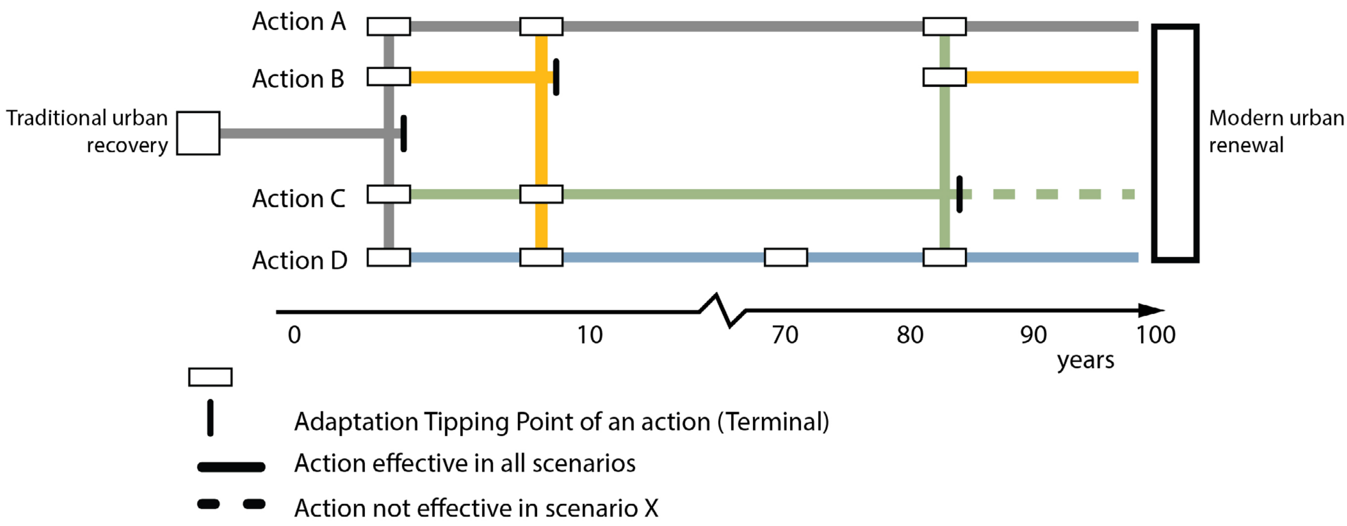
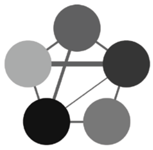


Fig.5: Example of an Adaptation Pathways Map and corresponding Scorecard. Source: Haasnoot e.a. - modified by author

Methodology

3x3x3 Analysis

In order to correctly asses future tipping points it is important to analyses how the current system functions and what future trends can cause tipping points to occur. In the example of climate change the question could be: How much sea level rise can the current system cope with? This starts the analysis at a different position than a more classical approach where the cause-effect chain starts with analyzing a certain scenario and try to find what the risks are (Kwadijk e.a., 2010). A way to identify these tipping points is to analyze the existing situation via spatial analysis/ modeling techniques. An approach that guides this process is the spatio-temporal approach (Kuzniecow Bacchin, 2015). This method is useful in analyzing the complexity of data and finding relations between layers and scales. It guides the development of a framework to acquire data, analyses it, interpret results and design alternative spatial strategies. The method builds on the Dutch layer approach by adding the layer time. The Dutch layers approach is an approach developed in the last decade of the in the Dutch planning practice in which the layers stand for aspects of concern in the domain of urban and regional design and planning (Schaick & Klaasen, 2011). The original Dutch layer approach consists of three main layers. The bottom layer is the land and its substratum which includes water, soil and rock. The middle layer is made up of infrastructural networks providing for development, transportation and settlement. The top layer consists of human occupation and urban patterns (Meyer, Bobbink, & Nijhuis, 2010). By adding time to this approach patterns or trends can be identified which provide input for tipping points.



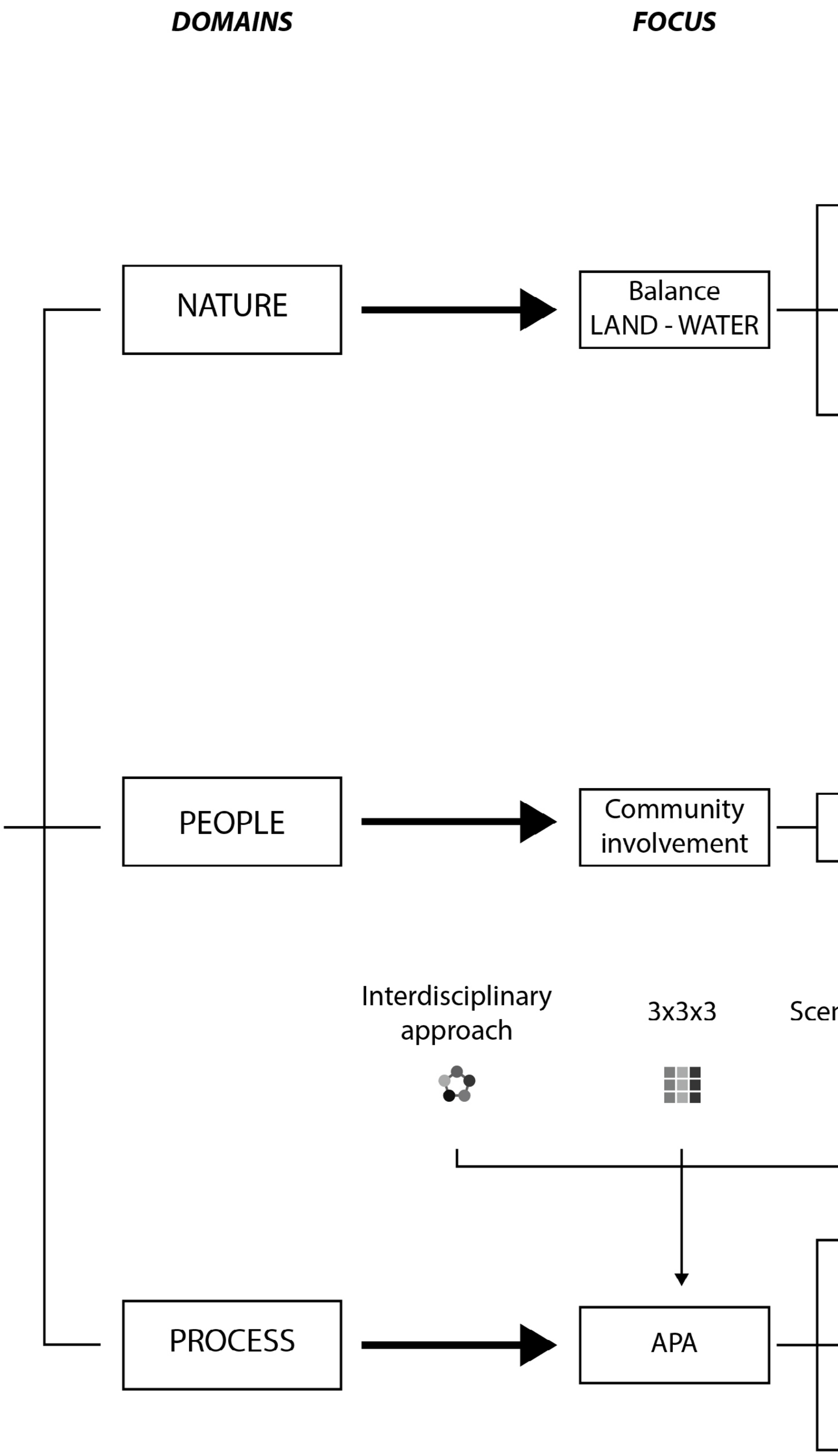
Interdisciplinary approach

There are many problems in society which cannot be solved by one scientific discipline. Therefore, interdisciplinary working gets increasing support from scientists, policy-makers and funding agencies. Buanes and Jentoft (2009) mention 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. 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). When multiple disciplines with different pillars discuss they can establish common goals. This can be used by the stakeholders and decision makers to identify the scopes and desired outcomes and therefore increase the rate of succes.

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 as the action points.

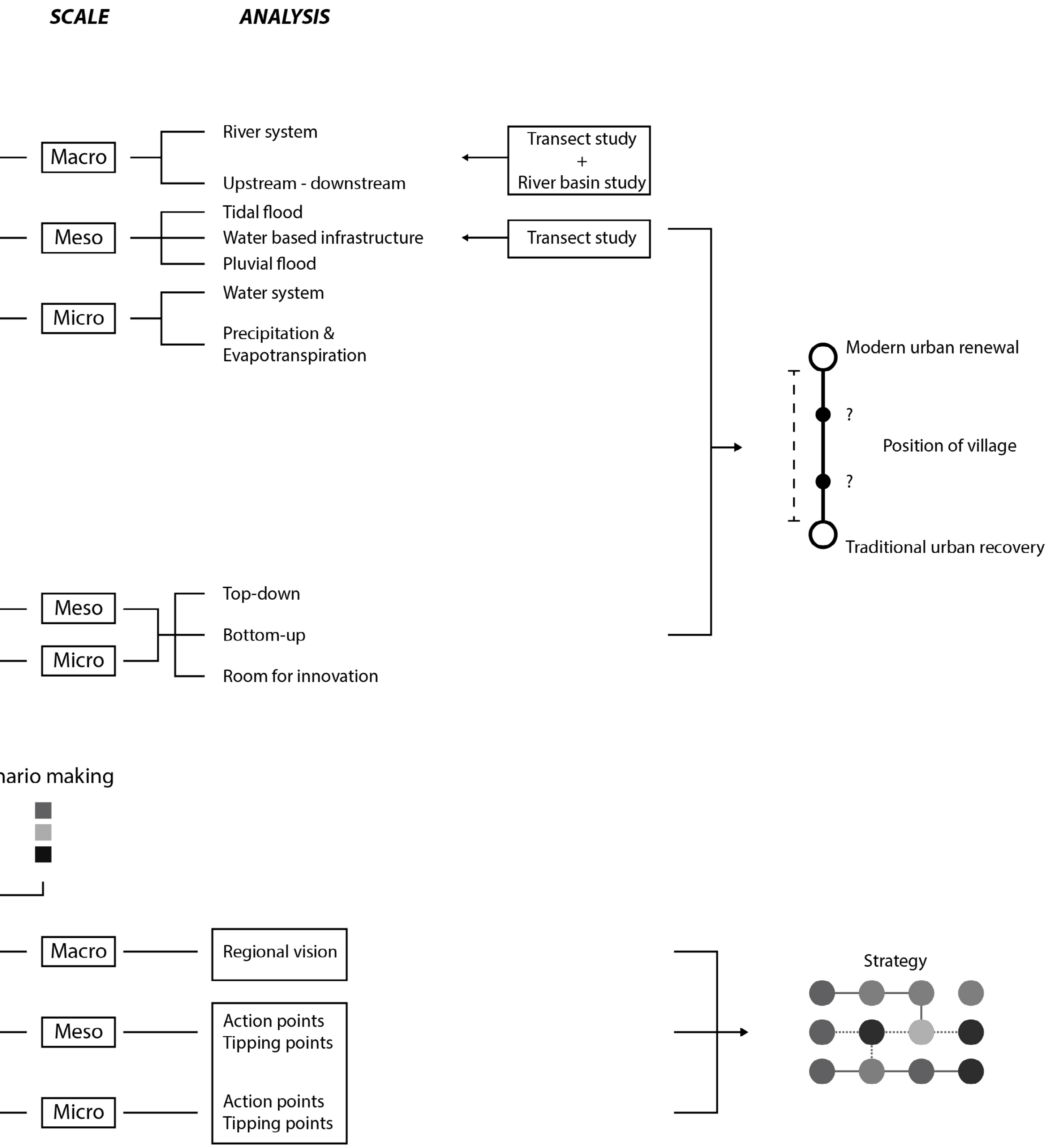
Research framework



Research question

How can traditional urban recovery be brought to the level of modern urban renewal?

Fig.6: Framework of the research process. Image: Author.



SCALE
ANALYSIS
Macro
River system
Upstream - downstream
Transect study
+
River basin study
Meso
Tidal flood
Water based infrastructure
Pluvial flood
Transect study
Micro
Water system
Precipitation &
Evapotranspiration
Modern urban renewal
?
Position of village
?
Traditional urban recovery
Meso
Micro
Top-down
Bottom-up
Room for innovation
nario making
Macro
Regional vision
Meso
Action points
Tipping points
Micro
Action points
Tipping points
Strategy

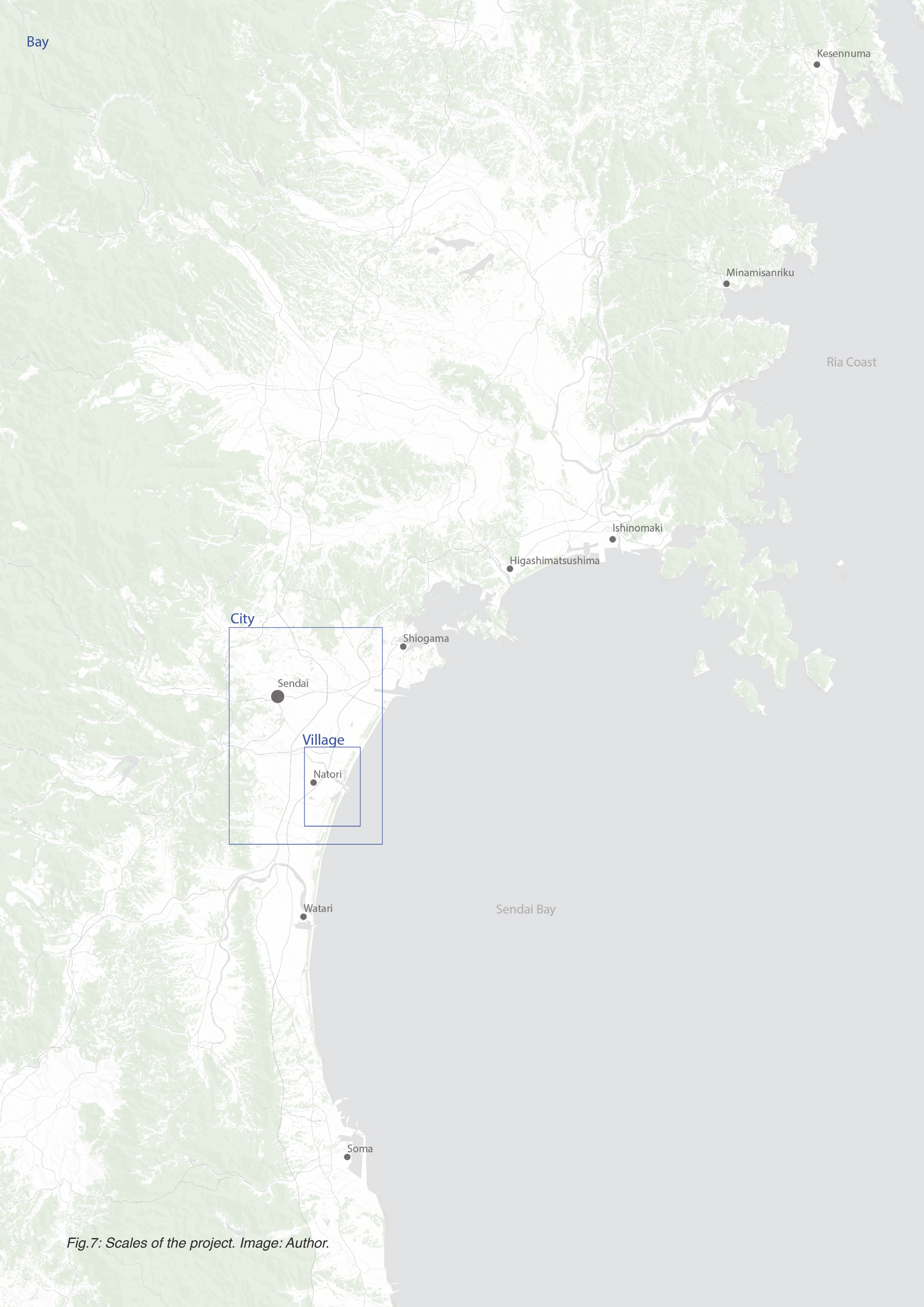


Fig.7: Scales of the project. Image: Author.

Scale

Issues and approaches can be varied by different scales. Especially in the case of hydrological systems. A neighborhood can experience problems because of the condition of an entire watershed. Thus, a strategy is needed on a larger scale to solve the problem. Because the dynamic systems in the region follow their own path the boundaries of the scales do not coincide with administrative borders but set by geomorphological boundaries.

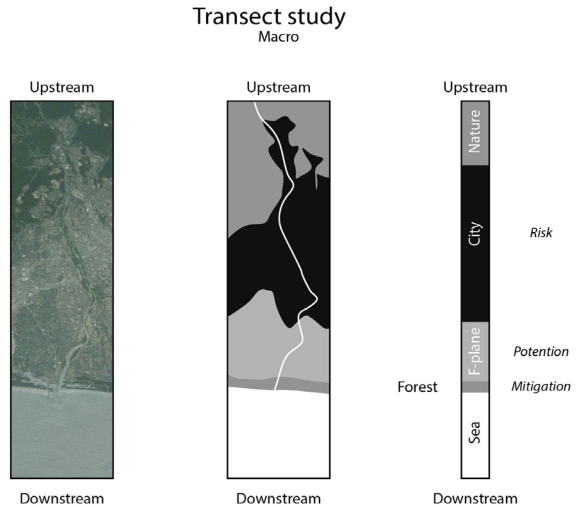


Fig.8: Conceptual example of a transect study that are used to decide tipping points. Image: Author.

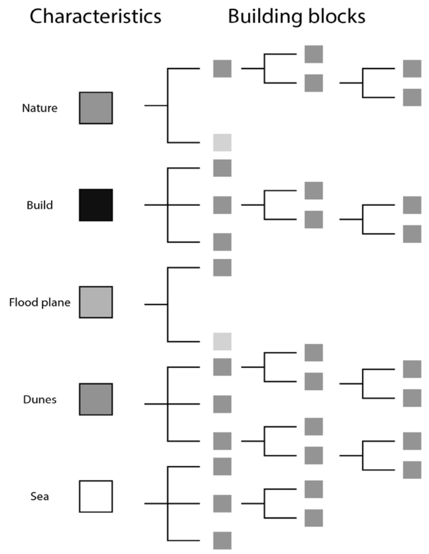


Fig.9: Conceptual image of building block that are used as action points in the APA. Image: Author.

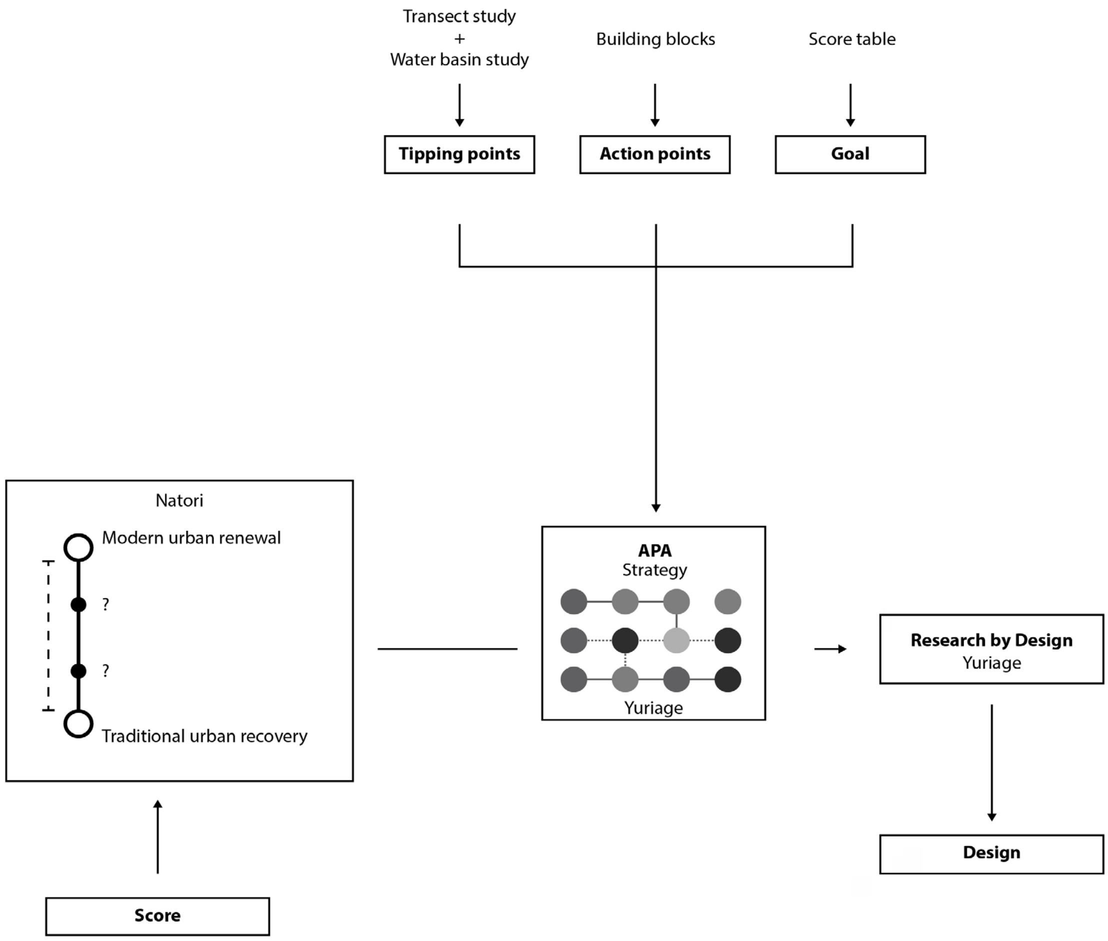


Fig.10: Framework of the products of the research process. Image: Author.

Intended end products

This section explains the expected outcome and intended end products of the research. Per scale is described what the products will be and where the conclusions will be used for.

Bay - Macro

The analysis of the bay scale lies the focus on larger hydraulic systems such as river basins. The aim on this scale is to find tipping points of the hydraulic system. This can be used in developing the adaptation pathway map. A second analysis on the bay scale is a transect study, fig. 8. This study can be used to determine the landscape characteristics and potential risk areas. This information is useful to create a strategy which is location specific. In order to create an extensive collection of building blocks (Fig. 9) multiple villages along the coast are being analyzed. These building blocks are solutions that fit at a certain landscape characteristic that are found by the transect study.

City - Meso

At the city scale a more detailed transect study is performed with additional information such as functions and soil conditions. This study focusus on the area of Natori, the coastal village in the prefecture Miyagi. In addition, this scale analyzes the reconstruction process and community involvement. Conclusions gathered from this will determine the position of Natori on the scale of traditional urban recovery and modern urban renewal. When the current position is decided a goal can be set for the future.

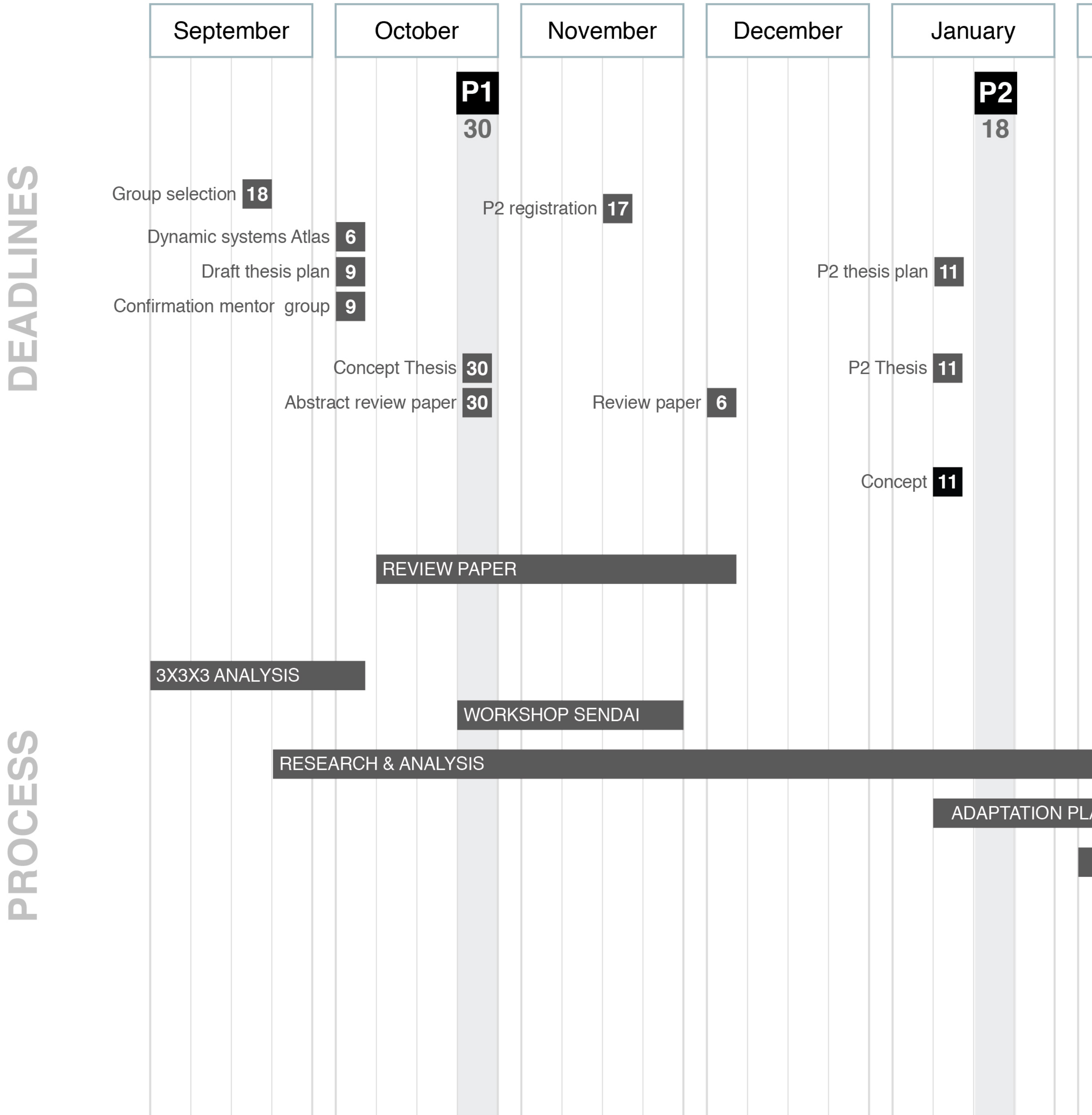
Village - Micro

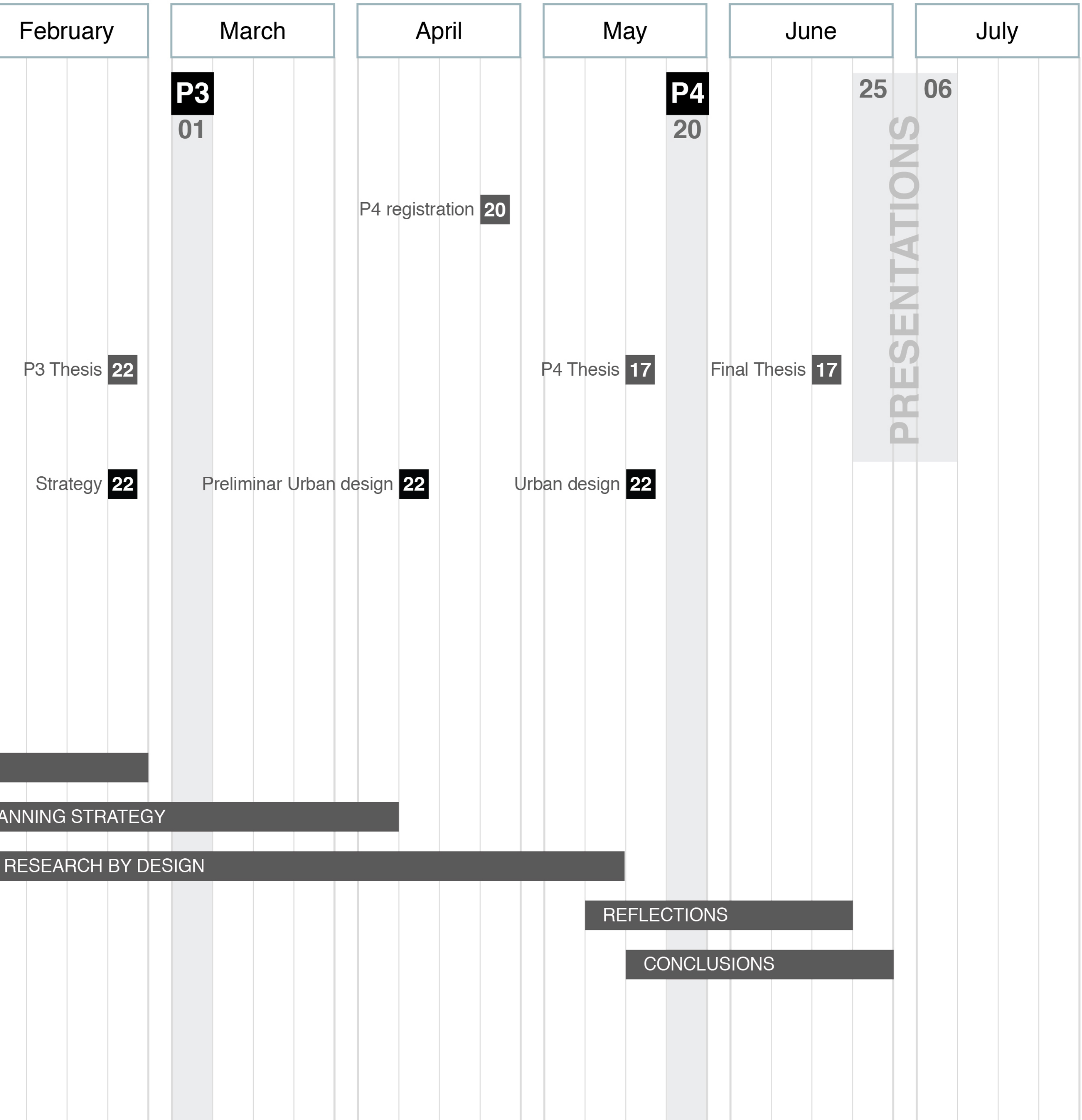
On the smallest scale, the village, the gathered knowledge and strategy is going to be applied. This results in a design task which takes the domains of nature, people and process into account. Important is to find the balance between land and water, hard engineering and building with nature techniques.

Adaptation pathway map

As described in the methodology chapter an adaptation pathway map is going to be developed on the meso scale. The previous described analysis provide the imput needed in order to determen tipping points, action points and the goal. This forms the basis for the urban design. In order to develop the framework help is needed from other expertises. Therefore there is a close working relation with four other disciplines: Hydrolic engineering, Geo engineering, Transportation and Water management.

Planning


September
October
November
December
January
P1
30
P2
18
DEADLINES
Group selection 18
Dynamic systems Atlas 6
Draft thesis plan 9
Confirmation mentor group 9
P2 registration 17
P2 thesis plan 11
Concept Thesis 30
Abstract review paper 30
Review paper 6
P2 Thesis 11
Concept 11
PROCESS
REVIEW PAPER
3X3X3 ANALYSIS
WORKSHOP SENDAI
RESEARCH & ANALYSIS
ADAPTATION PL



February
March
April
May
June
July
P3
01
P4
20
25
06
PRESENTATIONS
P4 registration 20
P3 Thesis 22
P4 Thesis 17
Final Thesis 17
Strategy 22
Preliminar Urban design 22
Urban design 22
ANNING STRATEGY
RESEARCH BY DESIGN
REFLECTIONS
CONCLUSIONS

Literature

Arm, Vervaeck, & Daniell, D. J. (2012, maart 10). *Japan - 366 days after the Quake...* 19000 lives lost, 1.2 million buildings damaged, $574 billion. Geraadpleegd 2 november 2017, van https://earthquake-report.com/2012/03/10/japan-366-days-after-the-quake-19000-lives-lost-1-2-million-buildings-damaged-574-billion/

Buanes, A., & Jentoft, S. (2009). *Building bridges: Institutional perspectives on interdisciplinarity.* Futures, 41(7), 446–454. https://doi.org/10.1016/j.futures.2009.01.010

Castree, N. (2001). *Socializing nature: theory, practice, and politics*. Faculty of Social Sciences - Papers, 1–21.

Folke, C. (2006). *Resilience: The emergence of a perspective for social–ecological systems analyses*. Global Environmental Change, 16(3), 253–267. https://doi.org/10.1016/j.glo envcha.2006.04.002

Graaf, R. de, & Hooimeijer, F. (2008). *Urban Water in Japan*. CRC Press.

Haasnoot, M., Kwakkel, J. H., Walker, W. E., & ter Maat, J. (2013). *Dynamic adaptive policy path ways: A method for crafting robust decisions for a deeply uncertain world*. Global Environ mental Change, 23(2), 485–498. https://doi.org/10.1016/j.gloenvcha.2012.12.006

Hirschhorn, L. (1980). *Scenario Writing: A Developmental Approach*. Journal of the American Planning Association, 46(2), 172–183. https://doi.org/10.1080/01944368008977030

Kellens, W., Terpstra, T., & De Maeyer, P. (2013). *Perception and Communication of Flood Risks: A Systematic Review of Empirical Research*. Risk Analysis, 33(1), 24–49. https://doi.org/10.1111/j.1539-6924.2012.01844.x

Krabben, E. van der. (2011). *Gebiedsontwikkeling in zorgelijke tijden : kan de Nederlandse rui mtelijke ordening zichzelf nog wel bedruipen?* Geraadpleegd van http://repository.ubn.ru.nl/handle/2066/87179

Kuzniecow Bacchin, T. (2015). *Performative nature; urban landscape infrastructure design in watersensitive cities.* Geraadpleegd van https://repository.tudelft.nl/islandora/object/uuid:10f06b60-0f67-45b4-9390-785445a0dc7b?collection=research

Kwadijk, J. C. J., Haasnoot, M., Mulder, J. P. M. P. M., Hoogvliet, M. M. C., Jeuken, A. B. M., Kro gt, R. A. A. van der, … Wit, M. J. M. de. (2010). *Using adaptation tipping points to prepare for climate change and sea level rise: a case study in the Netherlands*. Wiley Interdisciplin ary Reviews. Climate Change, 1(5), 729–740. https://doi.org/10.1002/wcc.64

Meerow, S., Newell, J. P., & Stults, M. (2016). *Defining urban resilience: A review. Landscape and Urban Planning*, 147(Supplement C), 38–49. https://doi.org/10.1016/j.landurb plan.2015.11.011

Meyer, H., Bobbink, I., & Nijhuis, S. (2010). *Delta Urbanism. The Netherlands*.

National Institute of Population and Social Security Research. (z.d.). Geraadpleegd 20 december 2017, van http://www.ipss.go.jp/index-e.asp

Offermans, A., Haasnoot, M., & Valkering, P. (2011). *A method to explore social response for sustainable water management strategies under changing conditions*. Sustainable Development, 19(5), 312–324. https://doi.org/10.1002/sd.439

Pelling, M. (2010). *Adaptation to Climate Change: From Resilience to Transformation*. Routledge. resilience | Definition of resilience in English by Oxford Dictionaries. (z.d.). Geraadpleegd 20 december 2017, van https://en.oxforddictionaries.com/definition/resilience

Risbey, J., Kandlikar, M., Dowlatabadi, H., & Graetz, D. (1999). *Scale, context, and decision mak ing in agricultural adaptation to climate variability and change*. Mitigation and Adaptation Strategies for Global Change, 4(2), 137–165. https://doi.org/10.1023/A:1009636607038

Schaick, J. van, & Klaasen, I. (2011). *The Dutch Layers Approach to Spatial Planning and De sign: A Fruitful Planning Tool or a Temporary Phenomenon?* European Planning Studies, 19(10), 1775–1796. https://doi.org/10.1080/09654313.2011.614387

Shibata, K. (2008, januari 10). *The origins of Japanese planning culture: building a nation–state, 1868-1945* [Monograph]. Geraadpleegd 20 december 2017, van http://www.lse.ac.uk/col lections/geographyAndEnvironment/Default.htm

Smit, B., & Wandel, J. (2006). *Adaptation, adaptive capacity and vulnerability*. Global Environmen tal Change, 16(3), 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Take Your Startup to the Next Level Using Kaizen Philosophy. (z.d.). Geraadpleegd 20 december 2017, van https://www.startupguys.net/take-your-startup-to-the-next-level-using-kaizen-phi losophy/

van Veelen, P. C. (2016). *Adaptive planning for resilient coastal waterfronts: Linking flood risk reduction with urban development in Rotterdam and New York City*. https://doi.org/10.7480/ abe.2016.19

Walker, B., & Salt, D. (2012). *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function*. Island Press.

Walker, W. E. (2000). *Policy analysis: a systematic approach to supporting policymaking in the public sector*. Journal of Multicriteria Decision Analysis; Chichester, 9(1–3), 11.

Wittenberg, G. (1994). *Kaizen—The many ways of getting better*. Assembly Automation, 14(4), 12–17. https://doi.org/10.1108/EUM0000000004213

Zhai, G., & Ikeda, S. (2008). *Empirical analysis of Japanese flood risk acceptability within multi-risk context*. Nat. Hazards Earth Syst. Sci., 8(5), 1049–1066. https://doi.org/10.5194/nhess-8-1049-2008