

ACTIVATE RESILIENCE OF THE MIYAGI COAST



Student:

Nasiem Vafa

4112636

nasiemv@gmail.com

Mentors:

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

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

Studio:

Delta Intervention17/18

MSc Urbanism

Faculty of Architecture, Delft

Studio coordinator: dr.ir. Taneha K Bacchin

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PREFACE

Climate change is presenting unprecedented threats to communities across the world. With the future in mind cities living next to the sea will have to be pioneers in adaptation towards these extremes. The coexistence of land and sea is a pressing matter that has to be addressed as disasters are increasing in size and impact.

A report of the World Economic Forum in 2015 issued a warning that communities across the world will increase in vulnerability due to failures in urban planning and climate adaptation. The need of a broad approach that combines all these pressing matters is necessary in order to improve the safety and resilience within these communities. But what comprises a resilient environment? How should the regional and local fabrics be reconstructed after a disaster, in order to make it more resilient for future threats?

The studio of Delta Interventions hosted by the department of Urbanism at the TU Delft represent a graduation studio where collaborative research between different disciplines is offered. It forms an approach towards understanding the consequences of climate change specifically water related consequences and how this affects all aspects of the built environment. Studio project vary in size and form due to the different specialities working these, from a single building to regional plan are results of this research by design process. The knowledge that is accumulated over the years within the studio is mainly based on the Dutch delta but is open to explore applicability of this Dutch methods in other delta areas. This graduation plan is also set outside the Dutch delta, focussing on the reconstruction of the Japanese east coast that has been struck by a devastating tsunami in 2011. Working in an interdisciplinary set we design future prospects in an intertwined matter. Representing a new process for the affected region by collaboratively researching, developing, and implementing ideas for a more resilient future. Our personal project will be based within a multidisciplinary group from the Technical University of Delft. The group consists of the department of Hydraulic, Geotech, Transportation, Urban Drainage Engineering, and Urbanism all working around the theme of Tsunami resilience in Yuriage, Miyagi.

INTRODUCTION

The country

Japan consist of four main islands and a total of 6800 smaller islands (mostly uninhabited). To administer the territory the country is based on a two tier system the nation is divided into 10 regions three of them are metropolitan and seven local regions. Within the regions there is a further subdivision of 47 groups called prefectures. Miyagi is the prefecture that is the focus of our project and is highlighted the image found on the left.

The country has a very distinct topography that consist over 61% out of highland, this vast amount of elevation is difficult to cultivate therefore inhabitant are averted to the terraces and plains (27%). These plains and lie close to the coastal zones and are characterized by high urbanization an economic and social activity.

To generate a nuanced and comprehensive understanding of the region's varied vulnerabilities and their interdependencies we have to take a step back to see Japan as a whole. What are their main systems that drive the country? And how does the landscape and ecosystems affect their functioning as a whole? As the country is an island we can divide the mapping analysis in two main affecting bodies, *land* and *water*. Based on this partition we compare *environmental*, *infrastructural*, *economic*, and *social systems* that can be found within. These themes are based on research done in the project Research by Design (2013) to asses the region after hurricane Sandy. This analysis can be found in the appendix of the booklet.



Image 1: Japan and its prefectures
Source: Japanguide.com

DISASTER

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 specially in Iwate, Miyagi and Fukushima Prefectures were totally devastated. The total affected area by the tsunami was reported as 561km² along the pacific coast of Japan. The earthquake's magnitude was 9.0, the maximum ever recorded in Japan. The tsunami was also historical in terms of its height and area affected. Its run-up height reached over 39 m. Figure 1 the damage in one of the coastal towns of Yamada in Iwate is seen. Moreover, serious accidents at the Fukushima Nuclear Power Plants (NPP) No.1 of Tokyo Electric Power Co. (TEPCO) were caused by the tsunami. This so called 'triple disaster' (earthquake, tsunami and a nuclear power plant melt-down) resulted in 15,866 killed and 2946 missing, over 130,441 buildings/houses were collapsed or washed-away. The estimated damage overall was between 16-25 trillion yen.

\$183,000,000,000

IN ECONOMIC DAMAGES

15.850

LIVES LOST

4.400.000

HOUSEHOLDS WITHOUT POWER

1.500.000

HOUSEHOLDS WITHOUT WATER



Source: Reconstruction Agency

CONTEXT

Characteristics and damages vary between disasters. The most significant feature of the Great East Japan Earthquake and Tsunami is in its complexity. In order to rebuild the affected zones the Japanese government provided a budget of over 300 billion US dollars, the biggest budget provided for disaster reconstruction in history (Leelawat). Though after 8 years the affected regions still struggle to overcome this episode (Dimmer 2014). Understanding this situation one must ask some vital questions in order to pinpoint where resilience has to be improved.

How did this happen? Truly understanding the impact of the tsunami: Ability of the system and relationship

Why do people reside there or return? What are attractors of the location: Relationship of the system, community and or society

What are other elements that could be of influence in the future? Capacity building for learning and adaptation.

How

A tsunami is a series of long waves generated by a sudden displacement of a large volume of water. Tsunamis are triggered by submarine earthquakes, submarine volcanic eruptions, underwater landslides or slumps of large volumes of earth, meteor impacts, and even onshore slope failures that fall into the ocean or a bay. Most tsunamis originate in the Pacific "Ring of Fire," which is the most active seismic feature on earth. This is the case for GEJE (Great East Japan Earthquake) as seen in the landscape map on the next page. The trench of Japan is a border where several tectonic plates come together. When these plates reach a frictional stress limit the plates slide and an earthquake occurs at the plate boundary causing the displacement of water (image 2).

The impact varies between the area's that are affected that is not only due to disparity of the disasters that struck but also the landscape of the area seen in the landscape map and image 3. From plains around the Sendai area where lots of rice fields are located the run-up was comparable to the inundated area. Whereas the more northern locations in the run-up exceeded the height of 20m.

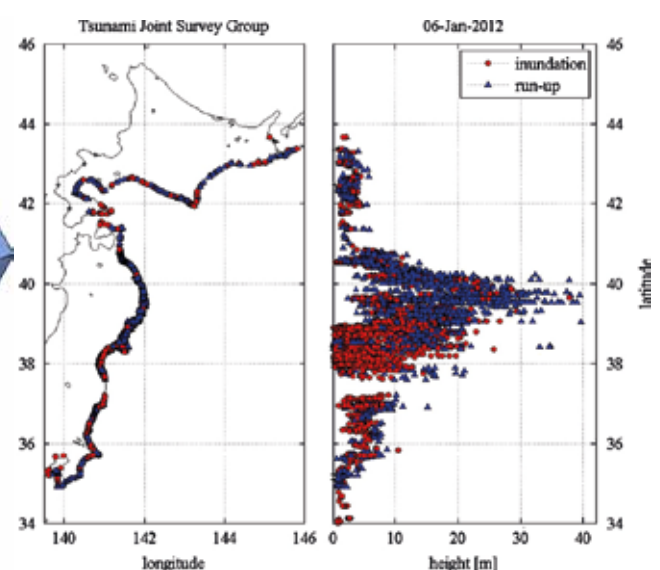
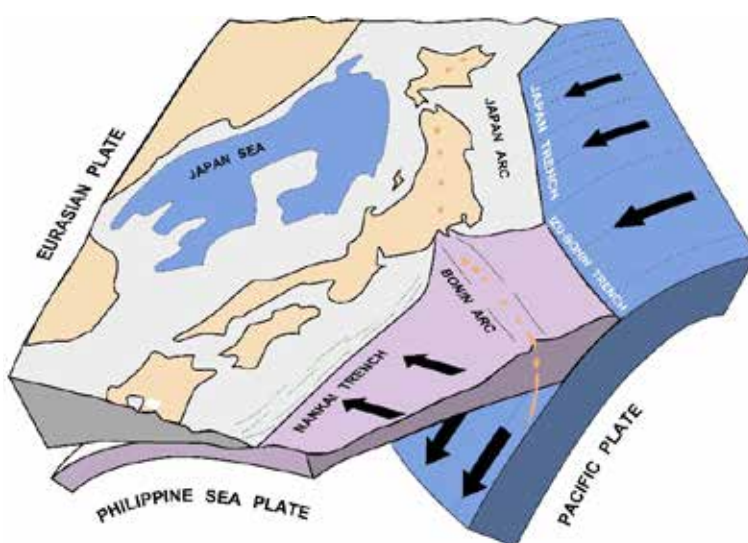
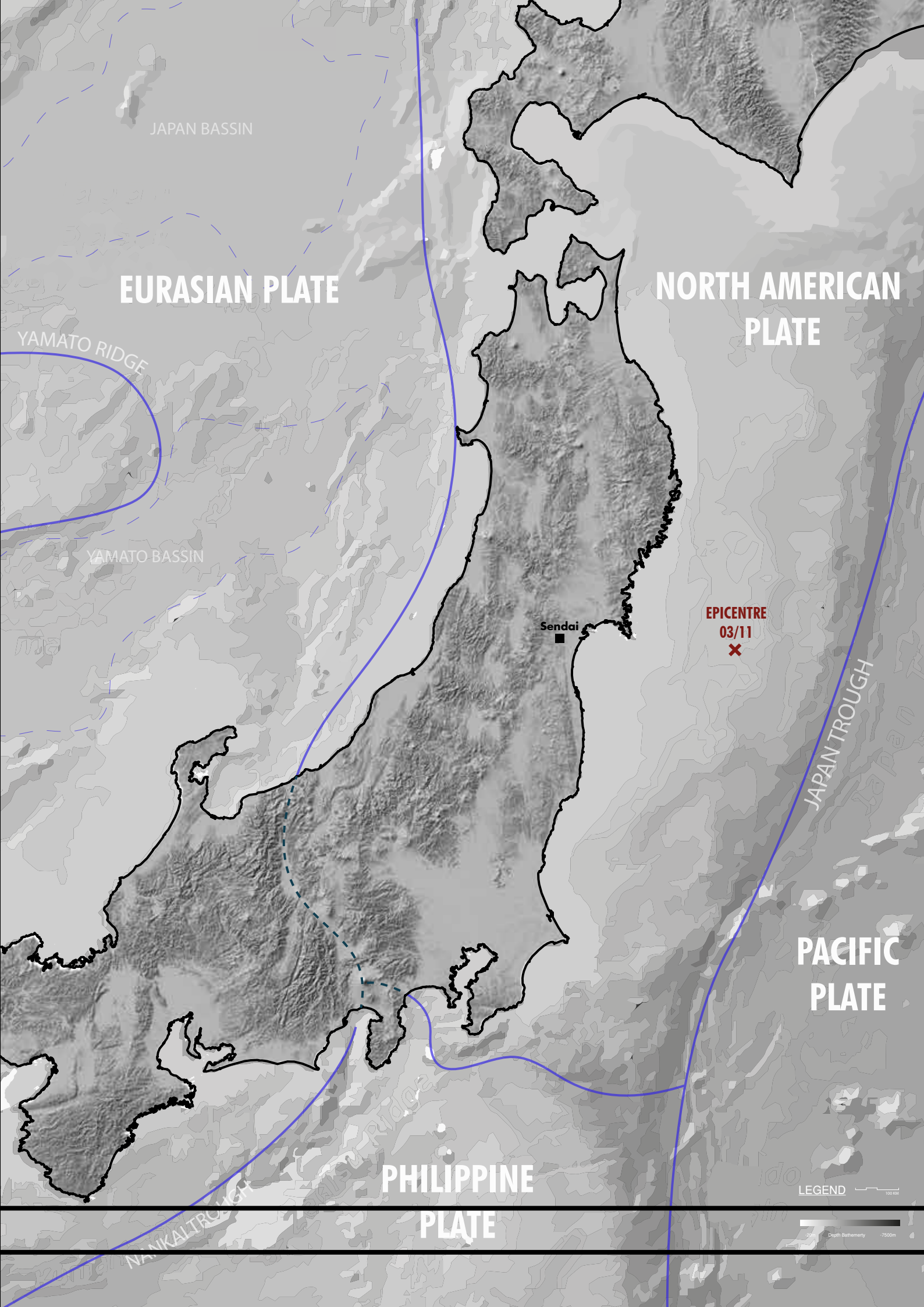


Image 2: Friction between plates, source MLIT
Image 3: Affected coast with inundation and run up height, source MLIT



JAPAN BASSIN

EURASIAN PLATE

NORTH AMERICAN
PLATE

YAMATO RIDGE

YAMATO BASSIN

Sendai

EPICENTRE
03/11
X

JAPAN TROUGH

PACIFIC
PLATE

PHILIPPINE
PLATE

LEGEND

100 km

0m -7500m
Depth Bathymetry

Why

The question rises why people continue to live in these disaster prone area's and if they should continue doing so. This is difficult to answer due to the many factors the local population adopt to stay. Scarcity of land is one of the main driving forces to stay at the location, people have been living there for many years also become attached to its landscape and lifestyle. The proximity of water at the coast is key for agricultural production and is an essential cornerstone in the economic welfare of Miyagi. Rich fishing grounds around is one of the drivers that keeps local communities close to the sea. The built up of mayor ports extends the economic value from only fishing to trade and transport.

The plains inland provide rice, making the area rich in nutritional value for the region and the country. This reflects back on their culture that tie the communities together.

What

At the same time, Japan's society also should address the other problems which correlate with decision made in the past that affect them now and the future. Japan does not have a lot of natural resources in terms of energy provision. It therefore relies heavily on import of vast amount of gas and oil that goes trough the ports of Japan every day.

Gas lines are not common in Japan (except for Tokyo) and therefore it is customary to use propane tanks in proximity of households. To minimize the dependency of fuel import, Japan invested in an intricate network of nuclear power plants. These where places mainly along the coastline in order to cool them sufficiently. These choices of energy provision ended to be a grave misstep considering tsunami safety. Propane tanks burst during the disaster creating large fires and in combination with the meltdown in Fukushima. We can say that part of cause of the disaster during 11th of March was man made. A shift towards a renewable energy network is essential towards a safer and cleaner society considering emissions and climate change. The latter also having other impacts on the future resilience of the country (see image 5).

The last future consideration is the rapid aging of the Japanese society. The ministry of housing and welfare predicted that in 2050 38,8% will be over 65 years, which will be a strain not only on the economy but has also his effects on society.

Reflecting on these details enforces us to address the *aging society, energy dependency and climate change in this project* and work towards a nature friendly society in an integrated manner.

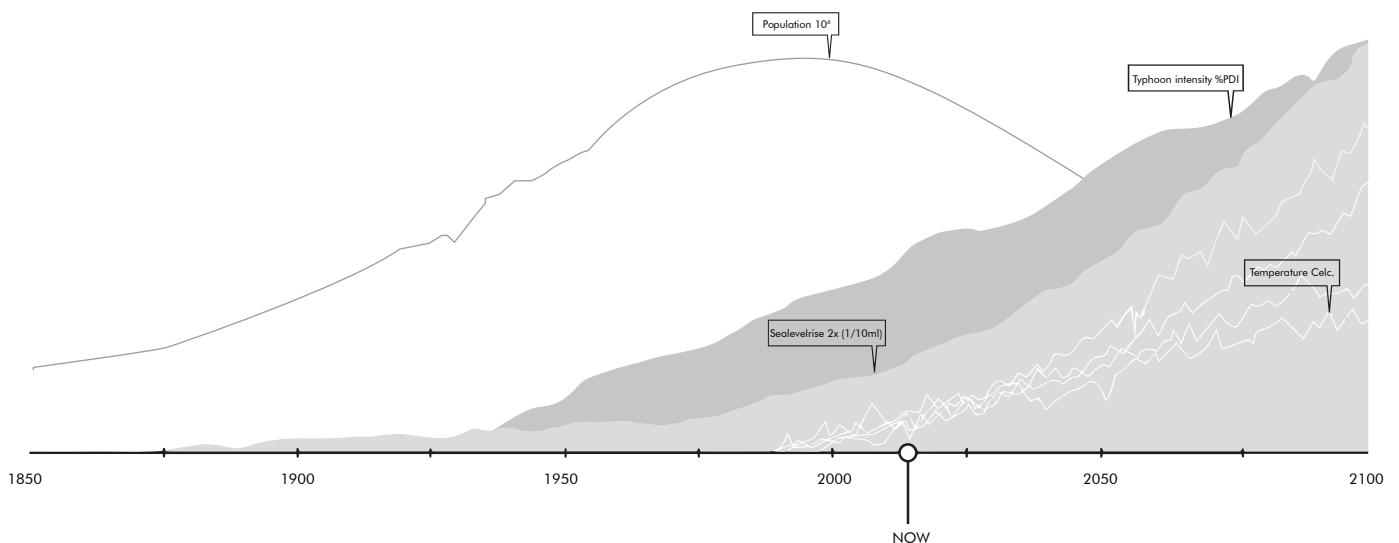


Image 4: tectonic plates in Japan, source: Author

Image 5: Future challenges projected on a time line, source: Author

INTERCONNECTED VULNERABILITIES

Understanding the effect that the tsunami had on the systems of the region we can uncover that there is an inter-connection between the vulnerabilities of a disaster. Environmental, infrastructural, economic, and social systems are all effected during a disaster of such a magnitude and can even magnify risks. Reconstruction is therefore not building the former local societies. But the creation of new societies which are safer, more environmentally friendly and more vital. This is a real challenge for Japanese society. Considering the interdependencies gives a detailed perspective on what the region needs and to identify ways to approach this complex problem and build resilience (see image 8).

So how do we build resilience? Academicians, organizations and governments have been working on concepts to understand ways to improve the conditions of communities and countries after disaster (image 7). They all have their own interpenetration towards resilience. This is also the case of the government of Japan, the budget they issued is connected to their own view and ways on how to reconstruct a region. In the next chapter we will describe that these steps where towards reconstruction and resilience.

Academicians	Framework	Keywords
Holling (1973)	...the persistence of relationships within a system and is a measure of the ability of these systems to absorb change of state variable, driving variables, and parameters, and still persist.	Relationship within a system; persistence of system.
Folke, et al. (2002)	...resilience for social-ecological systems is often referred to as related to three different characteristics: (a) the magnitude of shock that the system can absorb and remain in within a given state; (b) the degree to which the system is capable of self-organization, and (c) the degree to which the system can build capacity for learning and adaptation.	System can absorb; system capability; capacity building for learning and adaptation
Godschalk (2003)	...a resilient city is a sustainable network of physical systems and human communities.	Physical system; human communities
International Organizations	Framework	Keywords
IFRC (2004)	...the capacity to survive, adapt and recover from a natural disaster.	Capacity to survive, adapt and recover.
UNISDR (2009)	...the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.	Ability of system, community or society; resist, absorb and recover from the hazard effects.
USAID (2012)	...the ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth	Ability to mitigate, adapt to and recover from shocks.
Policy Makers	Framework	Keywords
CAS, Japanese Government (2013)	...We are committed to creating a strong and flexible (resilient) country against any large disasters under the following basic principles: prevent human loss by any means; avoid fatal damage to important functions for maintaining administration as well as social and economic systems; mitigate damage to property and facilities and prevent expansion of damage and achieve swift recovery and reconstruction.	Prevent human loss; avoid fatal damage; mitigate damage to property and facilities; swift recovery and reconstruction
BNPB, Indonesian Government (2010)	...the vision of disaster management in Indonesia is a nation that is resilient in facing disaster... in line with the Hyogo Framework for Action.	Hyogo Framework for Action

Sources: Prepared by authors based on Holling (1973); Folke, et al. (2002); Godschalk (2003); UNISDR (2009); IFRC (2004); USAID (2012); CAS, Japanese Government (2013) & BNPB, Indonesian Government (2010)

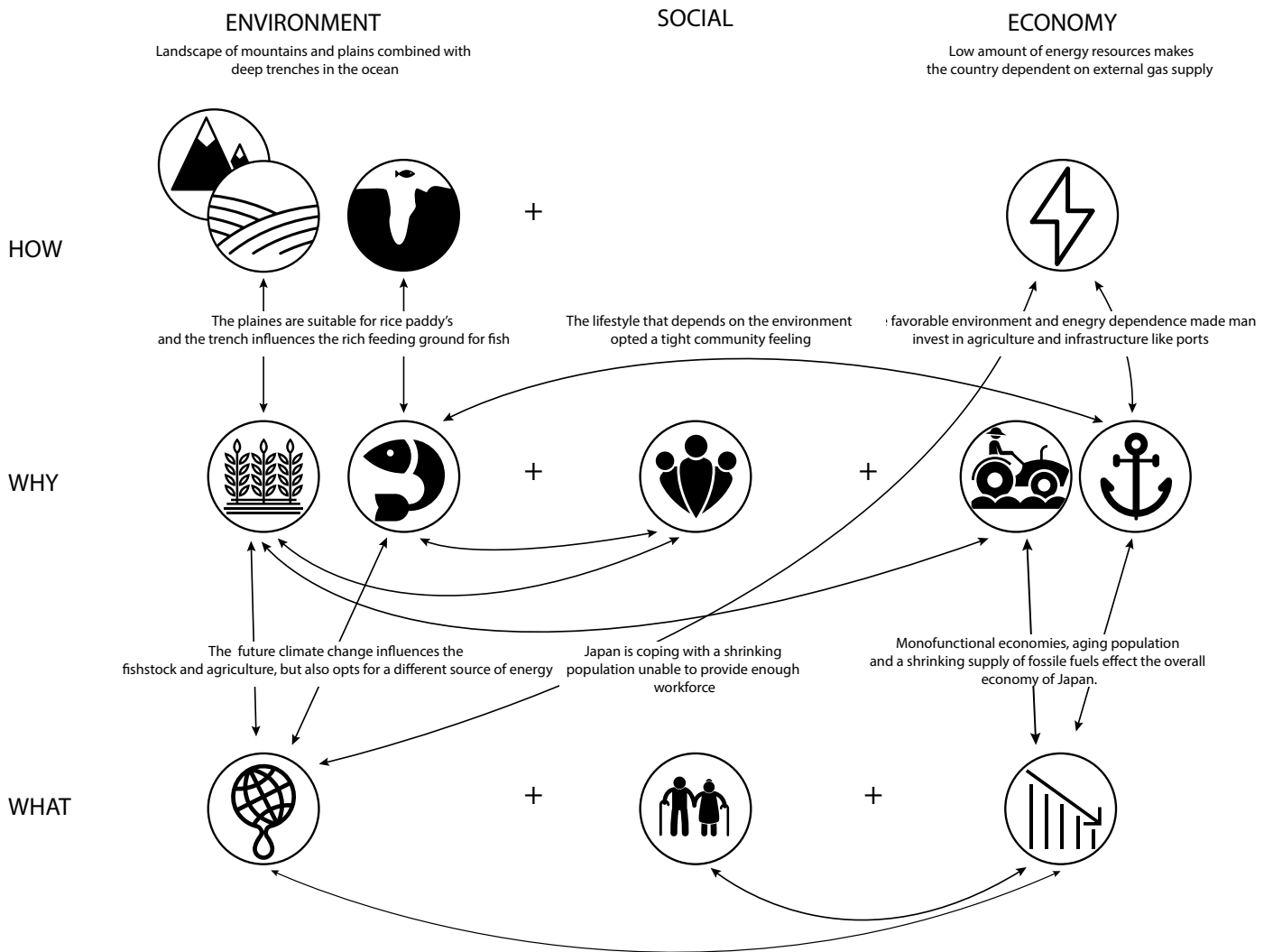


Image 7: Resilience based on different sources
 Image 8: Framework of interconnected vulnerabilities, source: Author

RESPONSE

Government agencies, businesses, non-profits, academics, and countless individual volunteers sprang up to tackle Miyagi's challenges. They wasted no time in transforming public and private spaces into emergency response centres, innovating and coordinating complex relief operations, and organizing support and emergency housing for those affected by the tsunami and earthquake. Acknowledging that the previous defence system was not capable to withstand the impact of the disaster the Japanese government adjusted their policy stating: 'We are committed to creating a strong and flexible (resilient) country against any large disasters under the following basic principles: prevent human loss by any means; avoid fatal damage to important functions for maintaining administration as well as social and economic systems; mitigate damage to property and facilities and prevent expansion of damage and achieve swift recovery and reconstruction' (Japanese Government 2013).



TWO TIER SYSTEM

The government of Japan set up the a two tier system to start the reconstruction. The first tier was the Reconstruction Design Council this council was used to oversee and guide the reconstruction progress. In June 2011 the council produced a document "Towards reconstruction – hope beyond the disaster" (2011) within this document they presented seven principles for the reconstruction of the affected area.

- Remember and honour the lives lost in the disaster.
- Make community-focused reconstruction the foundation of efforts towards recovery.
- Tap into Tohoku's latent strengths.
- Construct disaster-resilient and safe communities and a natural energy-powered region.
- Simultaneously pursue reconstruction of the afflicted areas and revitalization of Japan's economy as a whole.
- Seek an early resolution of the nuclear accident.
- Pursue reconstruction with a spirit of solidarity and mutual understanding.

The second tier was the governmental body lead by the ministry of Land, Infrastructure Transport and Tourism (MLIT) responsible for the physical recovery to insure the safety of the local population. The government in responses to their new stated policy

"Basic guidelines for reconstruction in response to the Great East Japan Earthquake".

It introduced a multi layered system where there is a division of living and working places. People should live in higher places, while they work on the coastal areas because of the importance of ports and other commercial activities. Based on the run up hight and inundation the relocation distance and coastline defence was to be determined (Strusiska-Correia, 2017).

The combination of the higher ground and elevated roads will ensure the safety of the 2011 tsunami impact which occurs 1/1000 years representing the largest tsunami in the past such as the GEJE. The commercial areas which lies closer to the coast will be protected to by a sea dike. The height was determined based historical tsunami run up records and local topography varies from between 5-15m. These dikes insure a safety return on 1/200 years. The implementation is seen in image 5.

In order to apply to the reconstruction budget, cities where requested to provide a reconstruction plan based on these guidelines from the council and government and the input of their local community. Within 6 months after the disaster all affected municipalities in the prefectures in Iwate, Miyagi, and Fukushima, developed in total 120 different recovery plans (Reconstruction Design Council 2012) (Strusiska-Correia, 2017)

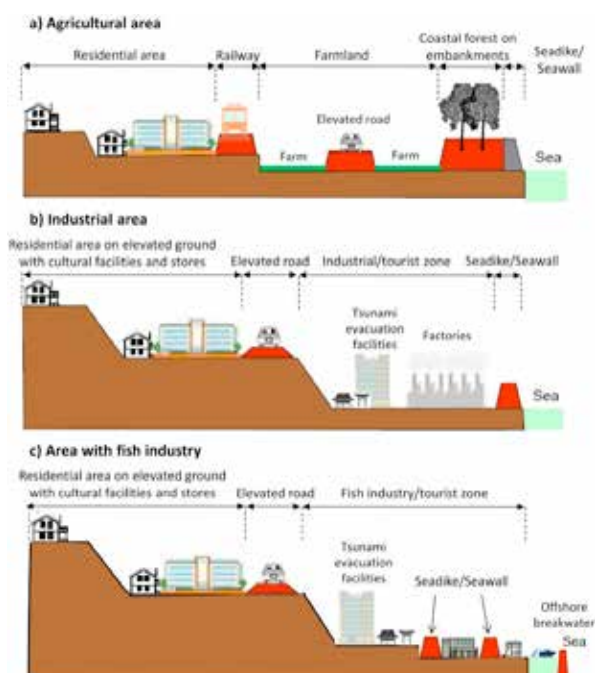


Image 9: Multi layered defence system, source Sendai city

UNSTRUCTURED PROBLEM

Though these guidelines are set and executed there is no certainty that such a disaster is only possible on the long term. The statistics the state used in order to determine the risk of a possible tsunami threat is similar to the one The Netherlands uses in risk assessments to determine the chances of flooding, the Japanese government simulates a similar risk analysis to determine the probability of a tsunami comparable as the one in 2011. This became the benchmark of the protection required in the region of Tohoku. Though one can argue that a similar tsunami may hit the coast in a 1000 years as in the history of Japan several tsunami's in 1896, 1933 and 1993 had similar and or higher wave heights (Shuto & Fujima, 2009). Determining the chances of this tsunami makes it a known unknown and brings forward the question if this level of protection is properly assumed (Pesch & Cuppen, 2016)? Based on these findings we can conclude that for the reconstruction areas the most effective strategy in order to save lives there is no other option than a swift evacuation.

This appeared to be an unstructured problem. Academicians in several papers discussed the reconstruction and their own conceptions towards a resilience of such magnitude (Murakami et al., 2014)(Cutter et al., 2008)(Roggema & Yan, 2017)(Strusinska-Correia, 2017)(KONTAR, Santiago-Fandino, Takahashi, 2016)(Pickett, Cadenasso, McGrath, 2013). Infrastructure engineers argue that building networks and housings with this time frame is counterproductive as their systems are efficient between 10-50 years due to a changing society and quality of the houses. On the other hand the method of defence was in dispute. Hydraulic engineers 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 combination of hard and soft measures "bio shields" (use of coastal vegetation for mitigating tsunami's) instead of a large dyke system. These discussions did not only occurred between academicians but trickled down to Japanese politics and society, and even in our own interdisciplinary group. Concluding that there is no consensus between the criteria used in solving the problem and that problems and solutions are dynamic (Pesch & Cuppen, 2016) (Santiago-Fandiño, 2017).

FIELD RESEARCH

Ishinomaki



Matsushima



Sendai



The tsunami affected over 400 km of coastline, with the highest fatalities in Miyagi Prefecture 57%, 33% in Iwate Prefecture and 9% in Fukushima prefecture (Mori, Takahashi, Yasuda, Yanagisawa, 2011). As our case is focused on Miyagi our team visited the university of Tohoku in Sendai, the capital of Miyagi. At the university we received lectures from a specialized research institute the International Research Institute of Disaster Science (IRIDeS) that was founded after the GEJE (Great, East, Japan, Earthquake). The IRIDeS conducts research on natural disaster science and disaster mitigation, learning from and building upon past lessons both in Japan and outside.

From there onwards we visited several cities along the coast to observe the reconstruction and communities that were affected. What stood out was the difference in how the multi layered defence system was implemented. Partly can be ascertained from the landscape where the cities reside but it is also an interpretation of what seemed important from a local point of view. Which affects in how the reconstruction villages are rebuilt. At the site visit of Yuriage (image below) we noticed that the village was rebuilt against all odds within the inundated area. A slab of 4m raised land was constructed to provide space for housing in combination of a large concrete dyke system to comply with the safety measures of MLIT. Whereas the village of Iwanuma 10km south of Yuriage redesigned the dyke integrated in a forest with a relocation further from the sea. All these different approaches along the reconstructed coastline led to a fragmented spatial design throughout the landscape.

The Miyagi prefecture though often perceived otherwise, can be seen as a prefecture potentially rich in terms of resources (Dimmer 2014). The question then, is how its resources can be activated to sustainably boost locally added value to address the challenges the region faces? Could the region skip the recovery phase, and focus on tackling their problems on head first? The current situation offers the region a window of opportunity. Indeed, much of what is considered in arrears today can be smartly developed into the foundation for transitioning into a resilient society.

Yuriage



Source: Author

PROBLEM STATEMENT

The essence of the problem statement comes from three core issues that are found during analysis and the field research.

- Fragmentation in the urban landscape
- The complex problem of intertwining vulnerabilities

Fragmentation:

Based national guidelines 'multi layered safety' produced by the Japanese government and the principles of the Reconstruction Design Council. Developed their own recovery plans as mentioned in the previous chapter.

As this seems as a good construction it did leave a fragmented appearance of the reconstruction. The dominant outlines of the multi layered system made it hard for the municipalities to construct a consensus among residents on a vision for land-use planning (including potential resettlement of communities), and the implementation program. The fishing community would prefer a connection with the ocean as this is their main income source. This seems impossible as the first zone is non residential. Relocation is therefore quite evident and does not leave a lot of leeway unless drastic civil measures are undertaken like in Yuriage (Dimmer 2014, 2017)(Santiago-Fandiño, 2017)

Another issue is the centralized systems the government implemented. Though most of the responsibilities lies with the municipalities, the central government placed reconstruction headquarters in every prefecture to lead the process in the right direction. This dismissed most of the responsibilities of the regional legislation. It achieved a direct consultancy with the national levels but on the other hand this system has its downside. Strong centralization results in vertical compartmentalization (tatewari gyosei) (Abe & Alden, 1988) in which local governments do not coordinate between their own prefectures and become competitive and fragmented (see image below).

Another aspect is that through this system a lot of time is spent in claiming this budgets by local government as agencies overlap in subsidies. Smaller municipalities usually do not have the capacity to apply for these budgets which makes it difficult to compete with larger ones who have a more man power (Tanimura et al., 2001). This is seen along the coast of Miyagi where reconstruction of the basic needs is there apparent but further development regarding the principles of the Reconstruction Design Council is difficult to achieve for smaller municipalities.

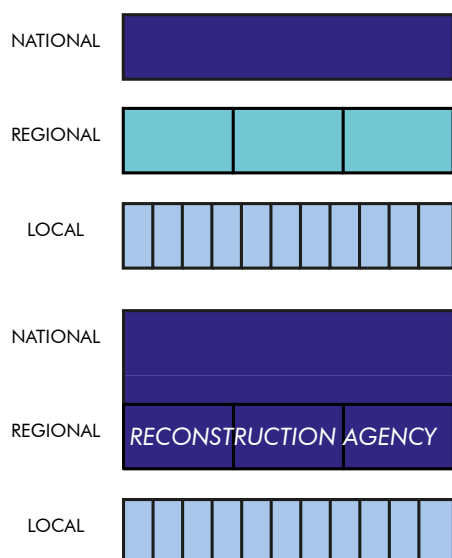


Image 10: Planning system before and after the disaster, source: Author
Image 11: Factor of difficulty, Source: Designing to Heal ,2013
Image 12 : Problem statement elements and wishes, Source: Author

Complex problem:

The reconstruction design council did mention challenges that needed to be addressed in the reconstruction of Miyagi. Though in the execution of the reconstruction most of these principles are not found in the plans of the local municipalities. Part of this is the fact that multiple challenges were present before the disaster happened which left the region already a step behind in recovery.

The first issue are the economic dynamics present in the Miyagi coast. The combination of a shrinking periphery and a economy depending on agriculture and fishing result in a fragile situation for coastal towns. The low birthrate that will not provide enough workforce is not the main cause of economic instability. More so is the lack of economic opportunities that lead to outmigration of the younger population in the towns towards Sendai which provide a wider range of job opportunities.

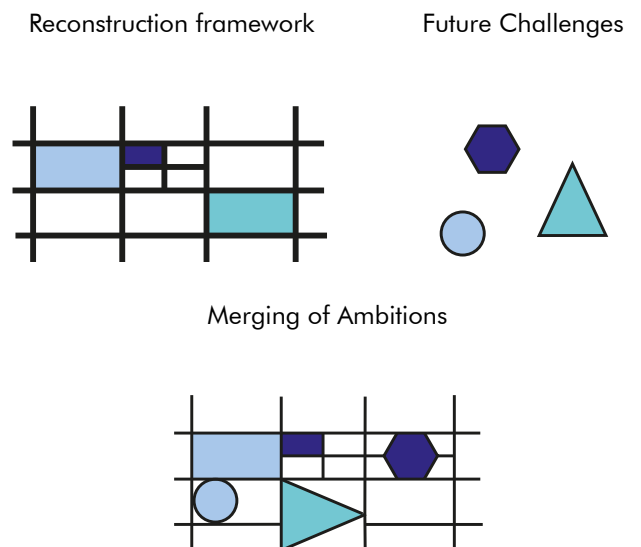
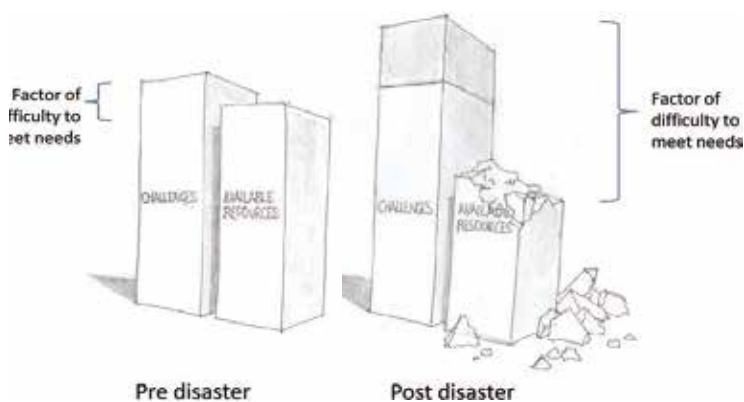
Another issue is the large reliance on many monopolistic utilities in Japan. Main one being energy. A decentralized energy system is not only less vulnerable in the event of a disaster, it also promotes a true devolution of political power, enables community empowerment and leads to a more even distribution of wealth.

These observations rise above the capacity of a single local force. The magnitude of the problems at hand struck by the disaster itself is a big challenge to tackle for a community, let alone solving a complex issue as economic

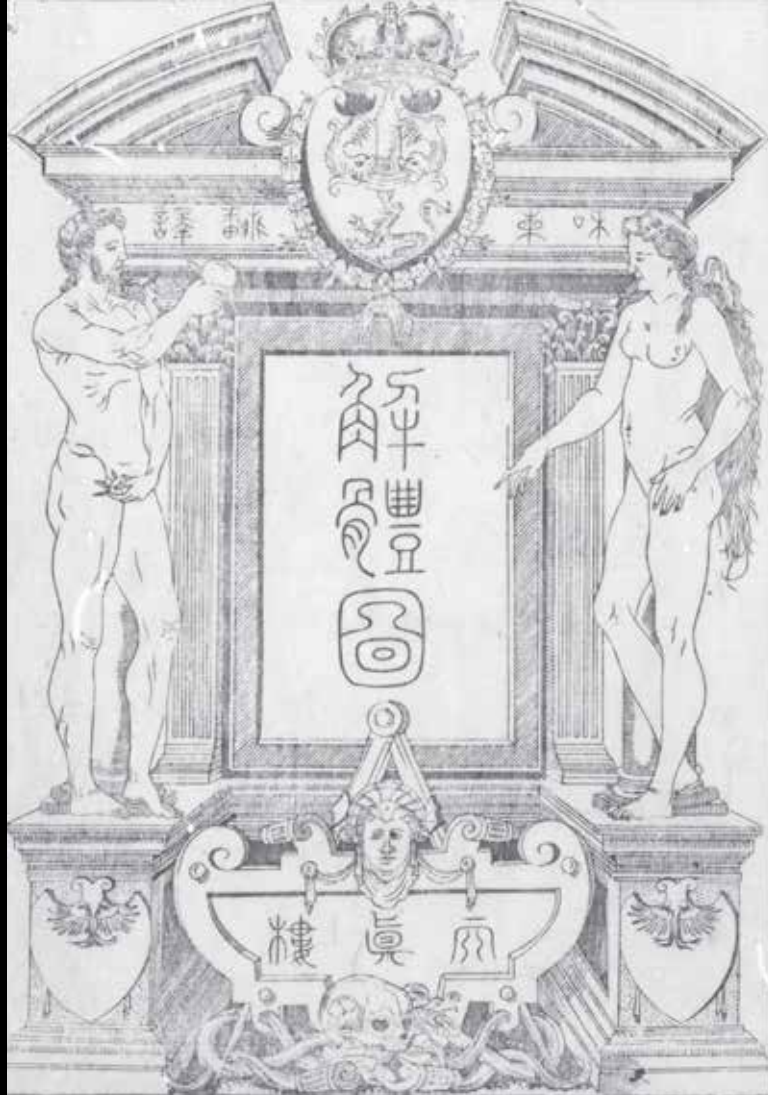
development and energy transition.

Implicit within this phenomenon is recognition that disasters create a gap between the size of the challenges people face and the locally available and familiar tools to meet those challenges (see image 11). As the way we look at our surroundings is influenced by the needs we call on those surroundings to meet (Porteous, 1977). The needs that we are aware of at any particular time will vary according to our economic/social circumstances; our age, gender, tastes, preferences, cultural values and experiences (Donovan, 2013).

We can conclude that the reconstruction framework presented by the government is too rigid to incorporate complex problems. The combination of the complexity of the disaster and future challenges overburden the local governances which result in an under achieving reconstruction. Presenting municipalities with more cooperative and flexible possibilities in where they can tackle large challenges together can lead to a comprehensive redevelopment. The main challenge is how to merge these aspects in order to improve the see current resilience of the region (image 12)?



HYPOTHESIS



The engraving above depicts the body of knowledge called Rangaku (translated as Dutch Learning) a period when Japanese scientist expanded their knowledge in medicine, physics and chemistry through contacts in the Dutch enclave Dejima. The only western country in contact with Japan during the enclave of 1641-1853. Could we reintroduce Rangaku in the tsunami affected coast to improve their resilience?

RESEARCH QUESTION

Could we resolve the fragmentation of the Miyagi coast line by inserting another layer that can integrate local and governmental demands whilst addressing them on a equal level of importance? This open and comprehensive approach of development is a way of thinking that has been part of the Dutch planning for a long time.

The Dutch planning system is known to have an extensive history as Martin Hajer (Moser, 2012), professor of public policy at Amsterdam University states: "We tend to think we invented the idea of multi-layered planning. Our problems with water meant we had to take collective political action in order to be able to build dikes. We always say that the origin of Dutch planning lies in this co-operative dike-building." This past makes it one of the most elaborate planning system in the world.

One of these concepts developed by Dutch planners is the Randstad. Plesman, the founder of KLM, Royal Dutch Airlines, has been credited with founding the term Randstad when he observed the area from the air before World War II and observed a string of cities Amsterdam, Rotterdam, The Hague, and Utrecht- form an urban network (Dieleman 1992).

By using the Randstad network as an overlay (image 14) we can string several cities like Sendai and the coastal towns addressing the compartmentalised redevelopment and integrate local challenges with future ones whilst respecting the differences of the local communities. In total we cover 10 municipalities using the same area coverage between Amsterdam, Rotterdam, The Hague and Utrecht (1150 km²). These are from north to south: Ishinomaki, Higashi matsushima, Matsushima, Rifu, Shiogama, Tagajo, Shichigahama, Sendai, Natori and Iwanuma. Using the rudiments of the concept we can define the challenges and opportunities to promote collaboration and distribution between the cities and therefore answer the research question:

Can the introduction of a regional design lead to development that can increase the resilience of delta regions?

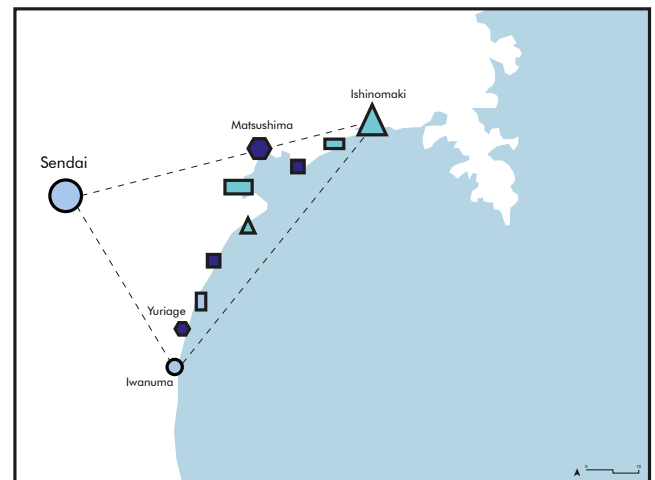
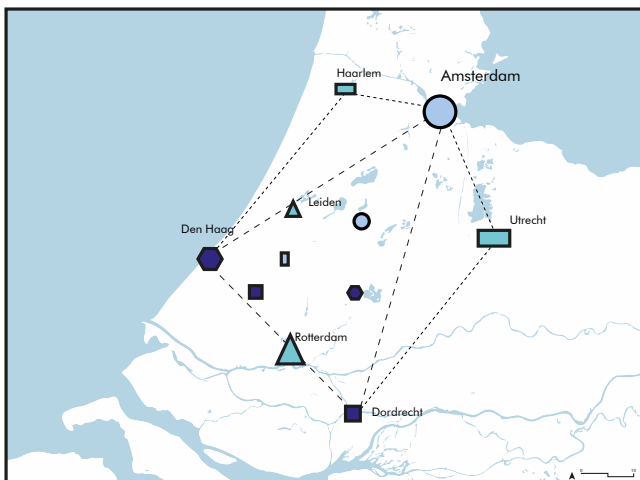


Image 13: Kaitai Shinsho, Source: Tokyo Medical University
Image 14: The Randstad principle projected on the Miyagi coast, Source: Author

THEORY

The results of the analysis have confirmed that a regional approach could offer a frame that allows us to make the much needed shift from central and causal planning (analysis leading to strategy leading to planning leading to action - although this last step almost never happens) to a more open planning approach, a work in progress that allows for much more complexity.

It is a method that helps us to detect the overlaps that make for strategic points of intervention and to connect challenges to development opportunities. As a frame for development it generates the emergence of a more multiple use of land. Understanding the potential of the country is also meaningful in connection to the chances of the wider region, and of the country itself. It allows for the recognition of opportunities.

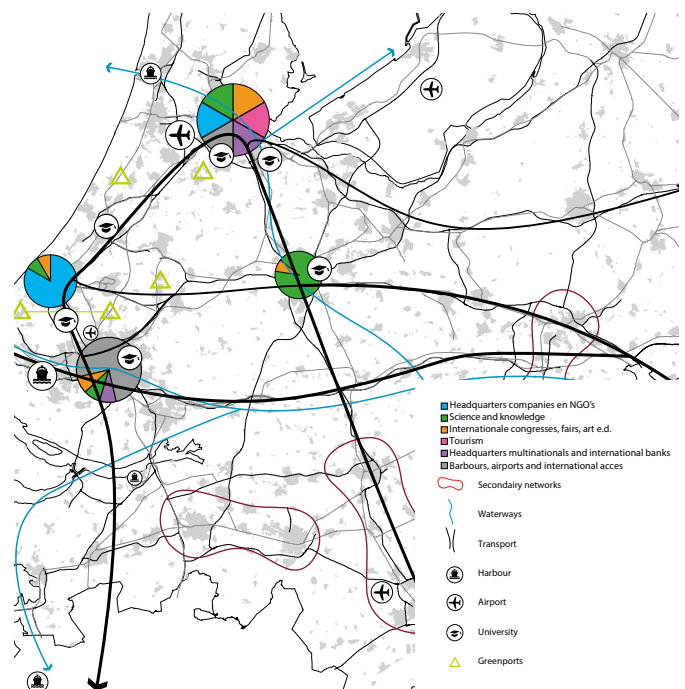
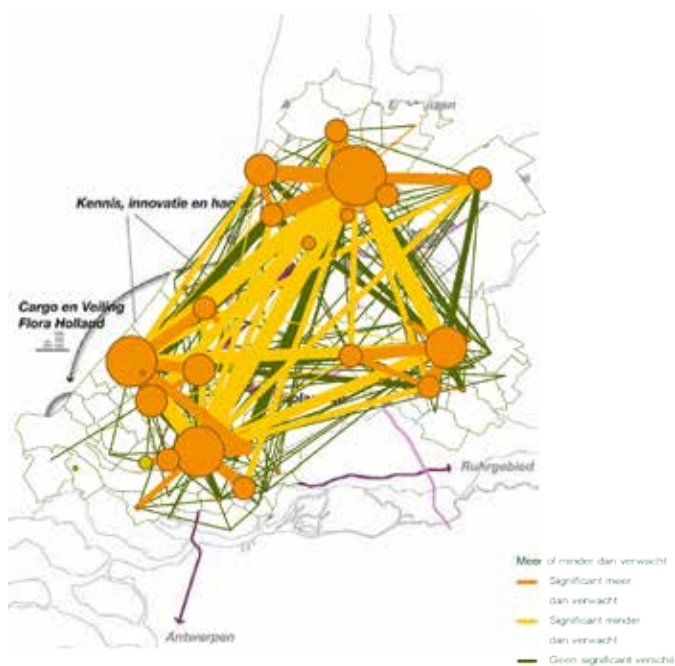
Positioning Miyagi within region and trends that affect the whole country while looking through the frame that the Randstad approach provides to identifying mutual advantages between towns. Obviously, the Randstad approach has many differences compared to the way regional planning has been done in Japan for years. But in the case of Miyagi it soon became clear that it also provides a potential to unlock new ways of looking at a region into a more integrated territory.

To understand the Randstad concept we define its core values and elements. From there we compare it to the situation in Miyagi.

The Randstad:

There are no official boundaries for the Randstad there is no exact location and size, therefore it does not fit into one of the three government tiers in the Netherlands. It stands in place as an abstract concept as no government policies are implemented. To avoid merging into a large metropolitan cluster the cities interact with each other based on their personal 'profile' that is evenly distributed throughout the Randstad. The division and reorganisation of the profiles gives the city or subregion a character and can complement the adjoining cities to form a economic 'powerhouse' (Brand, 2012) (image 15).

The distribution of functions and profiling is best seen in the so called 'big four' of the Randstad. It includes the cities Amsterdam, Utrecht, Rotterdam and the Hague. In image 16 the profiles are defined. Amsterdam functions as a capital with a diverse set of economic sectors, however is distinguished itself with an influx of tourism through the presence of cultural activities and the proximity of the international airport.



Rotterdam benefits of the presence of specialized multi-nationals that benefit of the large harbour. While Utrecht specializes in science and knowledge, it also is known for being the transport junction, as train and road infrastructure both connect the other 3 cities directly. And last The Hague is represented with the governmental heart of the country. On international level it houses several important task as the peace palace and the international Court of Justice attracting NGOs all over the world.

Ascertain is that the distribution of these method of concentrated businesses connects towns and cities as a polycentric model melding them into a integrated economy that has optimal growth potentials, and is able to compete against large metropolitans areas like Paris and London (Lambregts 2008)(van Oort, Burger, Raspe 2010).

This interaction of specialties is described by Saskia Sassen (2009) as a the functioning of a 'global city'. Each speciality takes place in a circuit, some on a international levels, others more regional. Sassen states that a perfect global city will interact with all of these circuits, forming a seamless global economy, with clear hierarchies. In reality this is not the case as these specialties come with high urban demands and geographical preferences, limiting the development of cities (Sassen, 2009). This was also the case in the Netherlands. The scarce amount of land and relatively small city size limits the grow of the capital. Secondly expanding in an economy becomes so complex that outsourcing and expansion is needed risking the economic diversity of other sectors. As a result of these limit a diversification was the most optimal choice. Crucial to its feasibility is the optimisation of transport of people and goods creating a physical connection of the model.

We can see that the main components of these profiles used in the Randstad are based on their *main sector* and *sub sector* and physical location that reflects on the *land use*.

Most important is that these profiles never stay the same over a longer period of time. Economy, politics and climate influence the profiles of a city within its local administration or from higher governmental bodies. An overview of development though multiple layers of governance creating a platform where the evolution of a region can be influences from a broad range of the society.

Transferable:

Using the approach and implementing it on the Miyagi coast seems a leap between two scales. But as we take a closer look to the characteristics of the Randstad as a whole we can compare similarities:

- Concept of polycentric urban regions: polycentricity refers to the morphology of urban areas, arranges between larger and smaller nodes structured around nodes, which have functional relationships between the urban areas in terms of commuting, industrial and business. Sendai with a core tertiary business varies between the southern fishing coast and northern agriculture.
- Diversity in business: Within the Randstad, the Amsterdam and Utrecht regions are particularly important business services strongholds.
- Main ports: Schiphol is one of the bigger airports compared in flight movements and Rotterdam harbour is one of the biggest in the world. In the placed triangle we can conclude that Sendai airport is one of the main airports in the northern region of Japan which is the same for the harbour of Sendai and Ishinomaki.
- Horticulture: Flowers are the principal added value activity of agribusiness in the Netherlands. It has been estimated that horticulture represents approximately 5% of GDP. It is concentrated around urban areas. In the Miyagi prefecture fishery and production is a main export product for the rest of Japan. (Lambregts 2008).

Image 15: Complementary interaction,
Source: Ruimtelijk planbureau
Image 16: Profile of the cities, Source: VROM,
Randstad 2040

METHODOLOGY

Spatial challenges are rarely formulated clearly: problems experienced at eye level are rarely the same problems as those experienced at a local, regional, national, or international level. Spatial issues that result from a single reason or cause manifest differently at different levels. It is therefore difficult to decide on what kind of problems manifest at an regional level and are appropriate to map and intervene. Therefore we use several methods in an iterative process to rule out irrelevant information to reach a clear picture of the delta region.



This goba pine in Matsumoto is called "Screw of screw thread". The root alone supports the whole weight. Perhaps it is thought that the tree that broke once broke because it continued to grow toward the sun. It represents repetition to succeed.
Source: Author

METHOD AND APPROACH

DOCA method

DOCA stands for Data, Opportunities, Challenges and Anecdotes, developed by urban design office FABRIC. Starting point is an organized search for available data or themes of data that concerns the mapping of information. Opportunities are identified by sketching possible connections between different flows. The domain of Challenges is conceived as the reversed engineering of current spatial problems, that is: reasoning back in time from the current problems to determine where things went wrong and what could have been done differently. Anecdotes is data collected through interviewing and collaboration between different disciplines and experts to gather point of views that have not been translated into a map. In here we add interviews and information gathered in Japan en collaborate with the other disciplines within the our multi-disciplinary thesis team to tweak and specify the individual design. By noting all available information on the current situation per theme, we can form regional maps that give a picture of the existing system. DOCA method is overall used as an iterative process , every phase will be tackled with use of a different approach in order to get results (Brugman, 2015).

Interdisciplinary approach

This helps to evaluate the work of several disciplines and how to combine them. Working in an interdisciplinary set we can challenge these future prospects in an intertwined matter. It represents a new process for collaboratively researching, developing, and implementing ideas for a more resilient future.

Layered approach

Thinking in layers makes this drawback easier to overcome. Looking at separate problems without understanding their position in the system is not effective. Thinking in terms of a layering it may start from an analytical perspective, but it is not aimed at achieving theoretical solutions. It focuses on the development of an integrated perspective that includes all levels, rather than on the isolated search for ready made solutions for sub-problems. It consists of layers based on systems like: substratum, networks and occupation. As the challenges in Miyagi is different I will base my 'layers' on drivers that are based on the results of the top down and bottom up drivers.

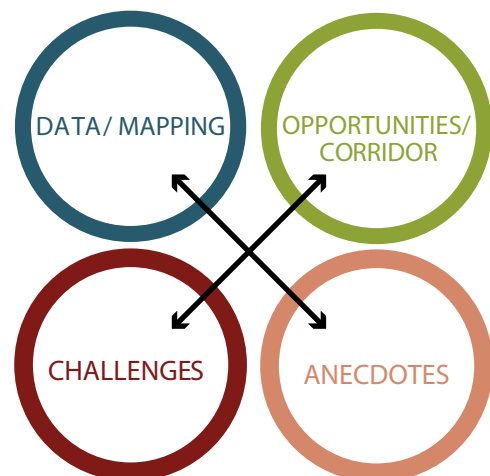


Image 17: DOCA method visualised, Source: Author

Multi scalar approach

This method has a focus on the relation between large scale strategies and design implications on smaller scales. It will be used to create a development strategy from the regional scale towards the neighbourhood scale. By extracting drivers top-down drivers from the government and bottom up from municipalities we can find relations between the layers.

Complex adaptive system approach

The basic principle of this system is linking social influences on the spatial scale. Depending on their influence a pattern will reflect the how the systems changes and is interrelated between subsystems. By placing the reconstruction plans of the municipalities and the government we can extract the main drivers and characteristics of the plans.

Mapping as a way to study

Mapping is a important tool for an Urbanist. It is used to grasp several ways to answer to a challenge. To determine these relations between drivers, visual representations like maps are needed to interpret their effect in a spatial sense (Meyer, 2014).

Interdisciplinary approach

This helps to evaluate the work of several disciplines and how to combine them. Working in an interdisciplinary set we can challenge these future prospects in an intertwined matter. It represents a new process for collaboratively researching, developing, and implementing ideas for a more resilient future.

Layered approach

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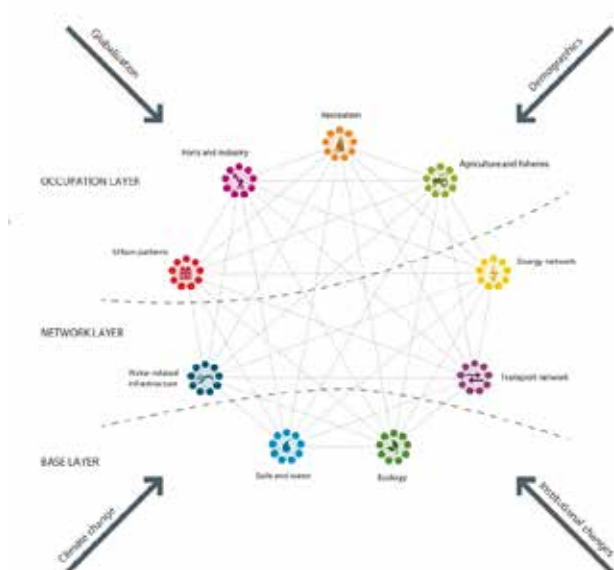


Image 18: Complex system approach. Source: New perspectives for urbanizing deltas (Meyer, 2015)

APPLICATION

The DOCA method starts the process with data collection. To be able to define profiles and to reorganize them we have to create the transparent field where the demands of both government and municipality are represented. Analysing their reconstruction and development program from the reconstruction agency, MLIT and the 10 municipalities in Miyagi can give us indications what demands are present within the organisations.

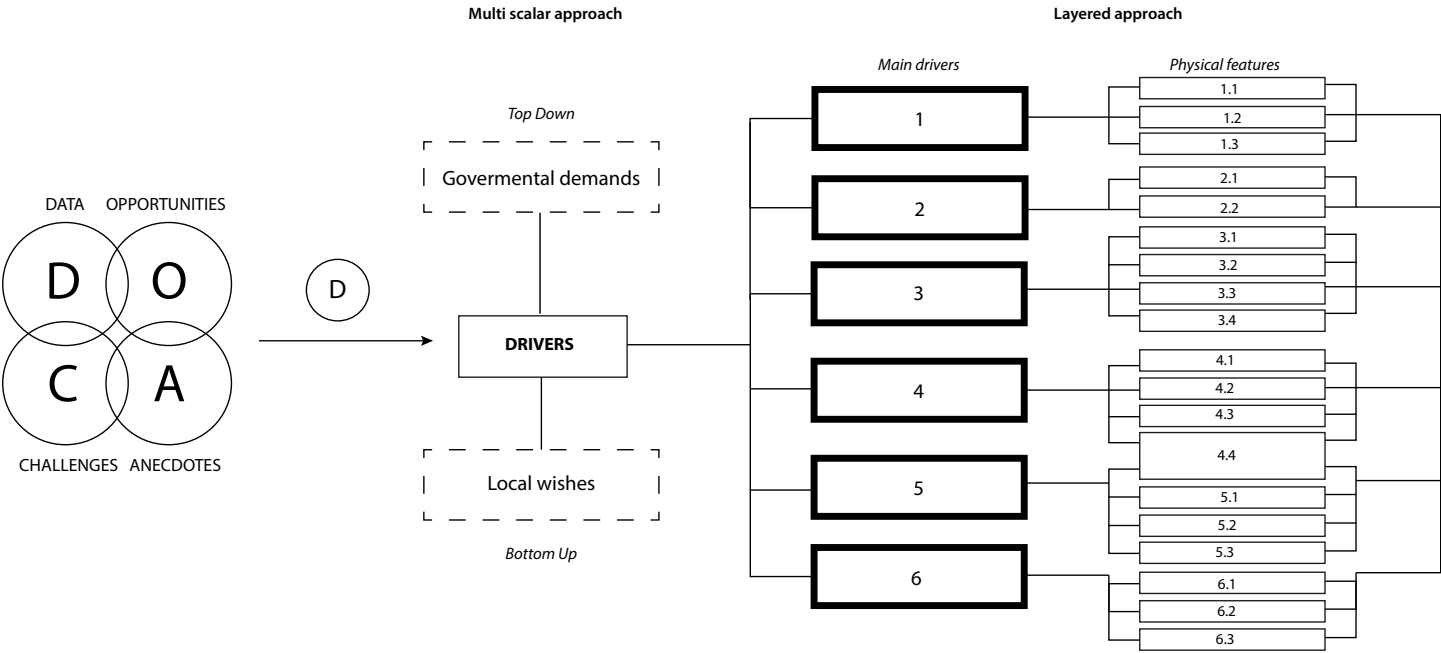
The demands from top-down and bottom-up will be re-defined into drivers that represent key themes in the development of the region. These drivers are described in catch-all-terms to overlap as much demands as possible. Translating these drivers into maps means a reinterpretation into multiple physical elements. This will be the base of our transparent playing field where we can define the profile of our 10 cities.

Understanding how the cities interact with each-other based on their profile will bring forward opportunities and challenges for our strategic plan. The last step is to reflect the effectiveness of the strategy by translating the plan into smaller scale design will test the research question on applicability and effectiveness on resilience.

RESEARCH FRAMEWORK

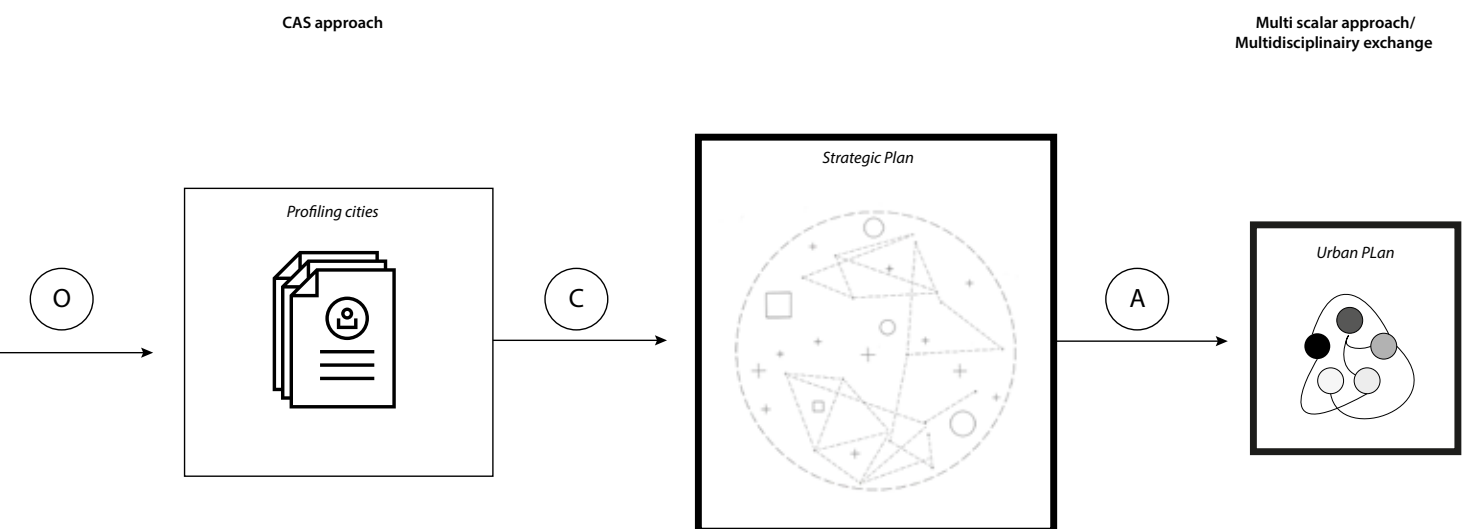
Can the introduction of a regional design in lead

Randstad pr
a



to development that can increase the resilience of delta regions?

A+B=C
Principle + Regional Design
= Resilient Miyagi?



DATA

The data collection from the municipalities, MLIT and the Reconstruction Design Council can be found in the appendix. After analysing their demands we established several main topics that reoccurred throughout the reconstruction plans of the Municipalities:

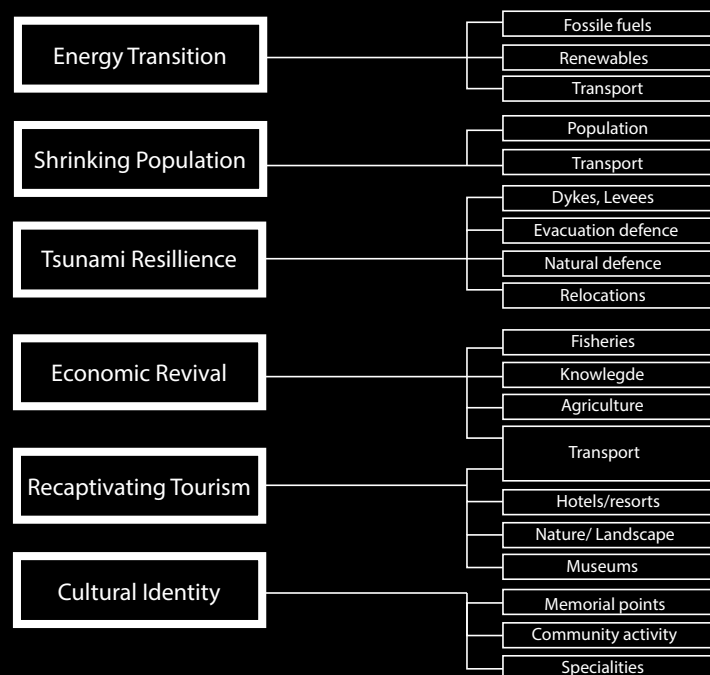
- Tsunami resilience
- Economic revival
- Recaptivating tourism
- Cultural identity

Using the main 2 documents produced by the reconstruction agency and the government: "Towards reconstruction – hope beyond the disaster" and "Basic guidelines for reconstruction in response to the Great East Japan Earthquake" we concluded that the main concerns are:

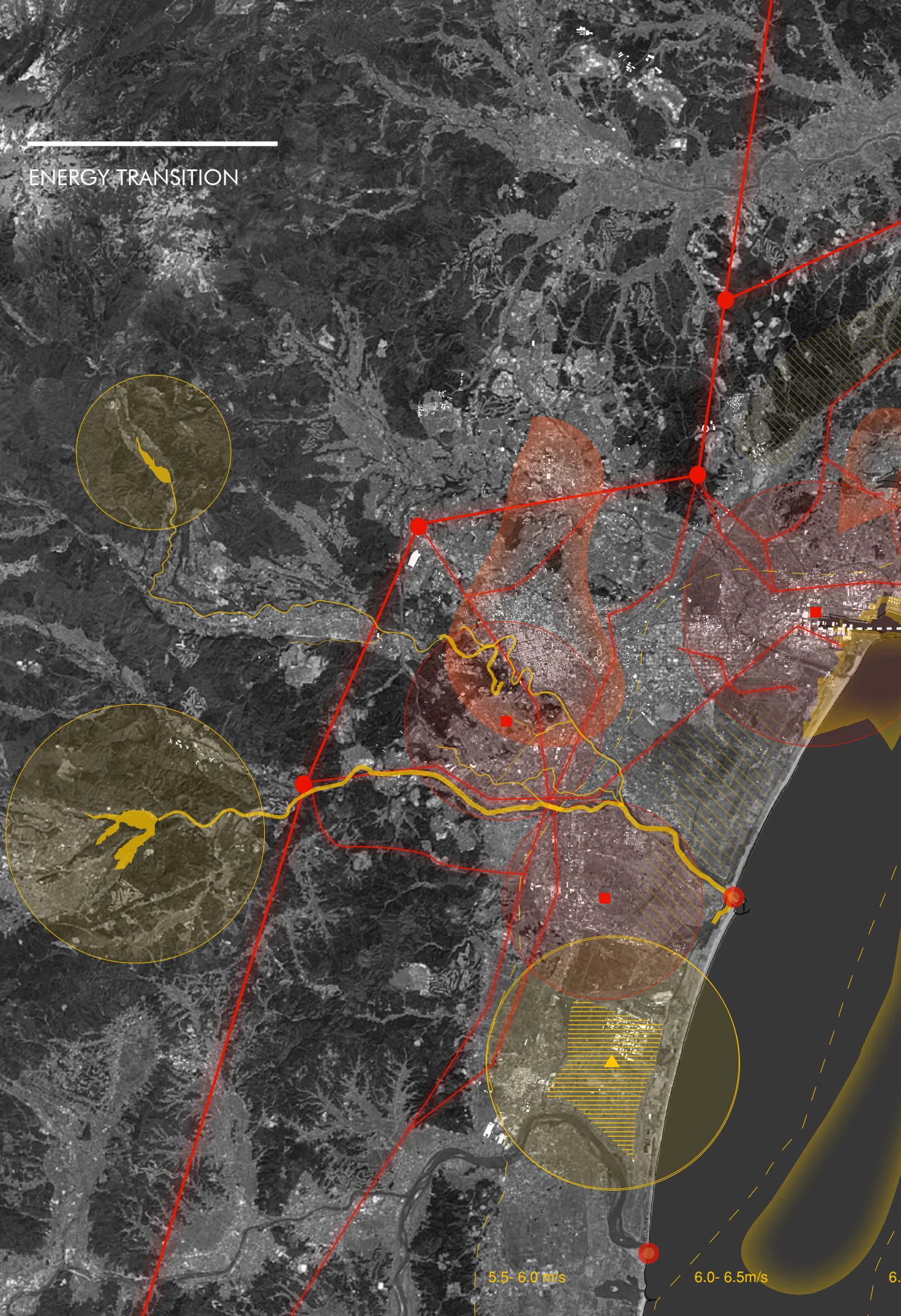
- Tsunami resilience
- Economic revival
- Energy Transition
- Shrinking Population

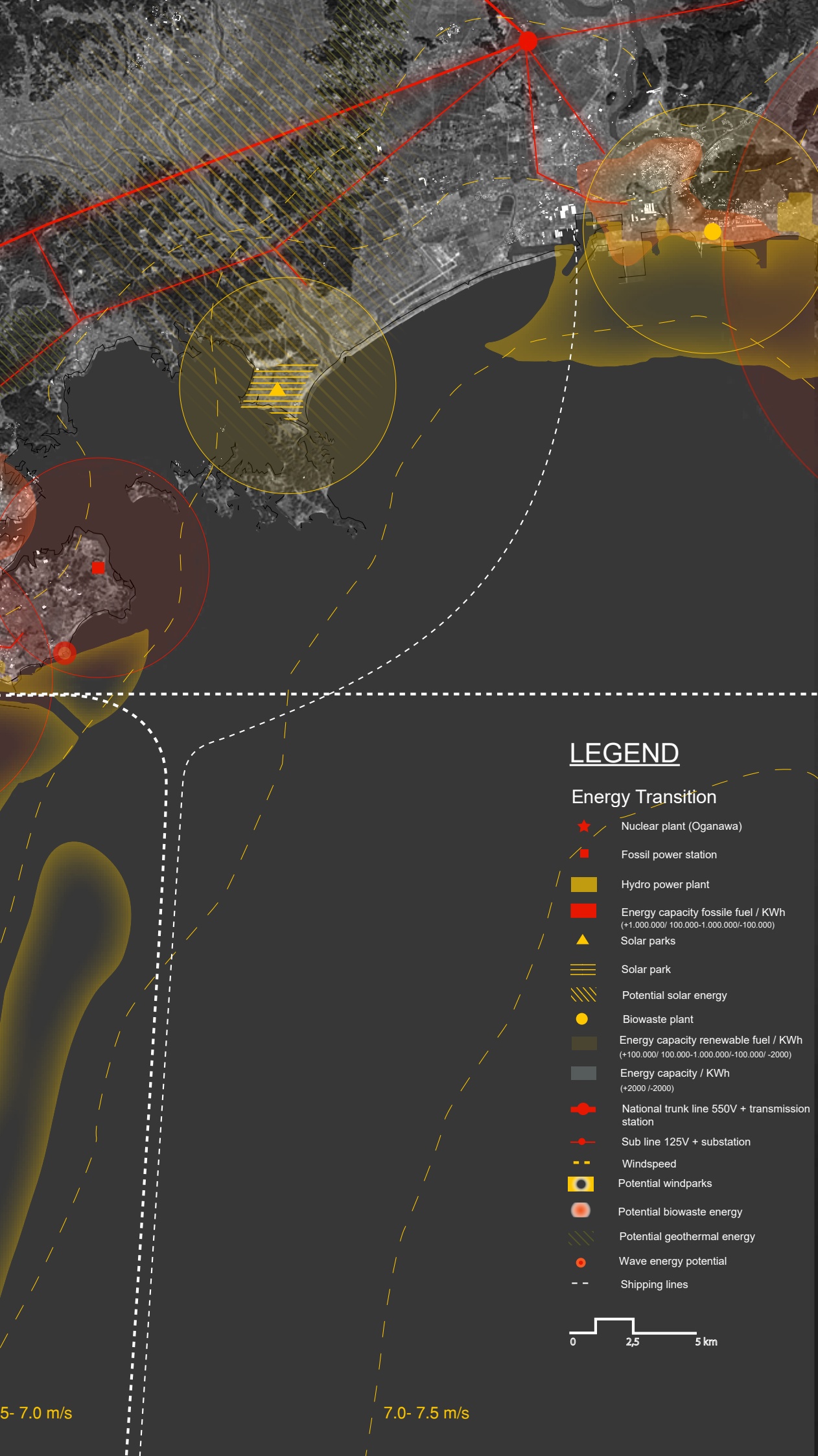
Combining them provides some overlap but adds some perspective in how they regard development in Miyagi.

The image below shows the translation of the drivers. In some cases physical features overlap between drivers as they seem to have a dual functionality. Other translations could be broken up in several elements to present a more nuanced representation of Miyagi. In the following pages you will find the driver map which combines all the physical elements. The page after that combinations of elements are made portraying detailed information that affects the region.



ENERGY TRANSITION





LEGEND

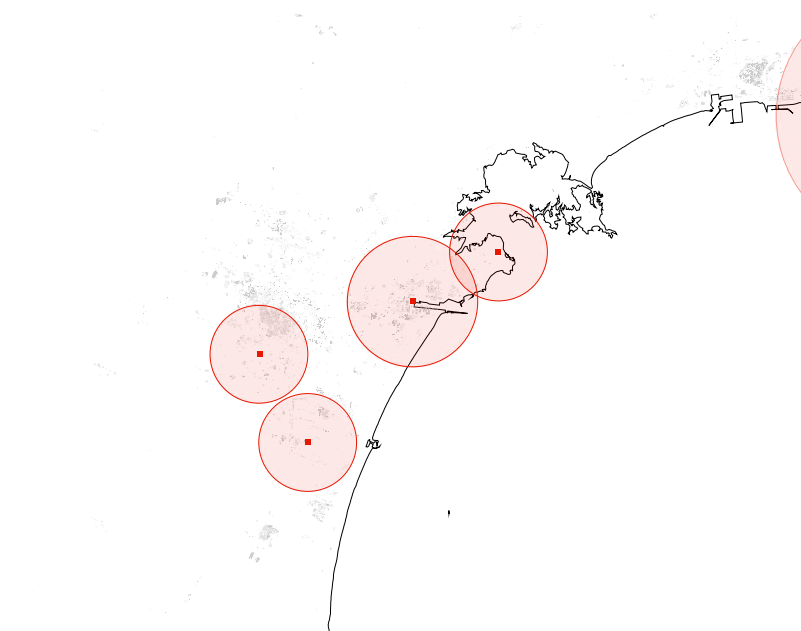
Energy Transition

- ★ Nuclear plant (Oganawa)
- Fossil power station
- Hydro power plant
- Energy capacity fossile fuel / KWh
(+1.000.000/ 100.000-1.000.000/-100.000)
- ▲ Solar parks
- ≡ Solar park
- ▨ Potential solar energy
- Biowaste plant
- Energy capacity renewable fuel / KWh
(+100.000/ 100.000-1.000.000/-100.000/ -2000)
- Energy capacity / KWh
(+2000 /-2000)
- National trunk line 550V + transmission station
- Sub line 125V + substation
- - Windspeed
- ☉ Potential windparks
- Potential biowaste energy
- ▨ Potential geothermal energy
- Wave energy potential
- - Shipping lines



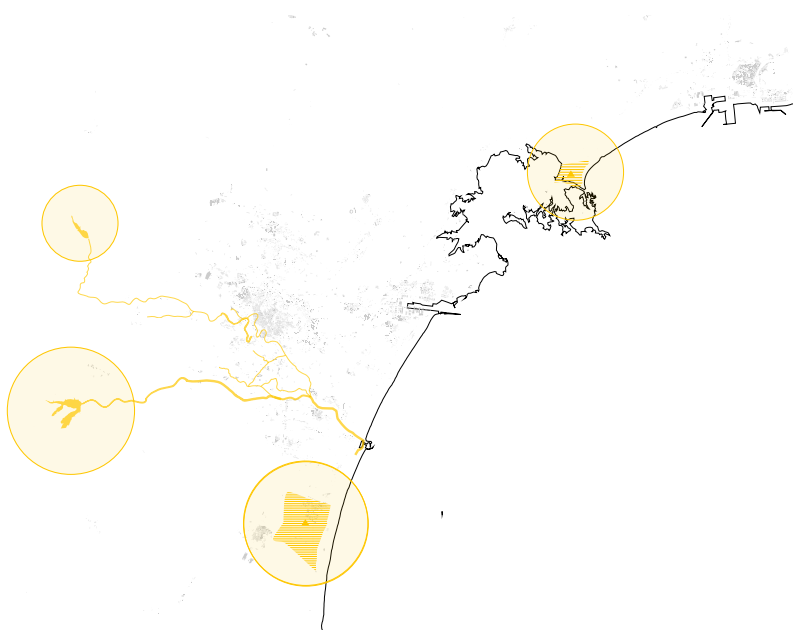
5- 7.0 m/s

7.0- 7.5 m/s



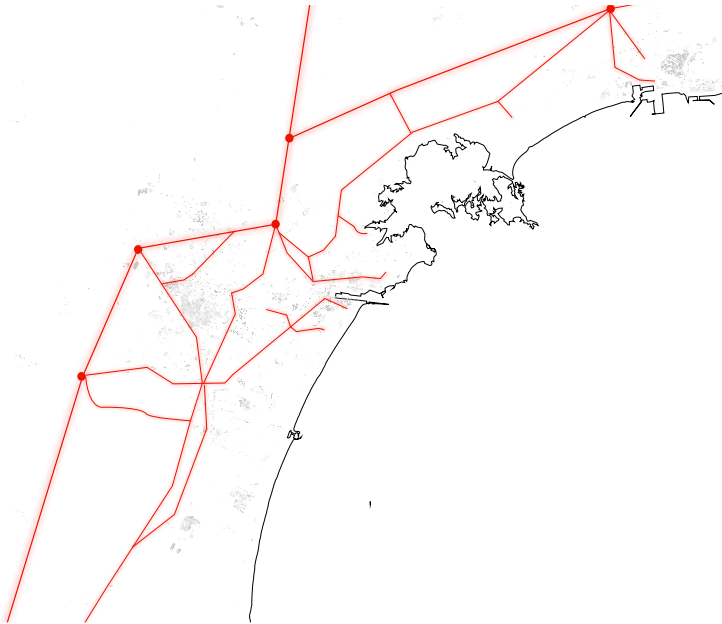
Fossile Fuels

The reduced map shows that most of the fossil fuels supply appear near the ports of the region. This could be potentially a weakness during a tsunami leaving most of the coast prone to a energy shortage.



Renewables

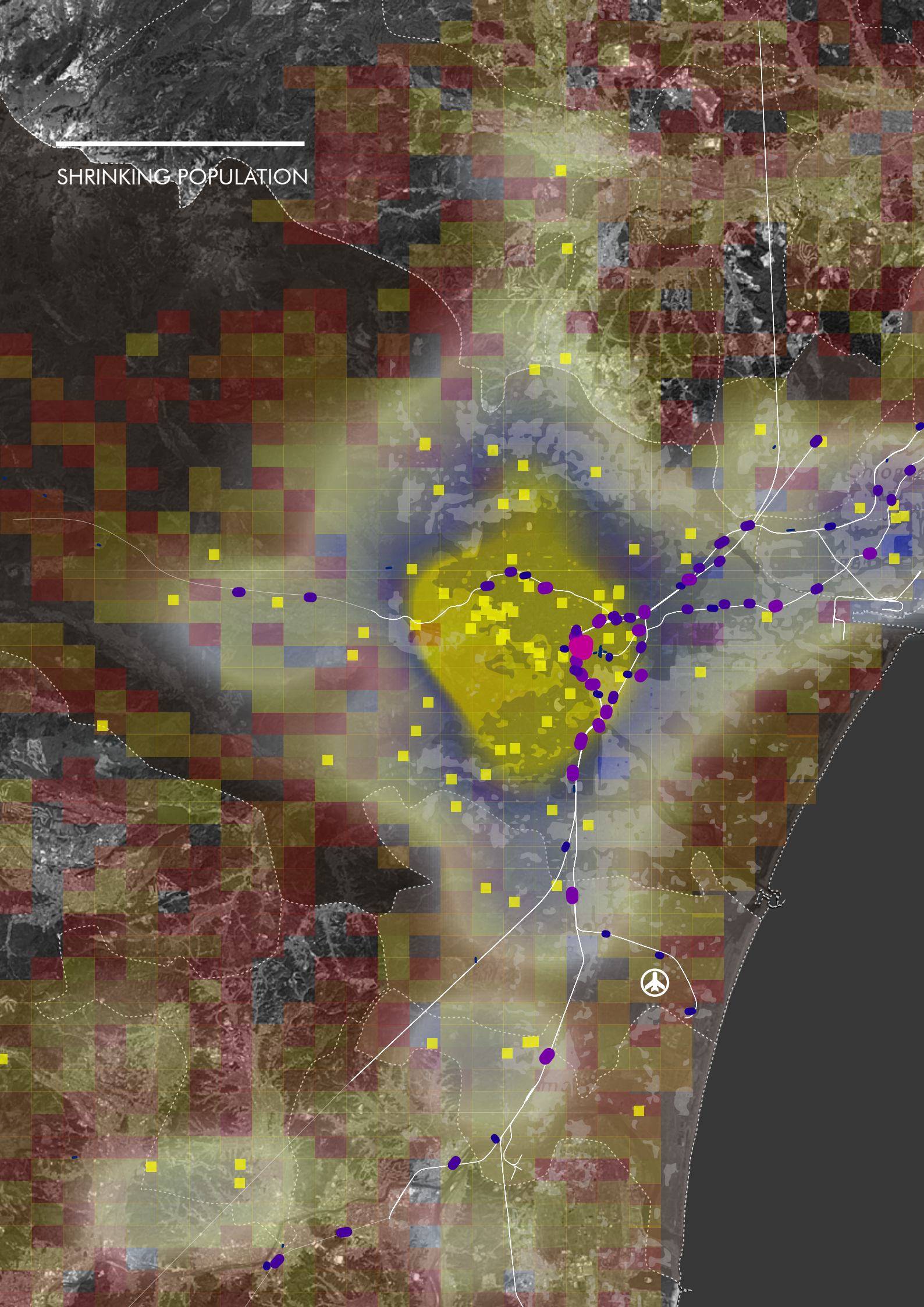
Japan has a history of building dams not only to control the flow of the rivers but also as a source of energy. Though they are not sufficient enough to supply for the whole region, an up-rising of solar parks have been a new face in the landscape the last years. A potential that can be expanded in the coming years. A disadvantage is that these parks tend to use a lot of space, a scarce commodity in Japan.

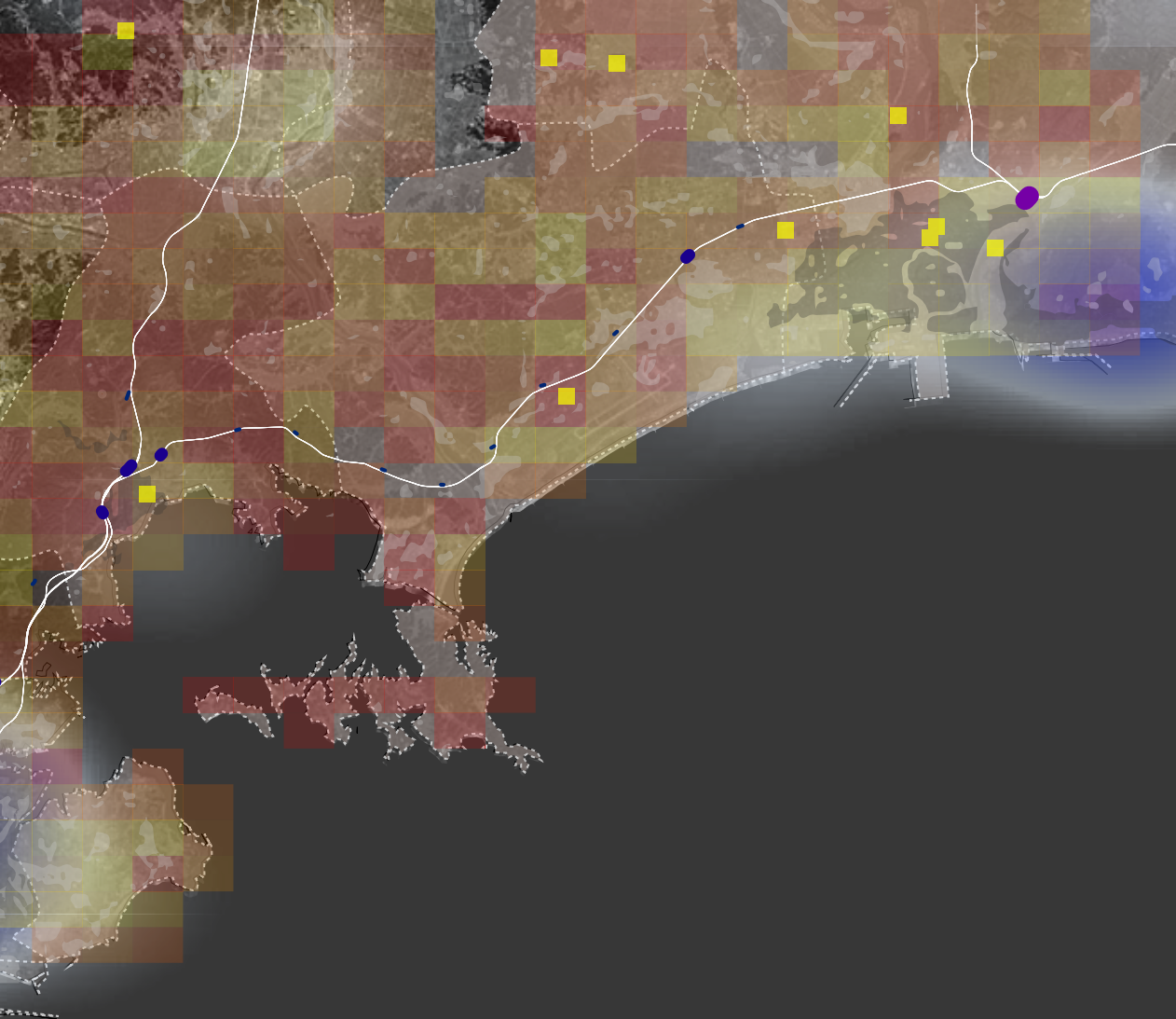


Transport

The main Tohoku trunk line follows a safe route inland. Wedged between the mountains and the plain area makes it safe from tsunamis. The supply is another issue, the main power sources except for the hydro power are located on the seaside this could affect the stability of the network.

SHRINKING POPULATION



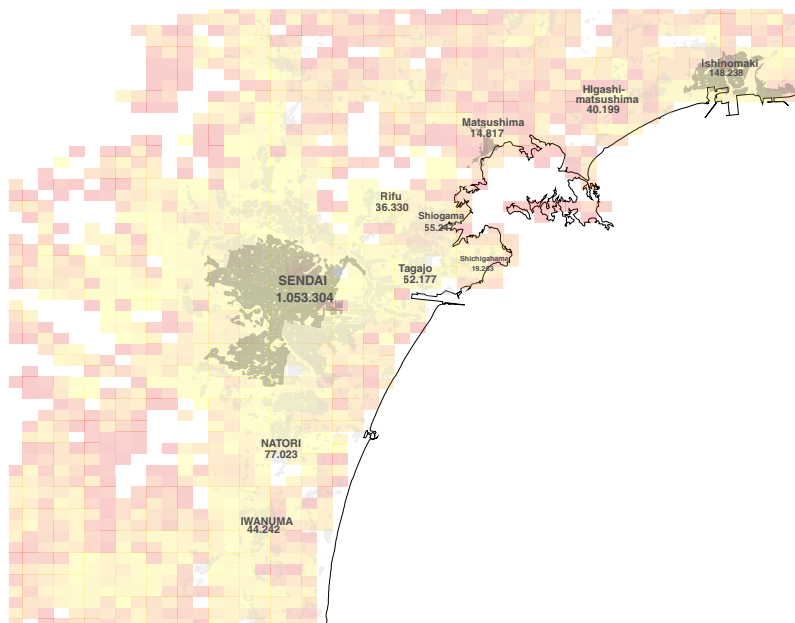


LEGEND

Shrinking Population

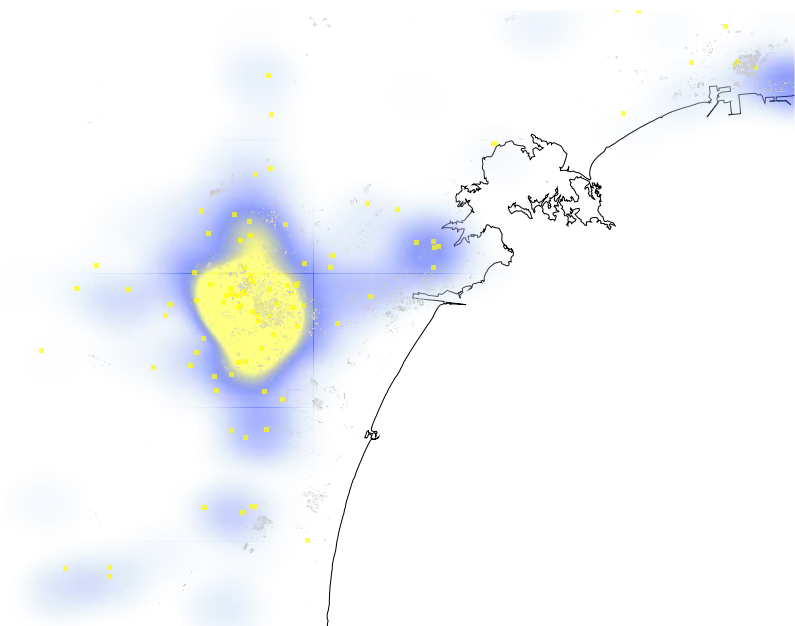
- High elderly engagement
- High car per capita
- Low car per capita
- Municipality boundary
- High concentration medical facilities
- Low concentration medical facilities
- Hospitals
- high 65+ population %
- Low 65+ population %
- Trainline
- National highway
- High amount of passengers +1.00.000
- Low amount of passengers -1.000





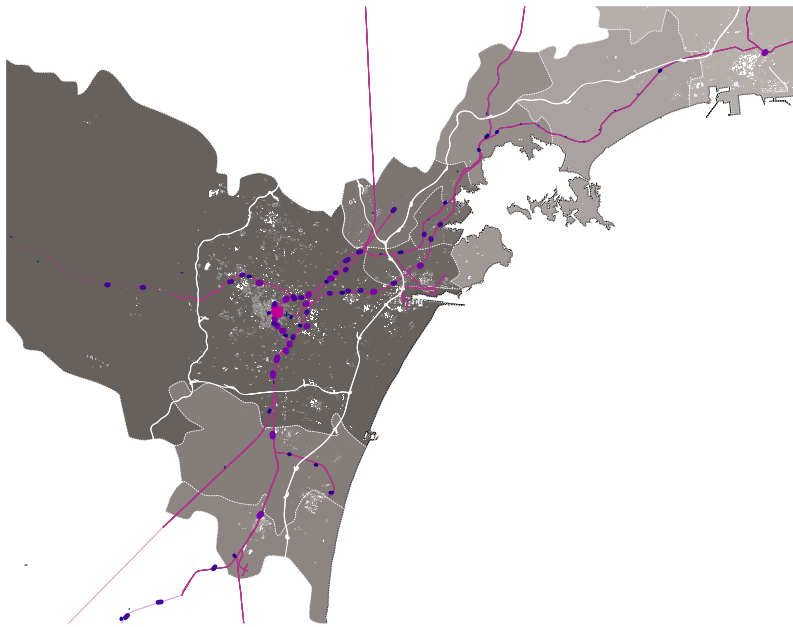
Population

This map shows a rapid aging population between the Sendai and Ishinomaki coast. This could result in an economic problem but also an isolation problem if the participation of elderly in the community is neglected. Cities like Matsushima set up a program that encourages elderly to voluntarily engage in several activities that engages them with the community. Examples are providing information at cultural attractions.



Medical provisions

A rapid aging society is in need of a well distributed medical network, as elderly are less able mobile. Unfortunately there are some missing links at the municipalities that age faster.

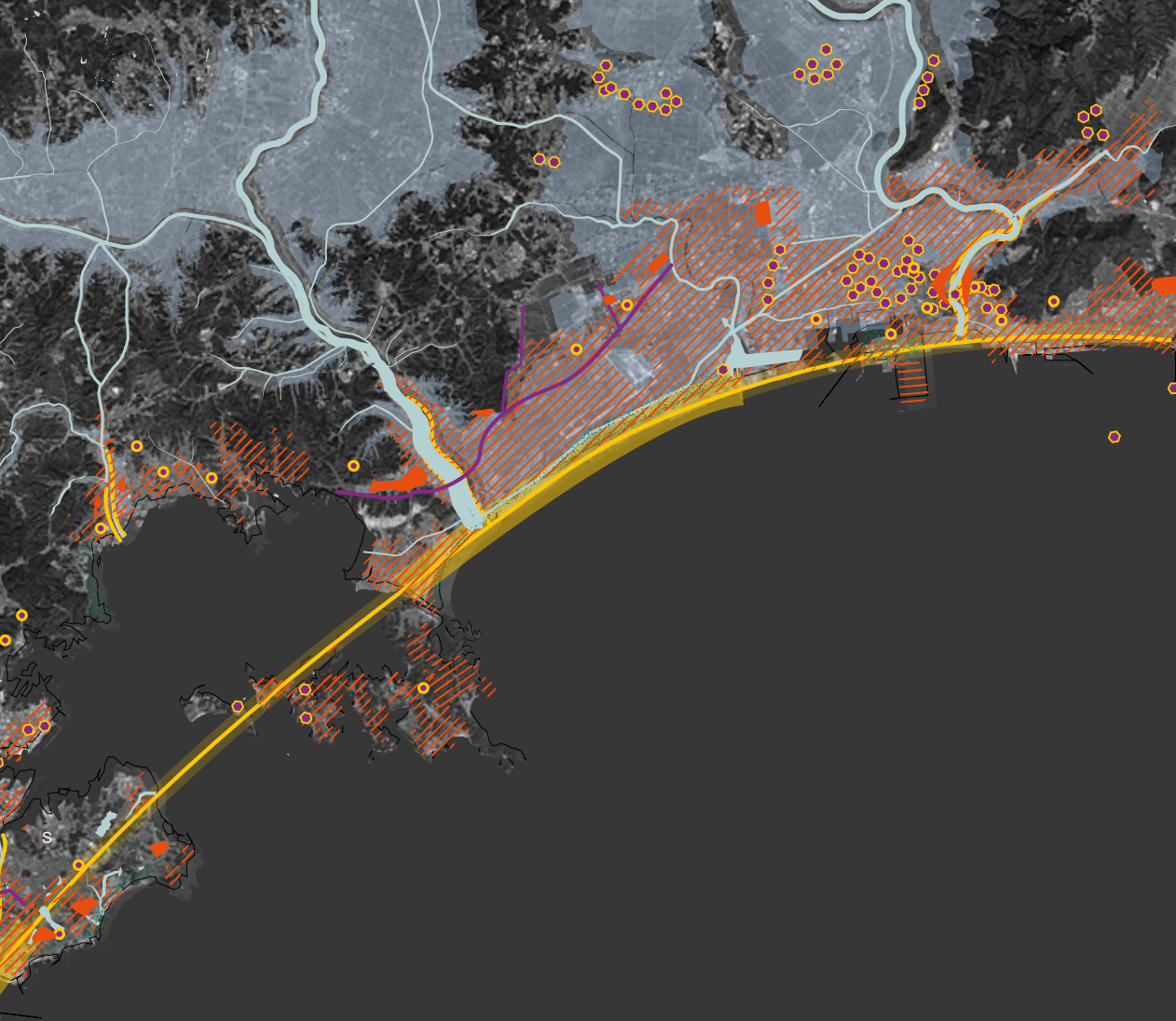


Transport

As people age they are more and more dependent on the use of cars or easy accessible public transport. Compared to the concentration of transport and car use in Sendai. Higashimatsushima, Natori and Iwanuma are low in the use of cars and public transport. Combined with the low proximity of a hospital these elderly are in danger of being disconnected. And investment of transport at these locations is desirable.














TSUNAMI RESILIENCE





LEGEND

Tsunami Resillience

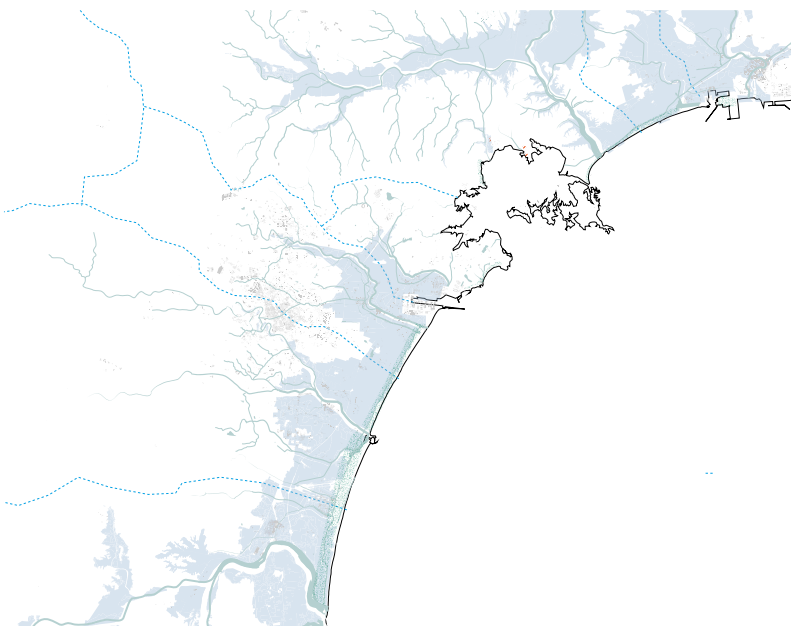
-  Inundated area
-  Levee height +5m
-  Levee height 5m
-  Levee height -5m
-  River embankment reinforcement
-  Coastal forest
-  Relocated villages
-  Tohoku expressway
-  Elevated road and evacuation route
-  Evacuation towers
-  River and water bodies
-  Flood risks
-  Evacuation location





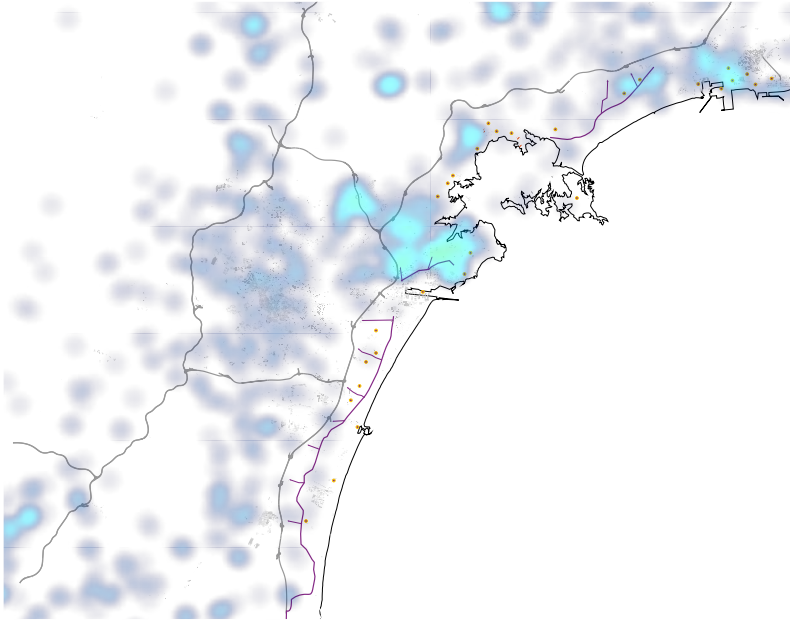
Man made defence

This map clearly illustrates the works of the ministry of MLIT regarding their implementation of the dyke height. Around the peninsula a lower dyke is being realised. The second dike is also realised along the flat area's of the coastline. An exception is the harbour area of Sendai, though there is a second dyke system implemented around the direct harbour area the Nanakita river is partially prone to flooding due to the lack of a second dike ring.



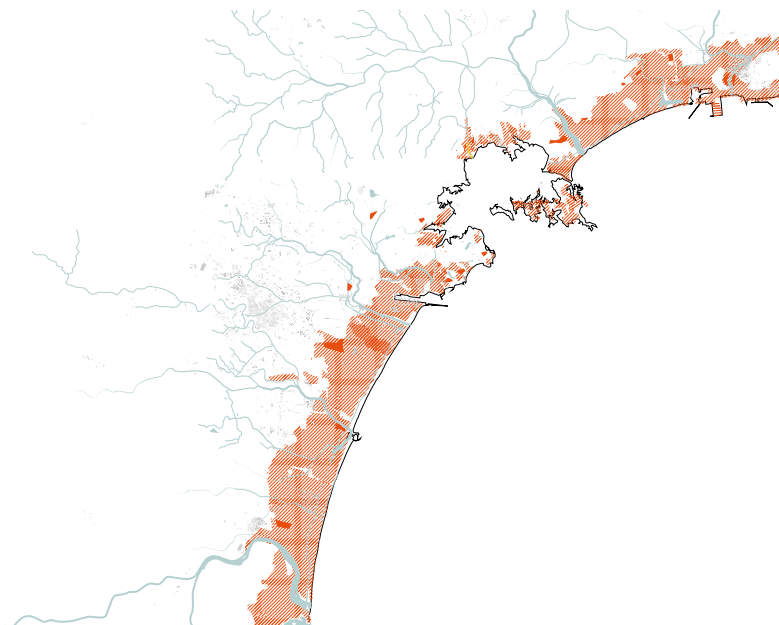
Natural defence

The implementation of coastal forest are realised along the plains of the Miyagi coastline. Even though they stretch several kilometres of coast they are built at the moment solely for mitigation purposes.



Evacuation defence

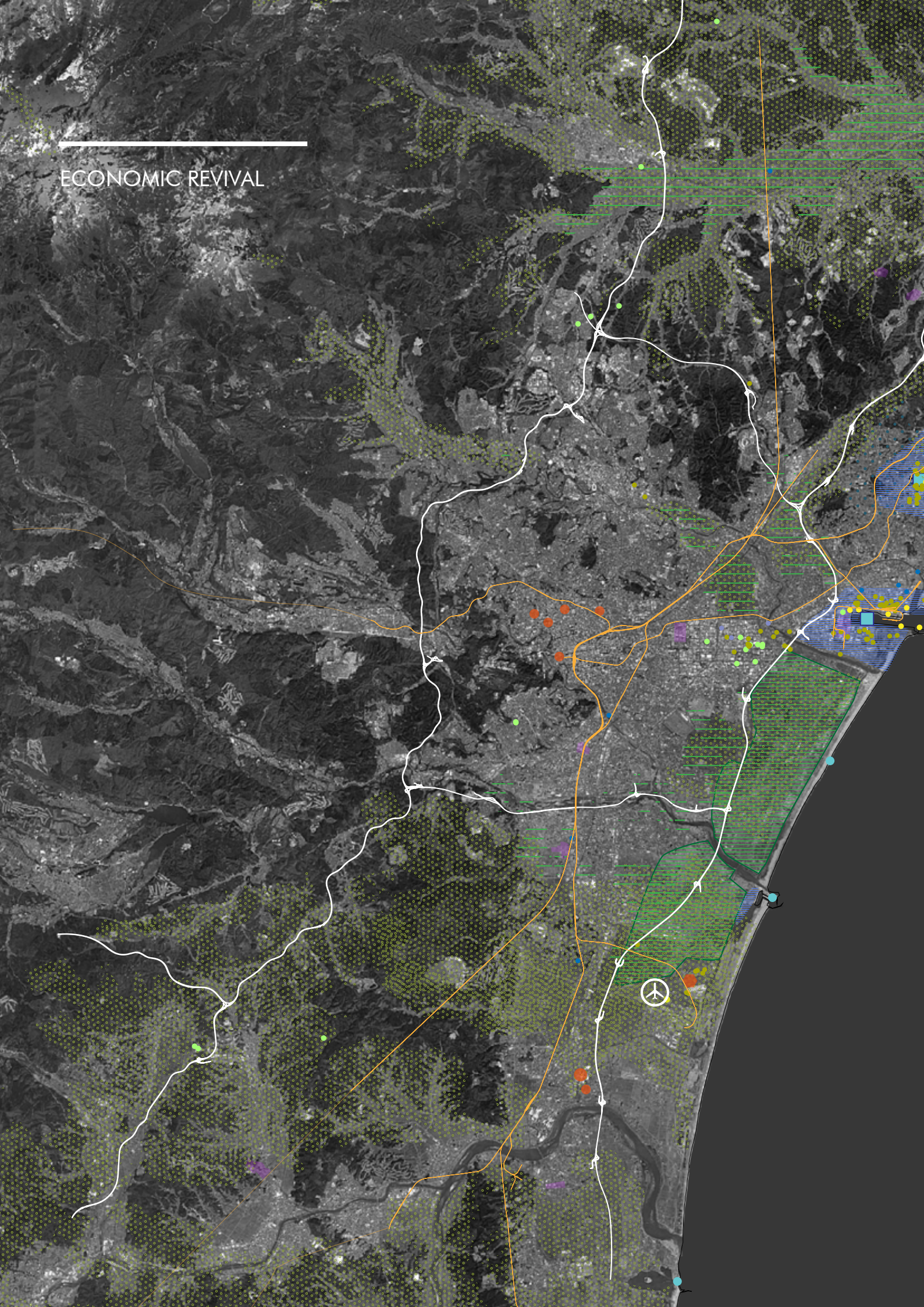
There is a good distinction between the towers along the inundated areas and the evacuation roads leading to safer ground. the concentration for evacuation sites more present in the mountainous area where landslides emerge. It is of importance that these issues will appear more often in the future due to climate change.

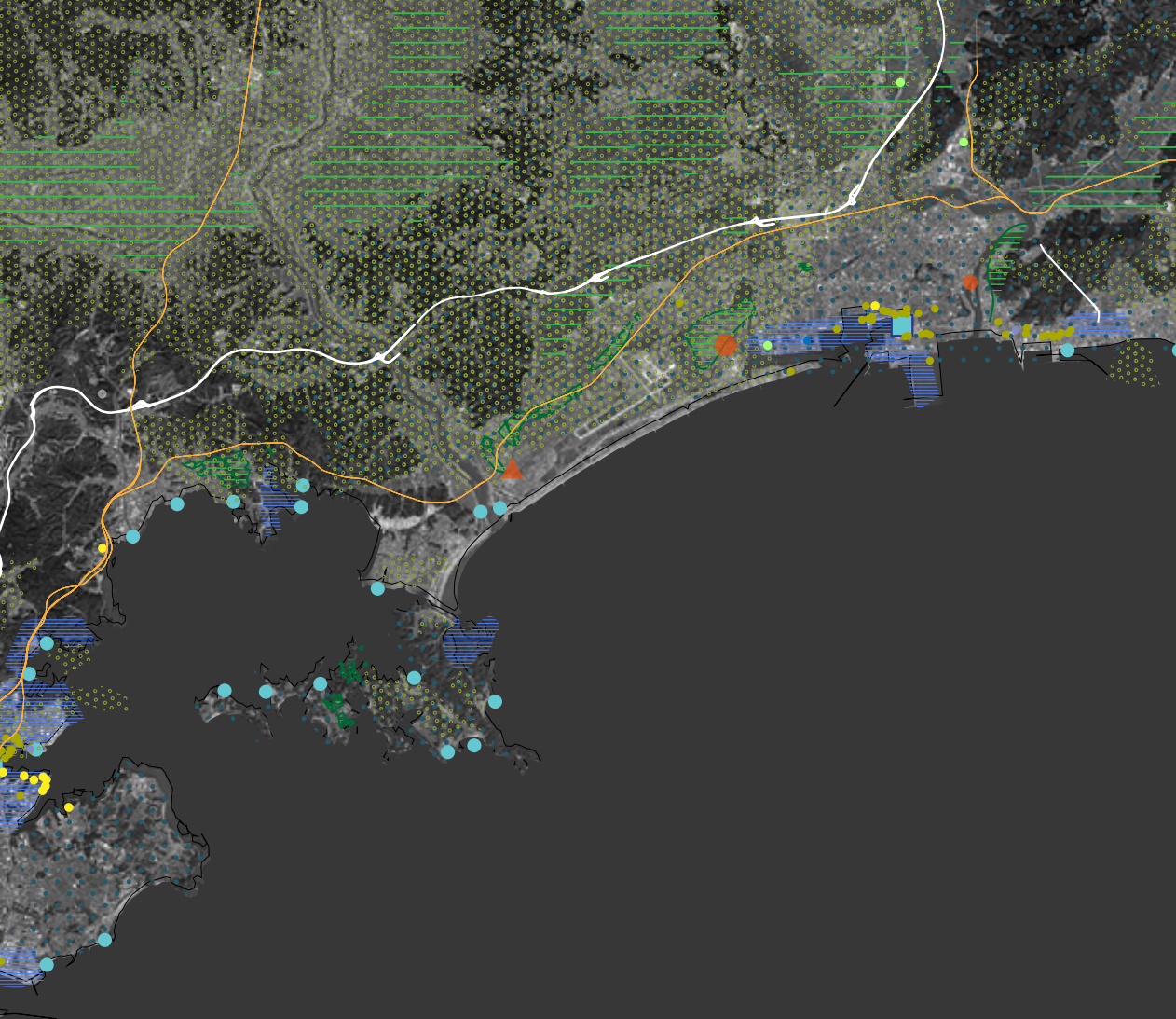


Recolations

Its clear in this map that Yuriage in Natori is one of the few location relocated within the inundation zone. Though more relations have been places uphill, other problems may occur like landslides as concluded in the map above.

ECONOMIC REVIVAL



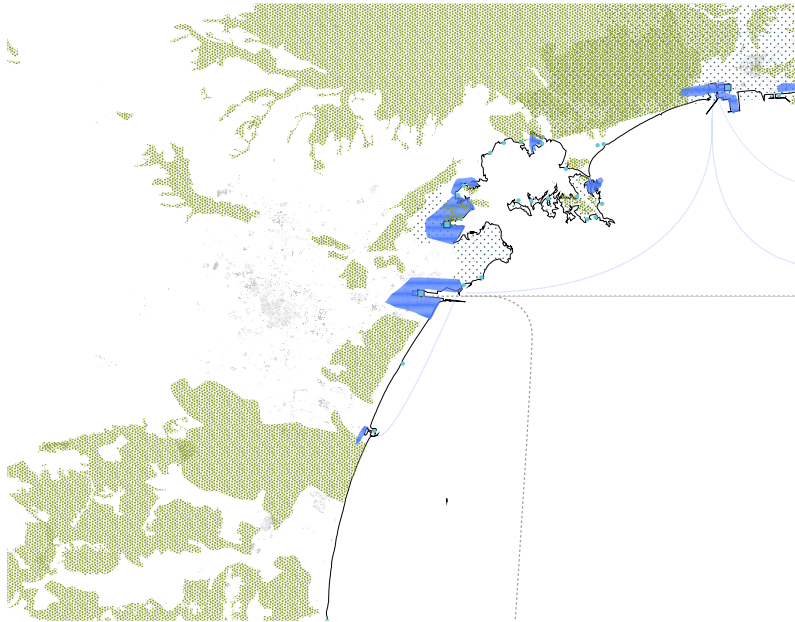


LEGEND

Economic Revival

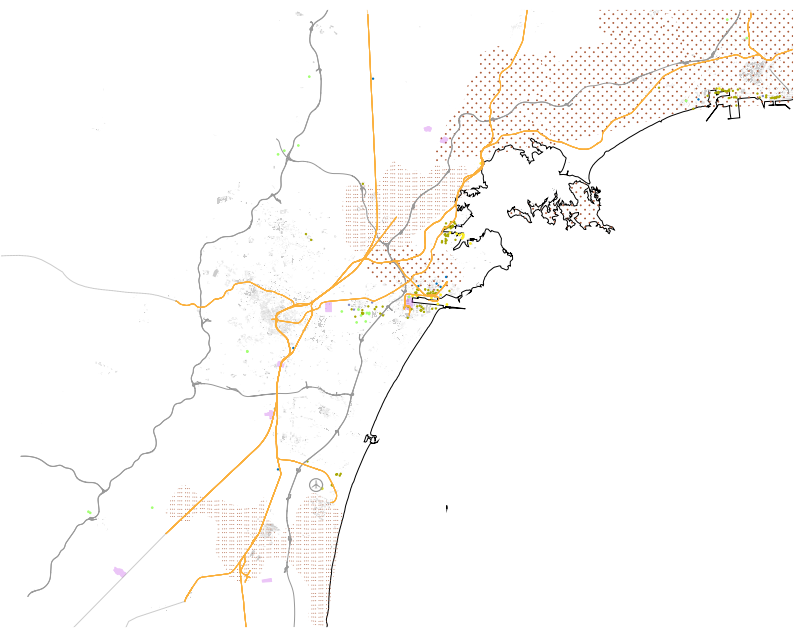
- Current rice paddies
- Reconstructed rice paddies
- Primary economy, Agriculture
- Fishing ports
- Harbour
- Primary economy, Fishery
- Tertiary economy, Retail
- Tertiary economy, Service
- Tertiary economy, Government
- Tertiary economy, Energy
- Knowledge cluster
- Trainline
- National highway
- Industrial area
- Logistics**
- Bonded, production
- Truck Terminal
- Wholesale
- Airo Cargo

0 2,5 5 km



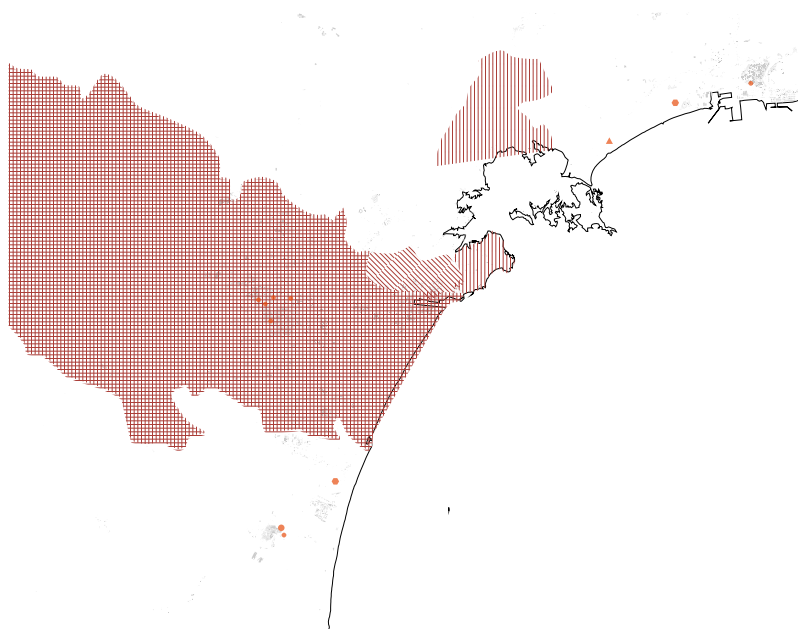
Primary sector

There is a clear line between primary activities at the coast compared inland. Though these activities are of importance most of the area's are clustered together, competing with each other. Especially the large harbours of Sendai and Shioyama, diversifying these clusters could be a positive for the local economy.



Secondary sector

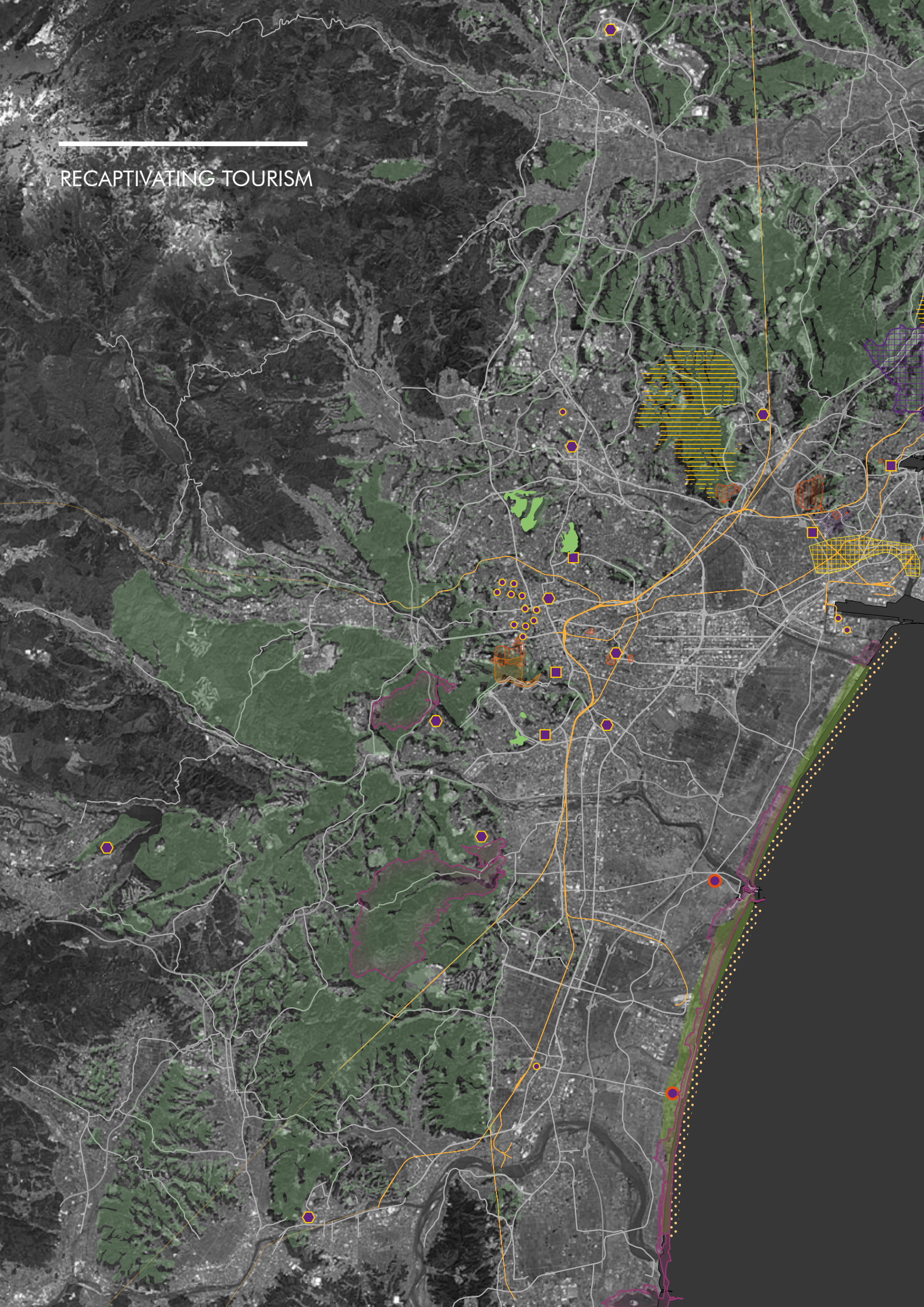
The secondary is located more land inwards with a concentration of logistics behind the harbours and the main road networks. The highway is more intensively used by industries compared to the Japanese society as they use public transport as their main mode of transportation. These large networks and their adjoining industrial sites often function as a barrier in the region. Diversification and or opening up axes for new typologies can result in a permeability of the existing fabric and bring a huge potential in the cities development.

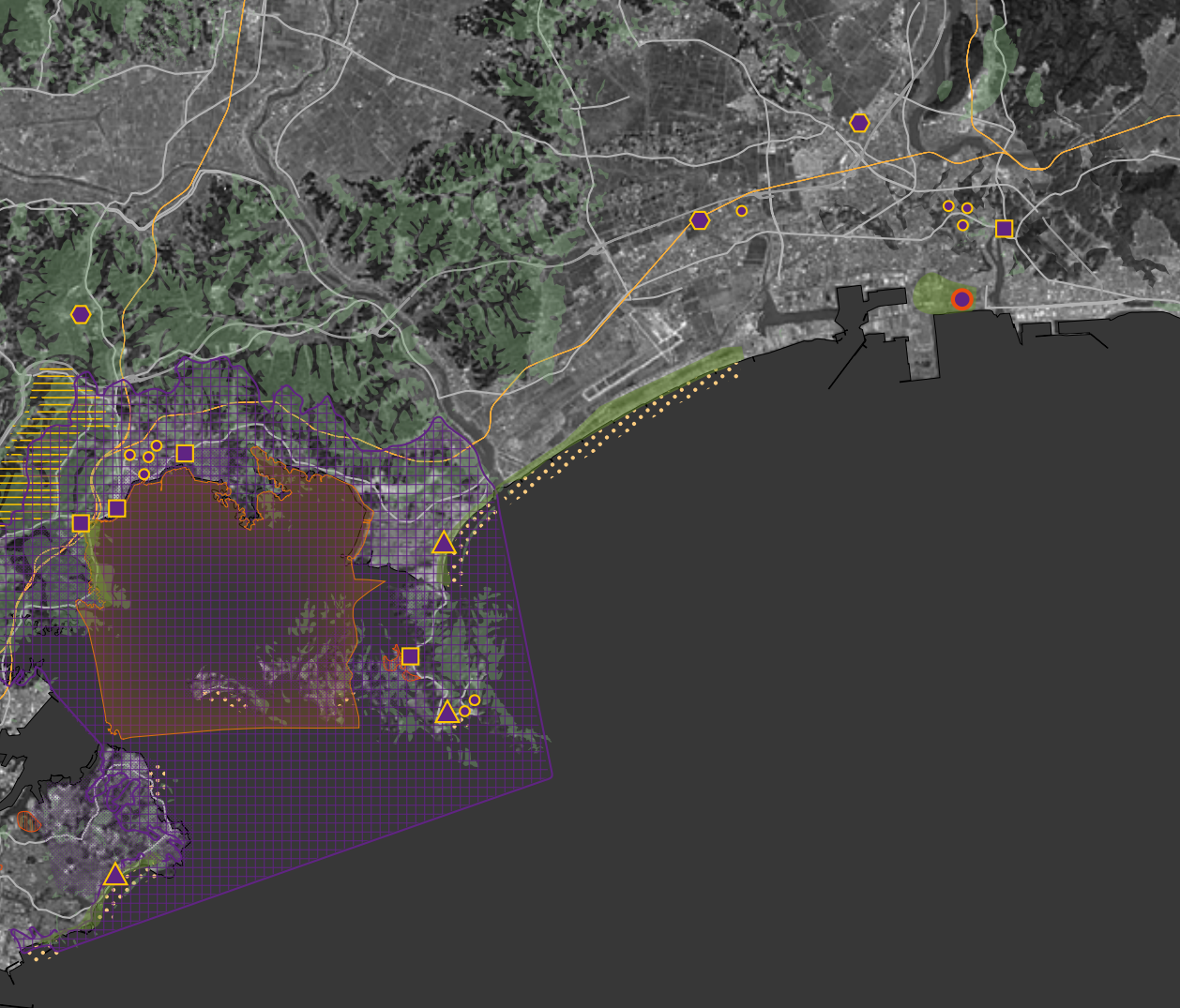


Tertiary sector

It's clear that the tertiary sector is concentrated in Sendai. With the exception of Matsushima that thrives on the tourist economy. By growing the service knowledge and specializing them in the other municipalities, a more even distribution of workforce could be realised. Keeping the younger generation within their cities.

RECAPTIVATING TOURISM

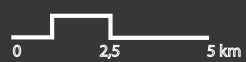


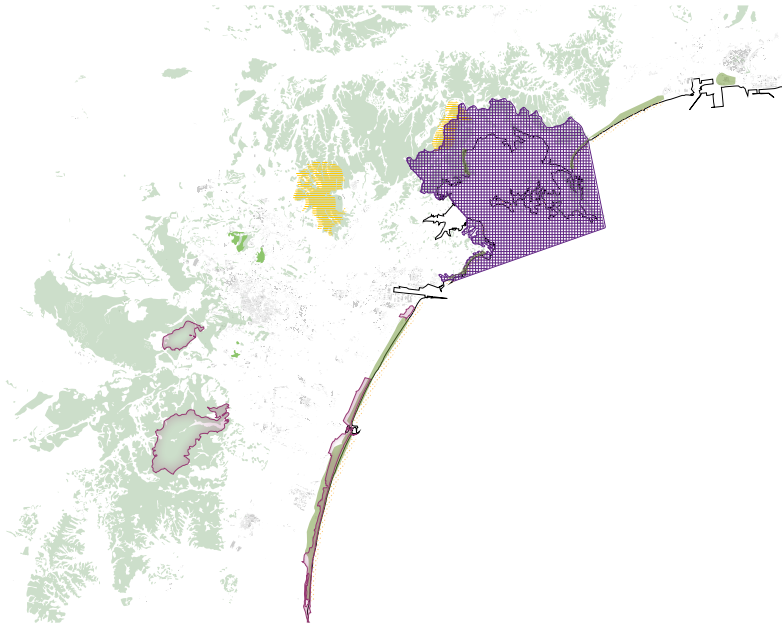


LEGEND

Recaptivating Tourism

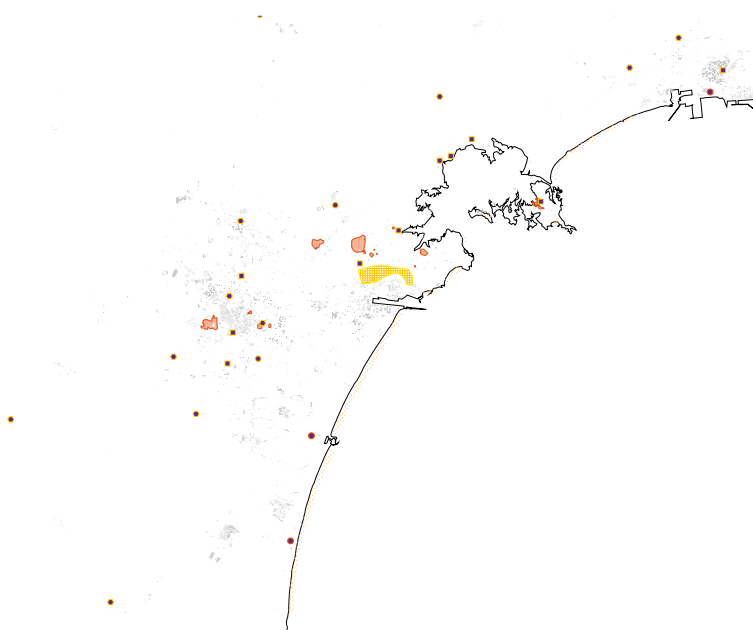
- Forest
- Park
- National park
- Beach
- Resort
- Museum
- Hotel cluster
- Onsen
- National highway
- Train lines
- Special scenery
- Coastal forest
- Cultural scenery
- Historic scenery
- Natural preservation area
- Wildlife preservation area





Natural landscape

The green qualities of the bay area of the is a diverse landscape that attracts a lot of tourist around Miyagi and Japan. Enforcing and expanding the connection between the northern coastal forest and the nature reserves in the west could expand the popularity of that area. But also have the potential to improve the quality of life in adjacent neighbourhoods.



Cultural landscape

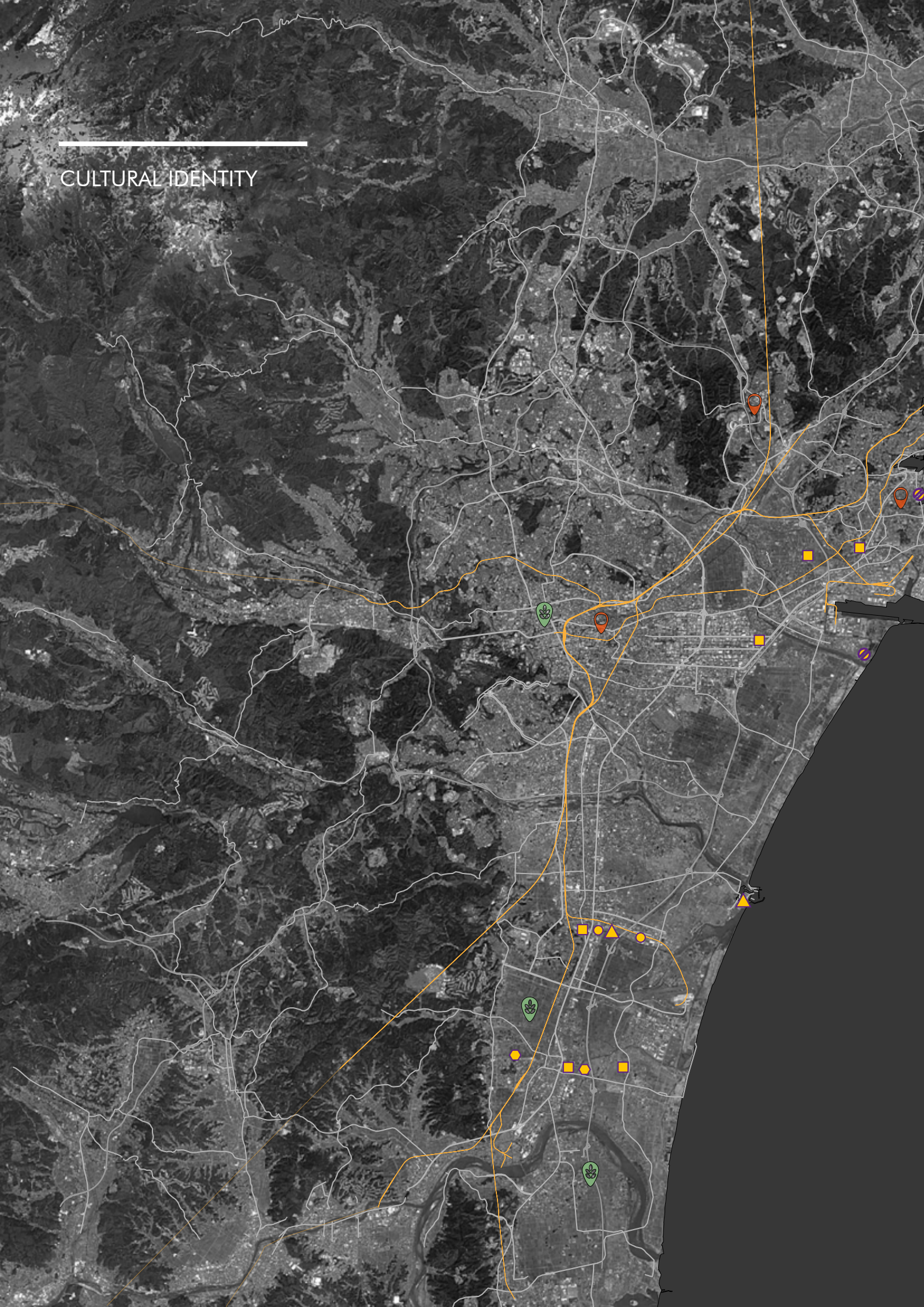
The cultural centre of Miyagi is to be found around the Sendai area where the university grounds and old castle ruins are located. More unknown is the historic river of Tajago emerging north of the Sendai port that ends in an old castle ruin. However these important places a little visible and weakly integrated in city life and thge historic routes are partially recognizable. Making special historic places visible and re-evaluation of axes and green/blue lines will improve the identity of individual districts and contribute as a better cohesion overall in the region.

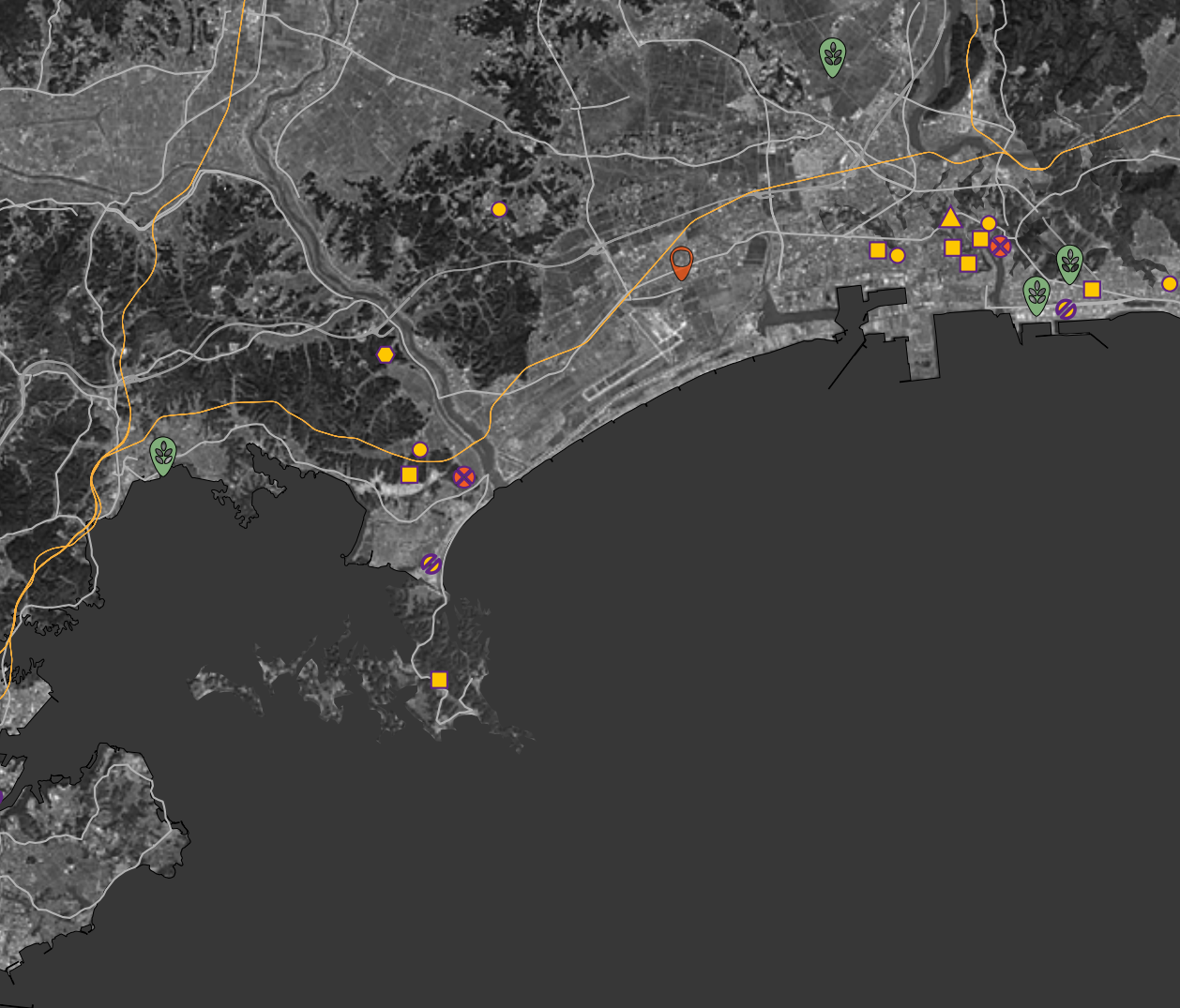


Hotels and resorts

Attractions are important but getting the tourist to the needed destination is a pressing matter. A big issue is the slow connection between the main city of Sendai and the natural area's of Matsushima. As the Shinkansen (Japanese high speed rail) diverts to the north the east coast is merely connected with a slow train system that will take up to 1,5 to 2 hours to reach Ishominaki from Sendai. The railway and vast industries have cut off some historical relations what is a problem for soft mode mobility.

CULTURAL IDENTITY





LEGEND

Cultural Identity

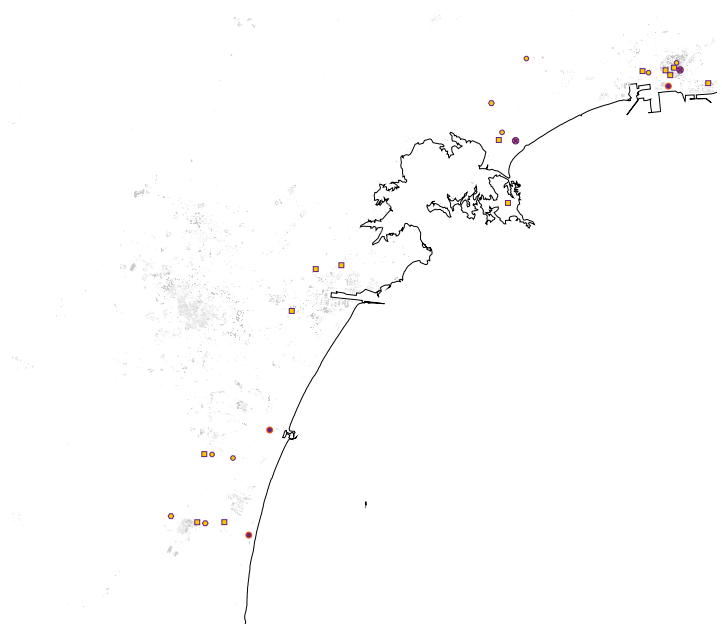
-  Local food speciality
-  Local craftsmanship
-  Local market
-  Community centres
-  Youth facility
-  Eldery facility
-  Cultural facility
-  Local industry
-  National highway
-  Highway
-  Memorial





Local industry and speciality

Local specialties like fish and shellfish are prone to the coastline. Selling them at local markets increases the community perception and characterizes smaller towns.



Community activity

Ishinomaki is most affected town due to the tsunami. To keep their local residents from moving they invested in community buildings, youth centres and other activities. This lead to a success in to keep their residents and even increase the numbers in the last two years. Using this concept to focus on a target group and adjusting the community provisions can characterize a city and increase the liveability of one.

PROFILES

Randstad concept is the development of profiles of cities to get a refined context in what way the cities could interact between each other. In the theory chapter we established that a profile of a city is based on three main components:

- *Economic specialisations: main sector and sub sector.*
- *Landuse: location and landscape.*
- *Driver influence: subjects that are of significance within the society.*

Answering these factors reveals the functions of the region as a whole and how they interact between each other.

Economic speciality:

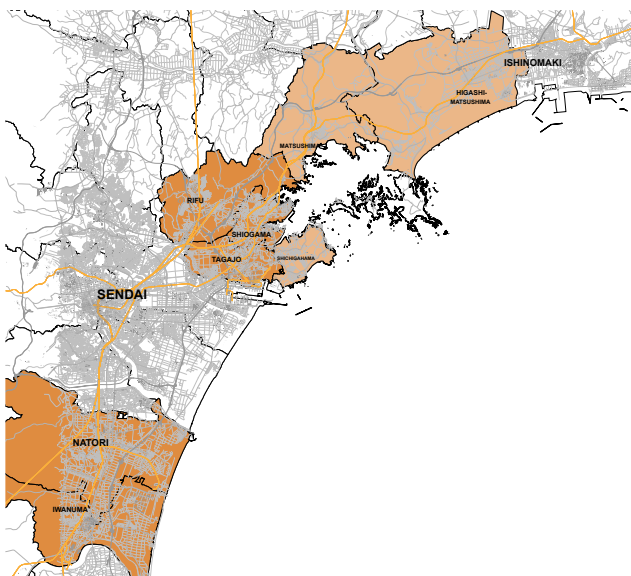
The combination of the drivers, Energy Transition, Economic Revival and Recaptivating Tourism exposed a variety of economies that are held within the region of Miyagi. With the capital Sendai having a broad dominance in the tertiary sector many surrounding cities function with conducive functions transporting and or supplying goods. This makes the surrounding municipalities mono functional in economic diversity between each-other.

A clear agglomeration between Rifu, Shiogama and Tagajo is distinguished and one between Natori and Iwanuma.

The first group has a strong link between the transportation demand surrounding the port of Sendai, though also depend on the proceeding of their own harbours. Their proximity of these markets cause a so called economy of agglomeration, which have advantages to the local market and lower transport cost due to effective use of the system. Though from an economic point of view these agglomerations are only successful unto a certain scale. This balance of agglomerations of economies versus diseconomies is defined by Roberto Camagni (2000) through an urban perspective based on 5 principles:

- *Agglomeration: size of the cluster.*
- *Accessibility: the capacity of the transport system.*
- *Spatial Interaction: the distribution of domestic and production activities.*
- *Hierarchy: competitiveness within the cluster*

Answering these questions precisely would go beyond our scope of analysis but we can acknowledge that an overbalance of these principles influence the state of the environment, land prices, liveability and overall economic stability of the mentioned municipalities (Capello, Camagni 2000) (Way 2016).



Legend


























-  Knowledge
-  Ports and Fishery
-  Agriculture
-  Transport network
-  Energy network
-  Tourism

Image 19: Proximity of the economies, source:

Author

Image 20: Distribution of branches and agglomeration, source: Author

	Economic sector	Gross production (¥)	Population
ISHINOMAKI	 	636.105	148.238
HIGASHI-MATSUSHIMA	 	224.003	40.199
MATSUSHIMA	 	57.127	14.817
RIFU	 	43.810	36.330
SHIOGAMA	 	187.265	55.247
TAGAJO	 	176.807	62.177
SHICHIGAHAMA	 	41.957	19.623
SENDAI	 	5.057.680	1.053.304
NATORI	 	281.326	77.023
IWANUMA	 	209.488	44.242

Landuse:

Inspecting the landuse charts on the right, we can see that the municipalities of Shiogama, Tagajo and Shichigahama are particularly over-represented in urban development. As they are wedged between a hilly landscape on the east and the ocean. In the previous chapter we observed that these municipalities had markets that are port and transport related. These primary and secondary typologies take up lots of space compared to service industries where densification is more apparent. Infrastructural networks are needed to connect the logistics hub to the capital. The above mentioned structures attract housing development as commuting to the capital becomes more attractive. The land prices are distinctively lower compared to Sendai, therefore the building typologies are not as dense.

A development of sprawl between Sendai and the surrounding northern cities is notable. Though the combination of space consuming markets and low density urbanisation has effect on available space within these municipalities. functions like a barrier between the north and the south side of the region.

Is affects condition of ecosystem in the region, decreasing the biodiversity due to fragmentation. Another consequence of the Japanese expansion is their method. Generally it follows a scattered development, filling in the grid of rice paddies that where previously developed. The development consist of grading the former paddy field that consist of specific dimensions enough for one road with housing at both sides (De Graaf, Hooimeijer 2008). Most of these expansions reduce the permeability of the land drastically as surfaces of roads, parking lots and to an extend some backyards are covered with impermeable materials (image 21) affecting the storage capacity for water.

Sendai and Ishinomaki have contradictory charts compared to the sprawl afflicted municipalities. Their urban environment is on average 30-40% less, we can partially credit this though the mountainous landscape both municipalities have in the hinterland. But the densification of their city cores, enables them to house a higher amount of residents per km² of urbanisation.



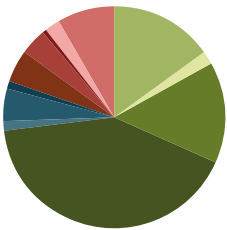
Legend

Rice paddies	Road
Farm land	Residential land
National forest	Industrial land
Private forest	Mixed use
Surface water	Other
River	
Waterway	

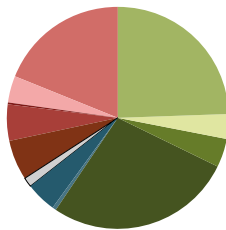
Image 21: Example of Japanese urban expansion, source: Google Maps

Image 22: Compared landuse municipalities of Miyagi, source: Author

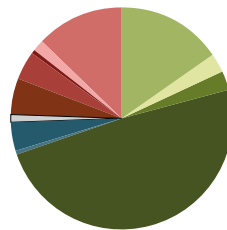
Ishinomaki
554 km²



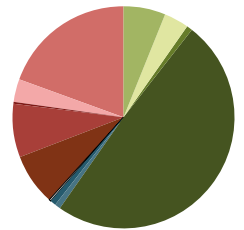
Higashi matsushima
101 km²



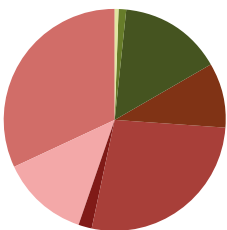
Matsushima
53 km²



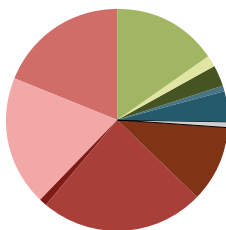
Rifu
44 km²



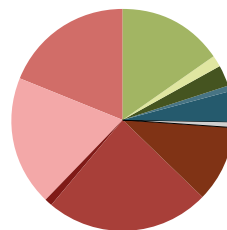
Shiogama
17 km²



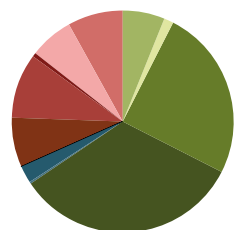
Tagajo
19 km²



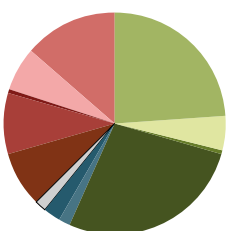
Shichigahama
13 km²



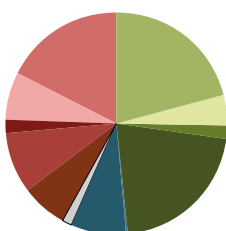
Sendai
786 km²



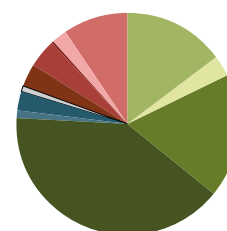
Natori
98 km²



Iwanuma
60 km²



Miyagi Prefecture
7.285 km²



Driver influence:

By mapping the data into layers we have been able to define where and how the themes affect and interact with each other. Some are determined by physical features like a flat landscape or a large port. Others are based on non material influences, a high aging rate or a local speciality.

Comparing how these themes interact with we use the complex adaptive system to estimate how these drivers perform. It is an open system that not only interacts with the themes but also shows if there might be external indications that influence the relationship. In the original system the main categories are based on occupation, network and underground. The themes in this case are already more specific. Therefore we will only work with the ones defined in order to keep the wishes of the parties involved as the main priority.

The image right shows that the systems of the Reconstruction design council and the Ministry of Land, Infrastructure, Transport and Tourism are heavily based on the prevention of a new tsunami disaster, the economy and energy supply.

These wishes do not correlate with most of the systems of the municipalities. Their investments are more focussed on tourism and local identity.

Some themes are not invested due to the inability to answer to all of the demands or the irrelevance of the driver for that specific municipality. The city of Rifu for example is less prone to tsunami threats due to their uphill location in the bay. But if we take the driver shrinking population we can see that Rifu but also other municipalities like Higashi matsushima, Tagajo and Iwanuma under represent investment in their greying population.

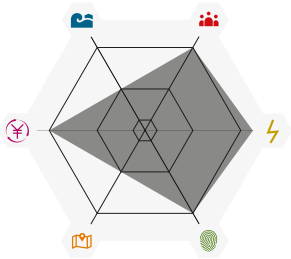
The most notable parallel is the low investments between tsunami resilience and the energy transition. This dependence on a single fossil energy source in combination with a tsunami/ earthquake was a great fire hazard in the disaster of 2011 and should be avoided risking recurrence.

Legend

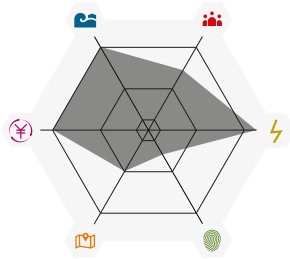
-  Tsunami resilience
-  Shrinking population
-  Energy transition
-  Cultural identity
-  Recaptivating tourism
-  Economic revival

Image 23: CAS of the municipalities, source: Author

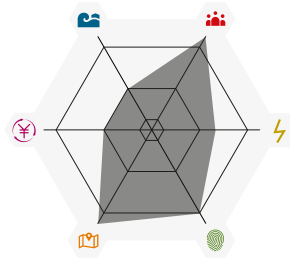
Ishinomaki



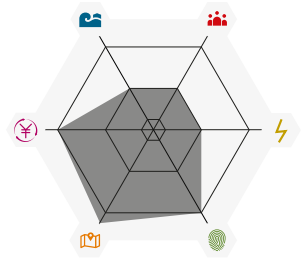
Higashi matsushima



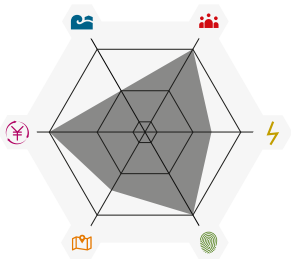
Matsushima



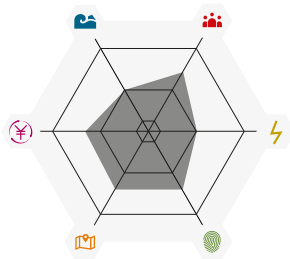
Rifu



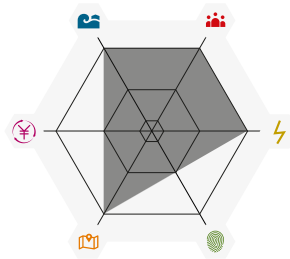
Shiogama



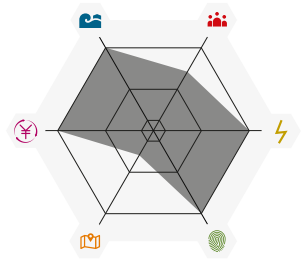
Tagajo



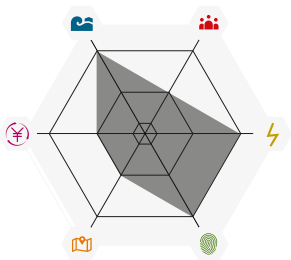
Shichigahama



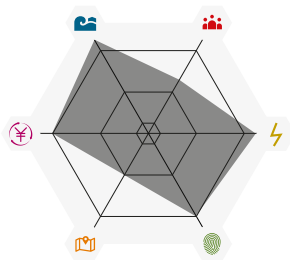
Sendai



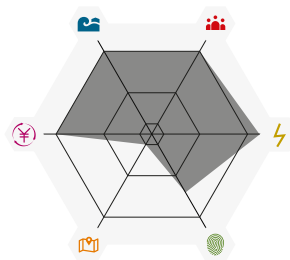
Natori



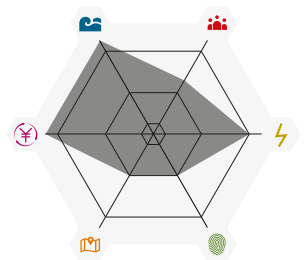
Iwanuma



Reconstruction Design Council



Ministry of Land, Infrastructure, Transport and Tourism



Profiles:

If we combine the findings of the based on the profile we find:

Mono functional economies:

Leading to a competitive and unbalanced inner regional economy. The concentrated focus results in an inconsistent distribution of public functions like hospitals, public transport and supermarkets, the sparsely populated area will leave the more fragile part of society immobile, particularly elderly (Mees 2000). Investments in transportation in rural communities will improve the vulnerability of such social groups. But also the diversification of economies could improve the distribution of functions and counteract the centrality of the region.

High central urbanisation

The centre of the region undergoes a sprawl following the infrastructure that connects the north and south, of which we learn in the previous chapter was constructed for the transport branches that function in that area. The urbanisation is low in density and causes an drastic increase of impervious soil cover. Environmental valued areas lie in the west of the region which consists of mountainous forest while at the coasts agricultural landscape resides. The central urbanisation barricades the flow of flora and fauna, fragmenting the environment. A consequence of dis economy described by Roberto Camagni (2000).

Increasing the housing density will provide space for connective branches between the north and south. And counteracting the merging of cities. Dutch planners used this type of development in the in the 1970's. This concept from the UK called New Towns came in was believed to limit the sprawl at the urban fringe by creating new settlements or existing villages that were located at a distance of 10 to 30 kilometres from the bigger cities. These 'growth centres' had to generate regional economic development of deprived neighbouring villages for instance. Others were completely new like Almere and needed to provide an ideal suburban living environment for family households (Nabieliek et al., 2013).

Disparity of driver interests:

Comparing the above mentioned findings, municipalities tend to emphasise mono functionality by investing in the same development like ports and agriculture. Not acknowledging urgent matters as rapid aging in their community. Or by not investing increasing their exposure to damage. A better balance between the profiles will be integrated as part of the strategy.

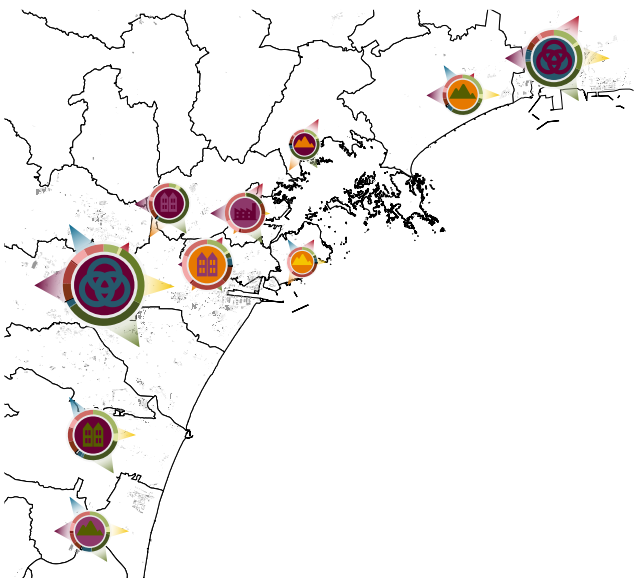
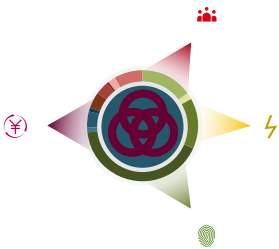


Image 24: Profiles represented on the map of Miagi, source: Author
Image 25: Profiles of the municipalities, source: Author

Ishinomaki



Higashi matsushima



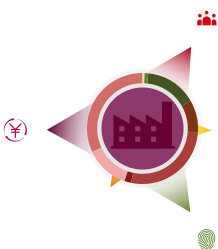
Matsushima



Rifu



Shiogama



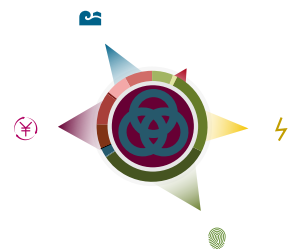
Tagajo



Shichigahama



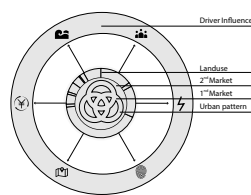
Sendai



Natori



Iwanuma



Driver influence	Landuse	Economic Market	Urban pattern
Tsunami resilience	Rice paddies	Knowledge	Mixed
Shrinking population	Farm land	Ports and Fishery	Residential
Energy transition	National forest	Agriculture	Rural
Cultural identity	Private forest	Transport network	Industrial
Recaptivating tourism	Surface water	Energy network	
Economic revival	River	Recreation	
	Waterway		
	Road		
	Residential land		
	Industrial land		
	Mixed use		
	Other		

INTERACTION

The prior steps where to characterize the cities through landscape and performance based profiles. This wide range of information between cities can be abstracted into an interaction map in where we can highlight the important structures and their context. These map (image 26) together with the profiles will provide a base for the strategy. We find four elements that symbolized the interchange of the cities in Miyagi.

Industrial sites: Vast industrial sites are another legacy of modernistic planning. Located near a river mouth at the coast the expansion inland function as a barrier between sites with specific attractive qualities. Integrating new typologies or diversifying the land use of these clustered ports will improve economic diversification and provide a better permeability with re-evaluated connections.

Bottleneck infrastructure: The mountainous area that encloses the bay makes it difficult to connect the east and west side of the coast. While express infrastructure like the shinkansen diverts to the north, slower infrastructures cover the coastal area, missing a train link in the south of the region or a express motorway in the north.

20th century expansions: Relatively large areas towards the north east and south are based on the structure of former rice paddies. Forming a coagulated area of low rise detached housing between cities. Accentuating the city cores will structure these areas.

Natural enclosure: the forest covered mountain range encloses and connect the north and south side of the region. With stretches of rice paddies across the coast line and wide embankments of the river have give the region a split but diverse ecology.

Legend











	City core
	Sprawl
	Port
	Ricepaddy
	Local trainline
	Shinkansen
	Highway
	River
	Natural landscape
	Elevated area

Image 26: Interaction map , source: Author



STRATEGY

Strategic planning is a matter of selecting certain actions in places to modify the spatial structure or relationship. Its about balancing and timing the sequences for implementing the different projects that will establish within a broader context in the urban environment. Each of this choices have their own specific timeframe, political and cultural conditions. As the construction of cities require time and often qualities that we admire or dislike today where not recognized or prioritized by those who built the cities prior to us.

Organizing the different strategic areas/projects identified in the plan based on the themes and characters of the municipalities involves thinking in several aspects: The technical one, involving power grids and civil constructions. The second one is tied to the mobilisation of public and private resources, the third is the concrete mobilisation of these different subjects and promoting them into individual subjects.

We can therefore say that in order to improving resilience within a region we should not only focus on the issues at hand one by one. Tsunami resilience does not solely mean to be able to withstand a single natural destructive force. But the be able to identify the chain reaction of consequences it effectuates. Reducing these consequences and the chain to a minimum while keeping the liveability at top priority provides the best position to recover after the next big disaster.



Left, highlighting spacial structures and their interaction Sendai-shi, Miyagi-ken, Japan, Source: Author
Right, images of the reconstruction progress, Source: Urban Renaissance Agency

Reconstruction of 200 houses in Higashi-Matsushima.



Reconstruction of 47 houses in Matsushima.



Excursion of primary school class in the reconstruction zone area of Shichiagama.



LAYERING THREATS AND OPPORTUNITIES

The next step is to combine the knowledge of the data collection maps. Crossing the sub themes with each other will show if there is a positive or negative clash between the two. A strong positive interaction between drivers suggests an interdependency that can be used to combine the themes as a strategic development. Is the link between the drivers in a negative matter indicates that shifts in one driver affects the other.

In the table below we can see the results. The table reveals several clusters that have a strong parallels between drivers. The tsunami resilience and recaptivating tourism themes have both a strength and weaknesses. Improving the integration between the driver itself and subsequently add or merge other drivers without losing its integrity or function is part of optimising the current system. For example, most of the reconstructed levees are built separately from the coastal forests (see tsunami resilience map page 42), by heightening the forest and merging it as part of the levee will improve the tsunami mitigation (Tanaka, 2012)

Adding a program attached to the levee and the forest improves the attractiveness and functionality (see image 28) and invests in a different driver.

Changing the table into the driver chart confirms the positive and negative relation of the tsunami resilience and recaptivating tourism driver. From the threat perspective several threats within the driver influence the sub themes of shrinking population, energy transition and recaptivating tourism. Therefore a strategy that improves tsunami resilience should incorporate at least one of the mentioned drivers. Same goes for the opportunities recaptivating tourism influences tsunami resilience, cultural identity and economic revival.

Understanding the interaction of the cities between each other and the interdependencies of the drivers forms the base of the regional strategy. In the next chapters the plan will be defined in three sub categories based on their driver impact.

Cultural i	Recaptivating t.	Economic r.	Tsunami r.	Shrinking p.	Energy t.
					Fossil fuels
					Renewables
					Transport
					Car use
					Elderly engagement
					Transport / Connectivity
					Dykes and levees
					Natural defence
					Evacuation defence
					Inundation and relocation
					Primary industry
					Secondary industry
					Tertiary industry
					Transport
					Tourist functions
					Natural landscape
					Cultural landscape
					Transport
					Local economy
					Local community

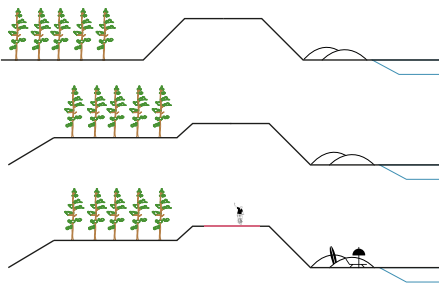
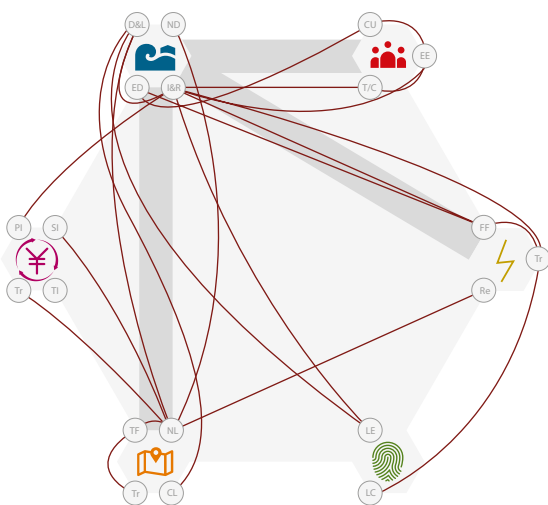
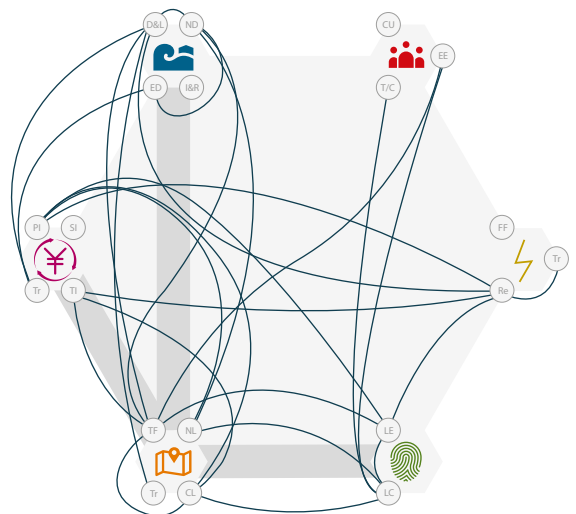


Image 27: Clashes of opportunities and threats mapped, source: Author
Image 28: Integrated levees. Source: Author
Table 29: Scheme threats and opportunities, Source: author



Threat scheme



Opportunities scheme

REGIONAL STRATEGY



LEGEND

- New powergrid
- Maximum flood area
- Wind energy defence line
- Wave enegry
- Biowaste energy
- Geothermal energy
- Coastal forest
- Dunes
- Transport waterway
- River ring
- Historical castle
- Cultural site
- Touristic port
- Beach site
- National park
- Park
- Transport focus (TOD)

0 2,5 5 km

DECENTRALISATION OF THE ENERGY NETWORK

The first strategy is a long term plan to phase out the dependency of the centralized trunk line and moving from centrally supplied, one-way consumption modes to open systems of distributed, ubiquitous providers and users of renewable and other energy streams. Distributed energy systems are defined as local, small-scale, modular technologies for on-site, grid-connected or stand-alone energy conversion and delivery. The energy production units may, for example, be located in a factory that is privately produced but also may be part of a larger distributor like TEPCO (Tokyo Electric Power Company Holdings, Inc) the largest energy provider in the region. Diversifying the regions economy and moving towards a more independent network.

One of the main dangers of the tsunami of 2011 was the vulnerability of industrial zones and ports. The lower dyke height made it possible to damage the ports and the located LPG factories. Using elevated windparks in sea could help reduce the impact of the next impact.

That could affect the energy supply of the region, a situation that is essential to avoid when help is needed after such a disaster.

The energy analysis showed that there were several potential renewable energy sources available in the areas. By categorizing them in sources that are located uphill and sources that are located in the flood zone, we can cluster them in a local grid to insure a constant supply even during and after disasters.

This local grid with two or more resources protects the city from when a tsunami strikes as uphill locations remain unaffected. But this also works the other way round. Mountainous areas are prone to landslides during long periods of rain or typhoon season. During an landslide inland coastal cities remain provided with energy derived from the lower located resources.

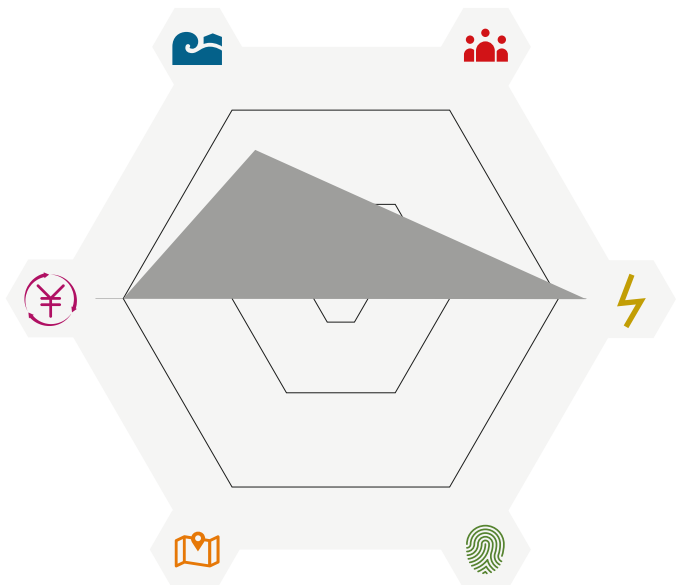
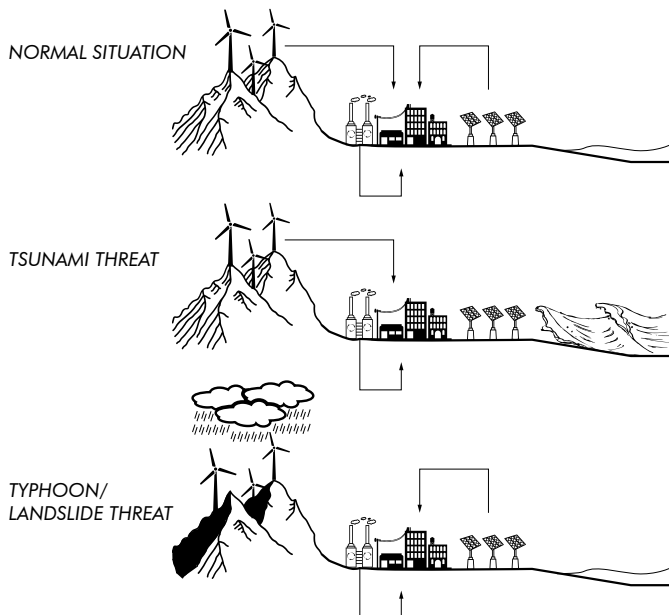
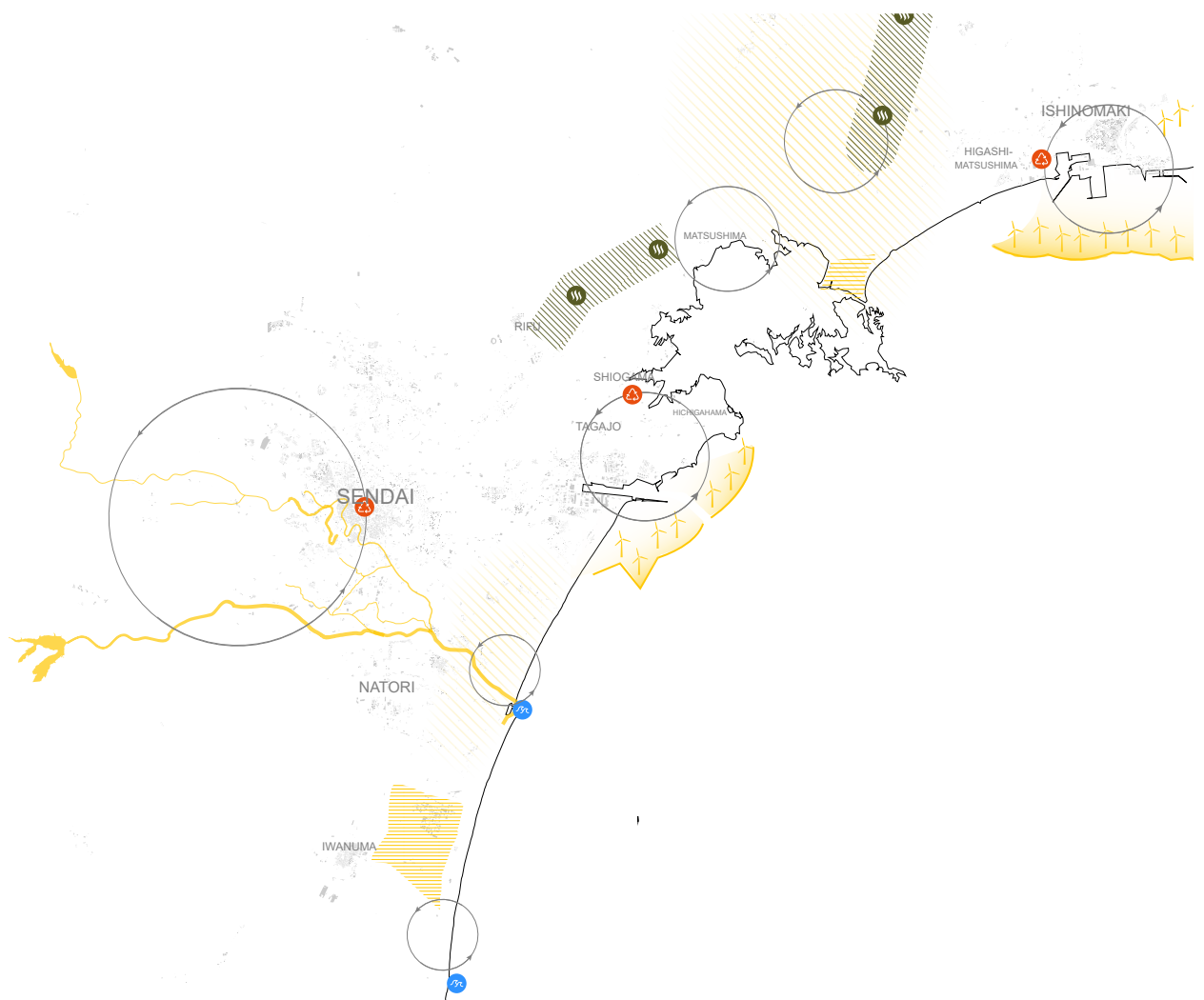


Image 30: High and low energy resources, Source: author

Image 31: Performance on themes, Source: Author

Image 32: Energy transition, Source: Author



CONNECTING GREEN AND BLUE

In the simplified regional map of Miyagi we could see that the way the mountain range folds itself around the southern parts of the region mounding out in the bay of Matsushima with peninsulas on either sides. This made infrastructure pass through a narrow piece of land that is heavily urbanised through urban sprawl. On the coast side we see large patches of rice paddies that contain a low ecological quality due to the effects of the tsunami. This expresses itself in a fragmented landscape disconnected in the north-south axis and the east-west. One of the few natural structures that manages to cross these barriers are the rivers Natori, Nanakita and the Sunaoshi river. The rivers connect several green structures, coastal forests at sea side, natural reserves and large parks. Strengthening these east-west axis's will function as a reverse planned buffer zone, creating clear lines between sprawl areas. The earliest example of these zones came from the UK, where green belts were installed to prevent urban sprawl and avoiding cities to grow together (Bontje, 2003). The Dutch adopted the concept in 1960

and called them buffer zones. These buffer zones restricted urban development in these zones.

Implementing only green blue infrastructure provides a lot of opportunities from an ecological standpoint. Though the lack of free space in the region does not rectify such a single use structure.

Integrating the natural landscape attractions and combining them with cultural attractors in a string of pearls kind of matter can showcase the highlights and characters of the region. Making them better accessible for tourists and locals.

This strategy integrates views from green areas and water contributing awareness of the necessity of natural space in urban areas as providing a safe corridor for soft modes of transport. An example is shown in image 23 where the whole province of Zuid-Holland is considered an oversized park held together by a green blue infrastructure and highlighted with local attractors.

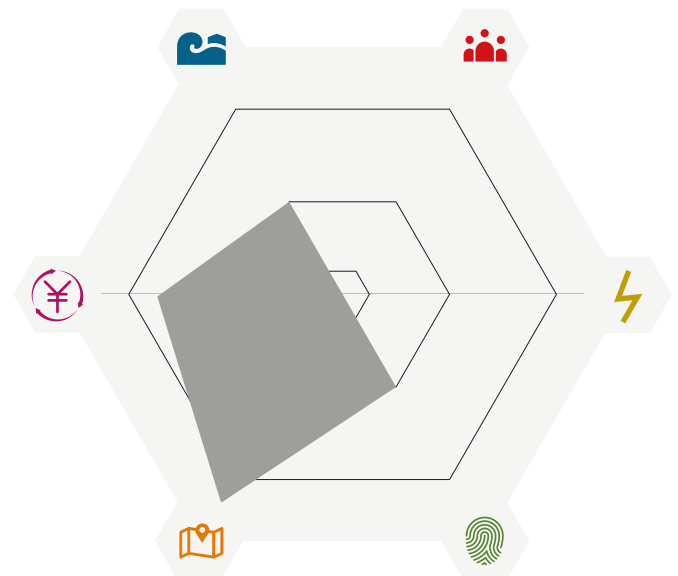
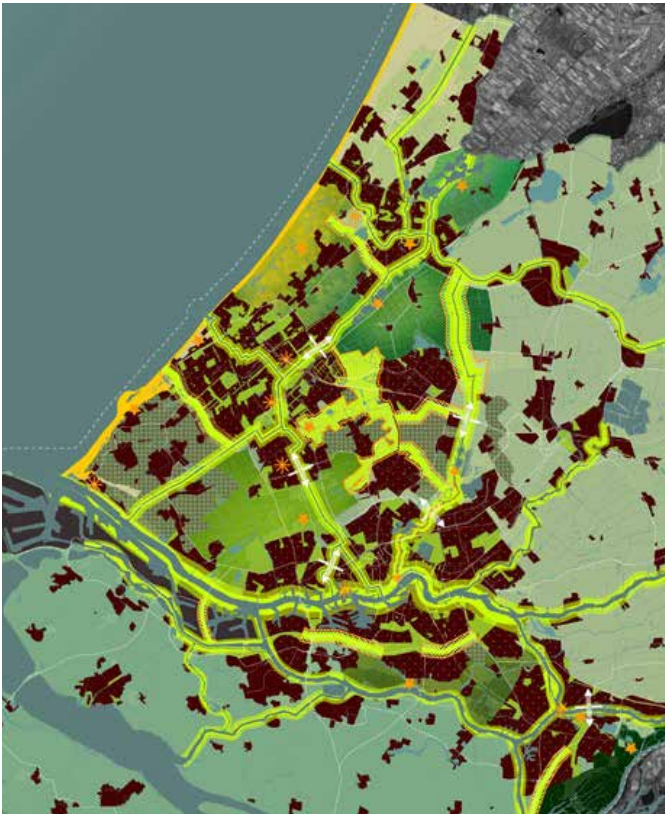


Image 33: An example of green blue networks

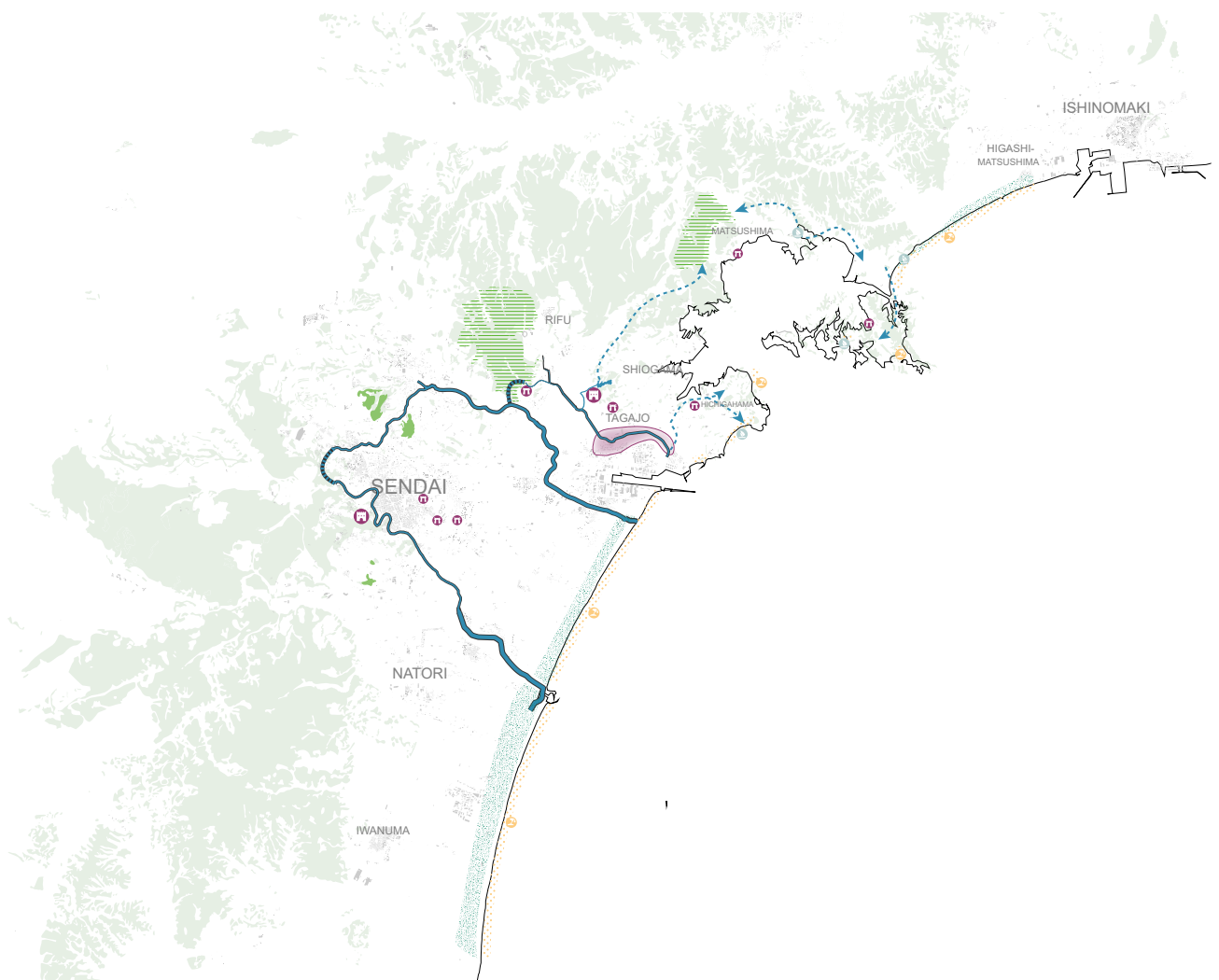
Source: Provincie Zuid-Holland

Image 34: Performance on themes, Source:

Author

Image 35: Green and blue network, source:

Author



RECONSIDERING INFRASTRUCTURE

In the previous chapters we concluded a missing public transport link along the coastline. As the aging rate is higher in the coastal region compared to Sendai, a threat lies here when elderly are not able to use their cars anymore to function on a day to day basis. Cutting them off from larger medical institutions that are located land inwards. And making them vulnerable to reclusion as community instances become harder to reach.

Extending the existent train network is a costly investment and not a flexible solution as it is unclear how intensive this link will be used in the future considering the shrinking population.

A chance lies in the canals that are constructed between the coastal cities. They function as a transportation line for fishing ports. Implementing a ferry line between the canals makes it able for elderly living in the coastal zone to reach larger towns without moving out of their community. This transport is also flexible as the fleet can easily be expanded or reduced if transport demand changes.

A second strategy element is the bottleneck of infrastructure lines located between Rifu, Shiogama and Tajago. These municipalities conjoined together by sprawl. This vast amount urban development request a higher density of train stations, reducing the speed and connectivity to the north. By investing in a new development core where most of these infrastructures come together we can decrease the travel time and make public transportation more effective.

This method is known as TOD (Transport, oriented, development) a planning concept that focusses one creating patterns which facilitate the use of public transport by conventionality placing itself between other uses of transport, like road, bike and bus. The the use of diverse the land typologies and densification. The different land uses should be able to be reached within 5-10 minuted walking. Left shows an example of how a city like Zaanstad can interlink a series of nodal development connecting Amsterdam to the rural North of the Netherlands.

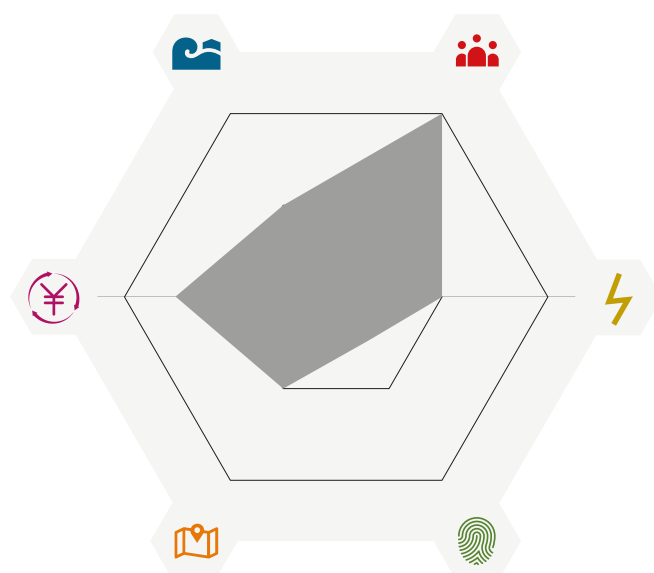
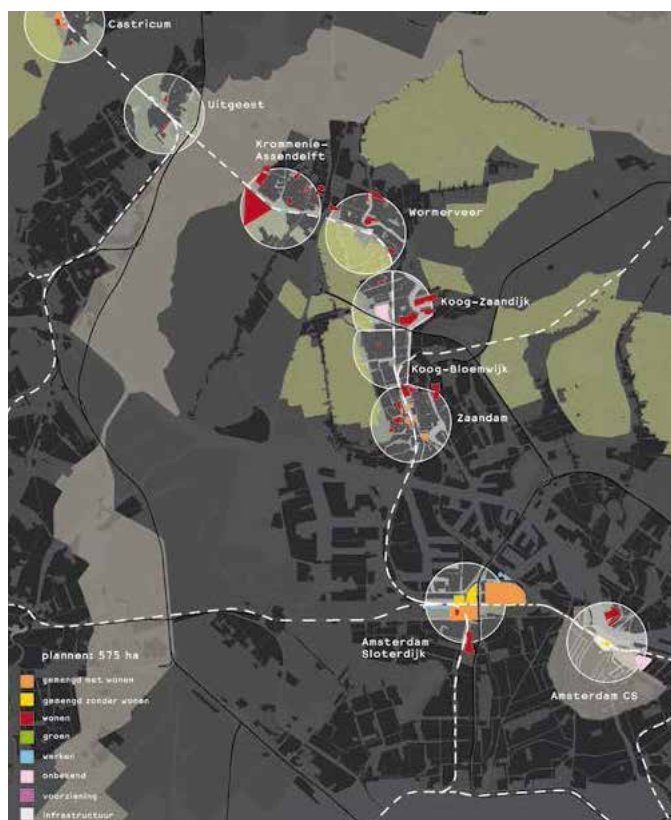


Image 36: An example of a TOD development in Zaanstad Source: Provincie Noord-Holland

Image 37: Performance on themes, Source: Author

Image 38: Reconsidering Infrastructure map, Source: Author



URBAN DESIGN

With the strategies orientated on the regional scale the next step is to translate this into a physical location to test the effect of the proposed strategy. The decision making progress of where the design location should take place is based on the proximity where the three strategies interact with one and other.

Based on the profiles the centre of region functioned as a core of many urban development problems and economical strain. If we locate the threat and opportunities that where identified in the clash table and project them on a map (as shown on the image beneath). We discoverer a clustering of around Rifu, Shiogama and Tajago similar to the interaction map. Using these municipalities for the urban design phase will result in the most comprehensive design.



DESIGN ACCORDING TO SCALE

Better urban planning and design of cities is closely related to the need for sustainable development. This is not translate itself directly to a square, street or even a neighbourhood. But the configuration of the green-blue systems, regions growth patterns, transportation network, water and sewerage systems and even industrial process. Design systems requires thinking about how they relate to all other elements of a given community, combining physical planning with public policy frame works that can also influence a design (Shahreen et al, 2018). Mapping themes that where affirmed by two bodies that function on different scales affect the outcome of the strategy. Merging the two scales in a newly introduced third "in-between" scale makes the outcome of some themes less prominent in the strategy than others. Therefore it is important to translate the strategies in the right design scale.

Based on the relatability of the scale as seen in image 24 an urban design for an infrastructure strategy like an TOD design will be most representable on a city till neighbourhood scale this. Locating an ideal TOD location is on a city scale but the actual design is neighbourhood based due to the walking distances that are required of 5-10 minutes walking. The broadest range is the green blue infrastructure. These systems can cover a whole river basin as the base of the design. But can be transferred a small section within the basin as representation of the larger scale as it is usually too complex to program the whole waterway. The energy transition is a more large scale design task where they key is to assign the most profitable locations (and based on production size) on a provincial and regional location. And the city scale to zone and rearrange the said location to optimize the network and safety.

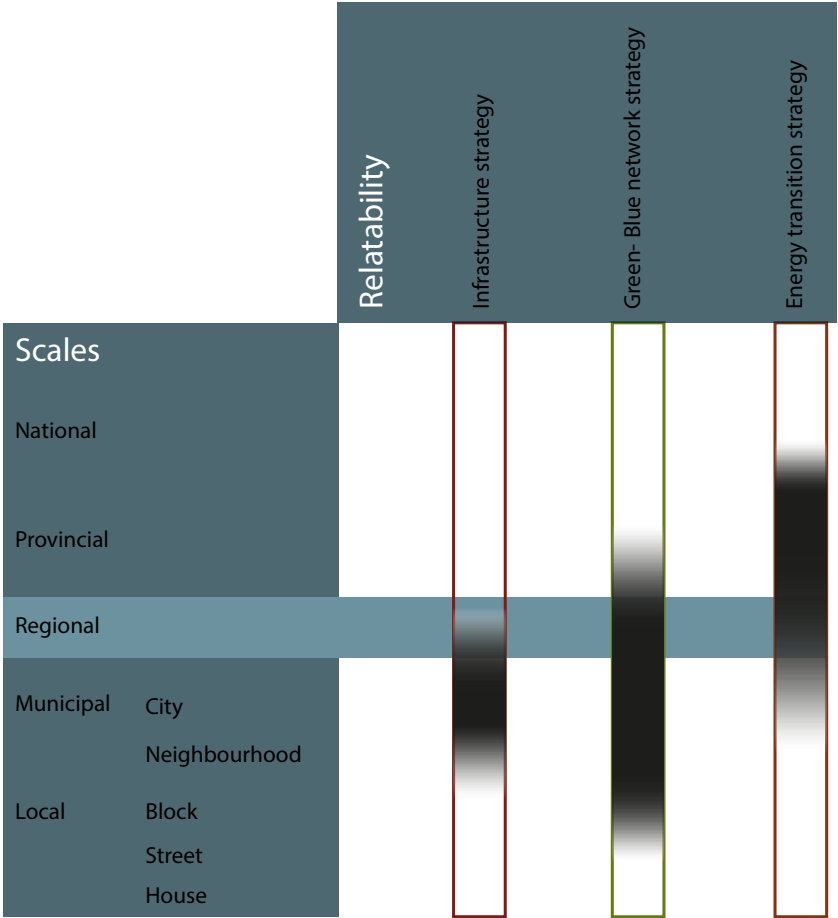
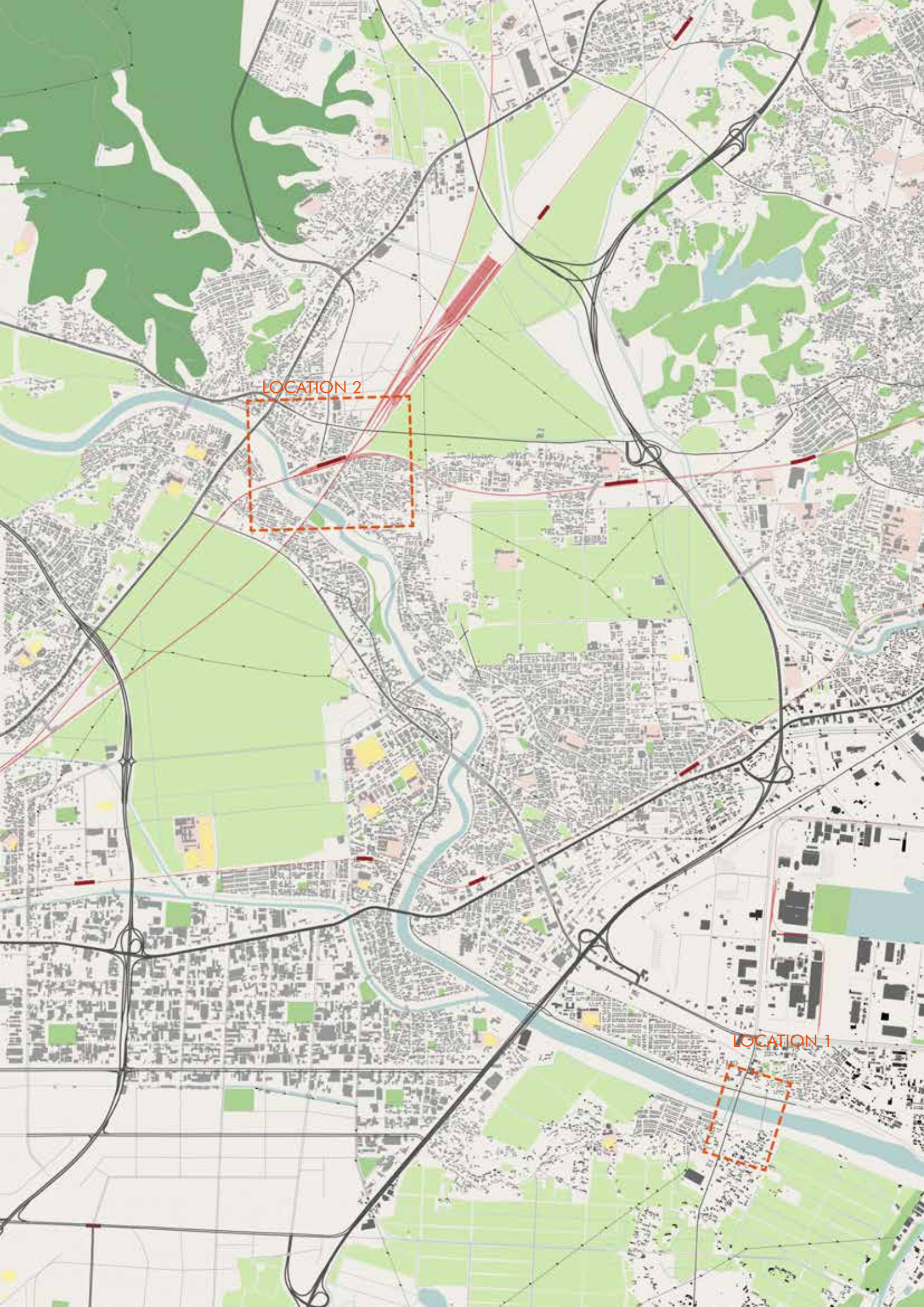
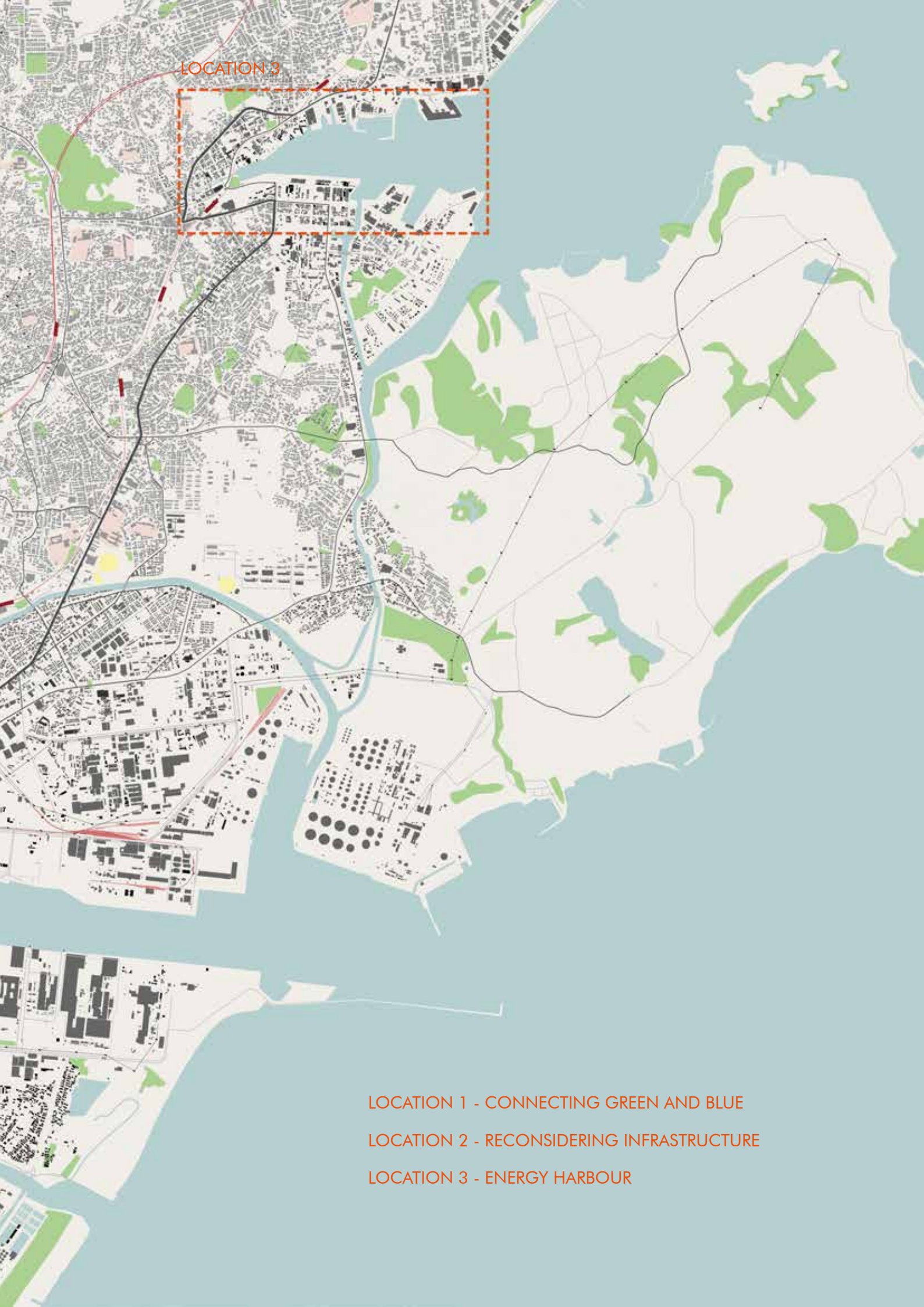


Image 39: Enumeration of threats and opportunities projected on the region, Source: Author
Image 40: Scales related to strategy, Source: Author



LOCATION 2

LOCATION 1



LOCATION 3

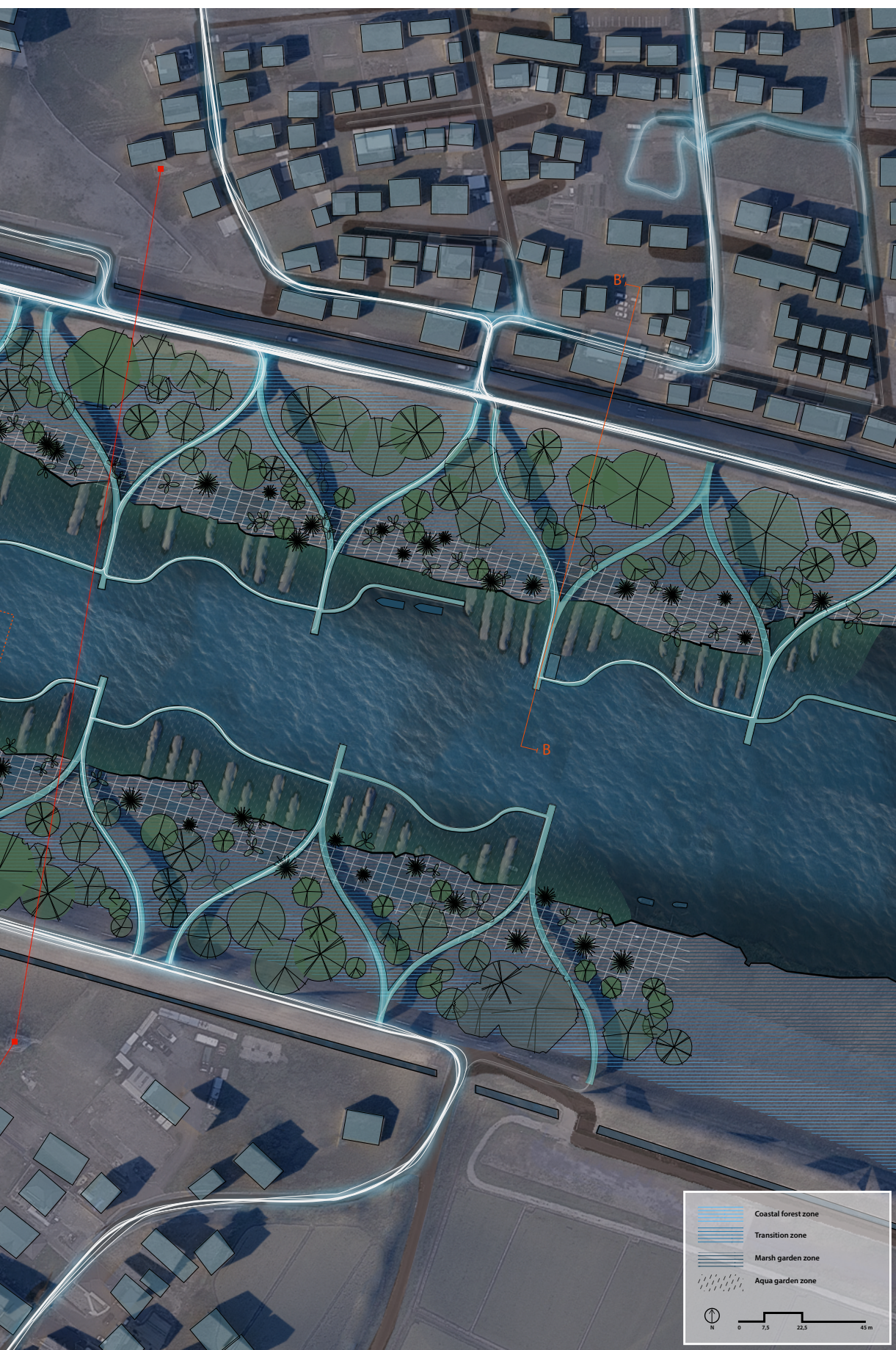
LOCATION 1 - CONNECTING GREEN AND BLUE

LOCATION 2 - RECONSIDERING INFRASTRUCTURE

LOCATION 3 - ENERGY HARBOUR

LOCATION 1 / ECO JETTY

This area is one of the tsunami prone locations where the implementation of a secondary dyke structure is missing. This is partially resolved by increasing the height of the levees flanking the river side. This increases disconnection of the adjacent residential neighbourhoods from the river Nanakita. Some of the housing is built so close to the foundation of the levee that it spares little to no space to implement a green blue infrastructure. However, the floodplains of the Nanakita river do lend themselves to implement some form of greening. A groyne like structure is designed that invites the locals and visitors behind the levee to interact with the river throughout the seasons.



VIEW A



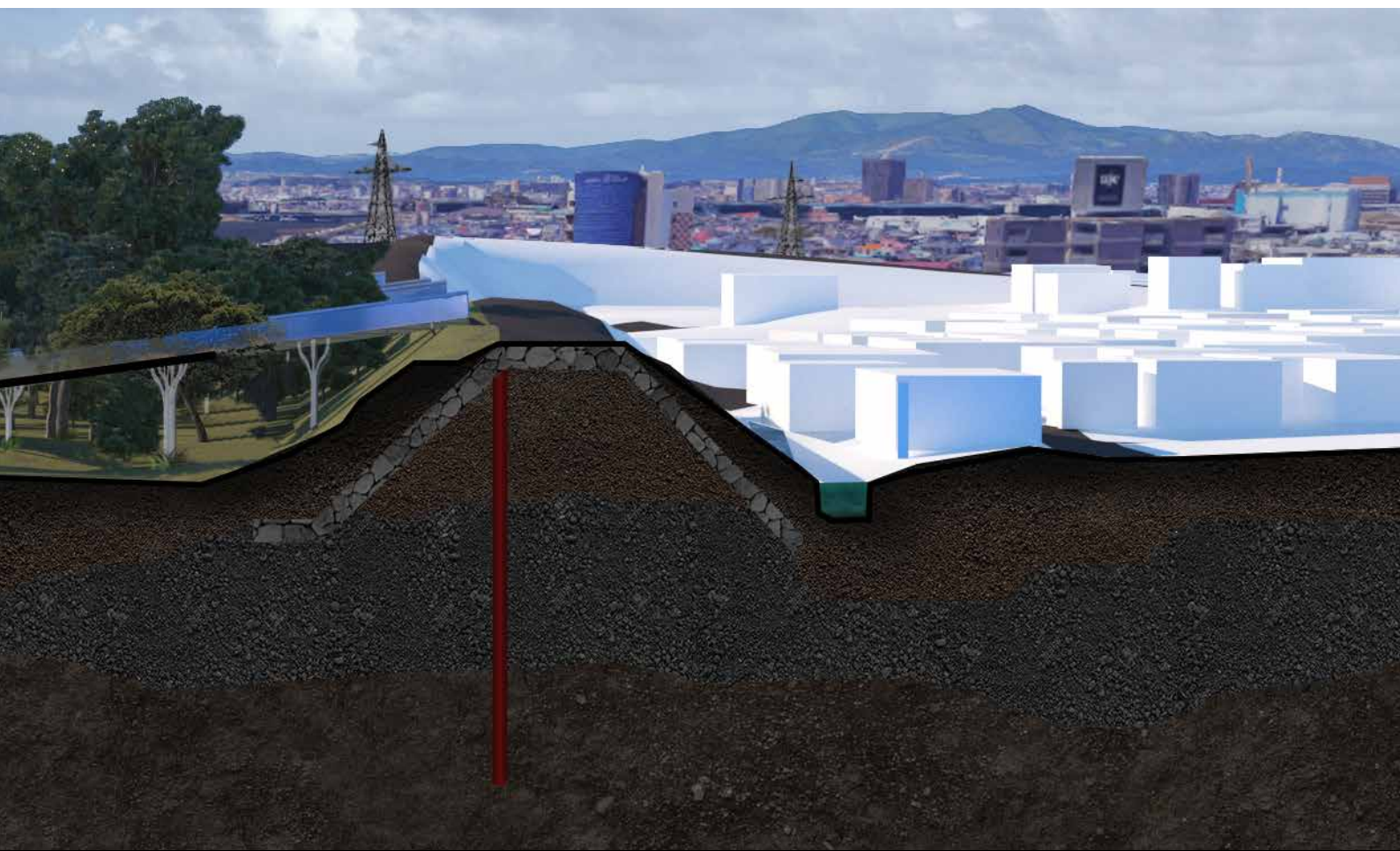


SECTION B-B'

The groyne functions as a coastal forest rotades in a 90 degree angle, this in order to get to the necessary 300-500m depth a coastal forest is required to be effective (Tanaka, 2011) (Gedan, et al, 2011). The other confliction is the minimal depth of the convertible land that is suitable to built a forest within the floodplains of the river (see image 25).

The groynes are connected though a flexible board walk so that it stays accessible most of the year. The variation in tides and the river level creates a wide range of ecosystems that can thrive here.





FUNCTIONS

The design is compartmentalized in several elements. First is the board walk, it connects the main road on the levee to the river. The pillars are made of sustainable concrete with the fanned out extremities mimicking a mangrove. This will function as a trapping effect for the forest that lies in between, ensuring most of the uprooted trees stay contained and will not float upstream during a tsunami. The second element is the natural embankments consisting of Japanese oysters, a local delicacy and specialty in this region. It gives the opportunity for locals to forage them and sell them on a stand attached to the board walk propagating their local culture and heritage.

Using these embankments is a way to counteract the erosion of the banks during the frequent tides but also contributes to the mitigation process of a tsunami.

This has been proven to be an effective method applied in sea embankments in Zeeland, Holland (Setegn, 2011).

The top layer consists of forestation divided in 3 categories based on averment against salinity. The aqua garden is a flexible garden that supports the oyster embankment

The marsh garden is placed under a supportive grid ensuring partial submerging won't unroot the growing flora. By spreading out it insures the soil stability during a disaster. The coastal park is a mixed use of Japanese red and black pine, native to the region. Mixing the forest with other native plants gives a variable trunk and crown height which benefits the mitigation (Tanaka, 2012).

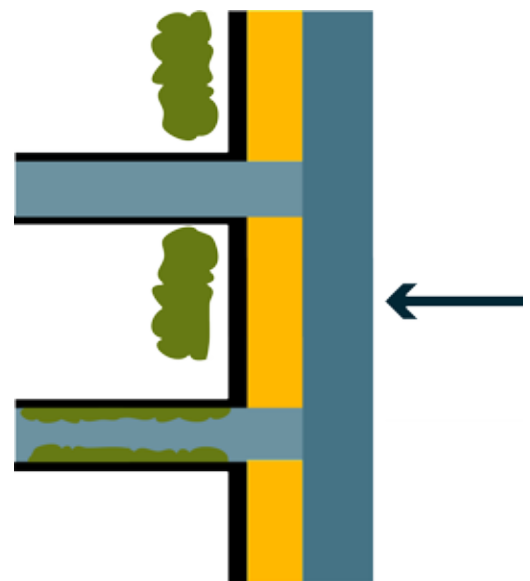
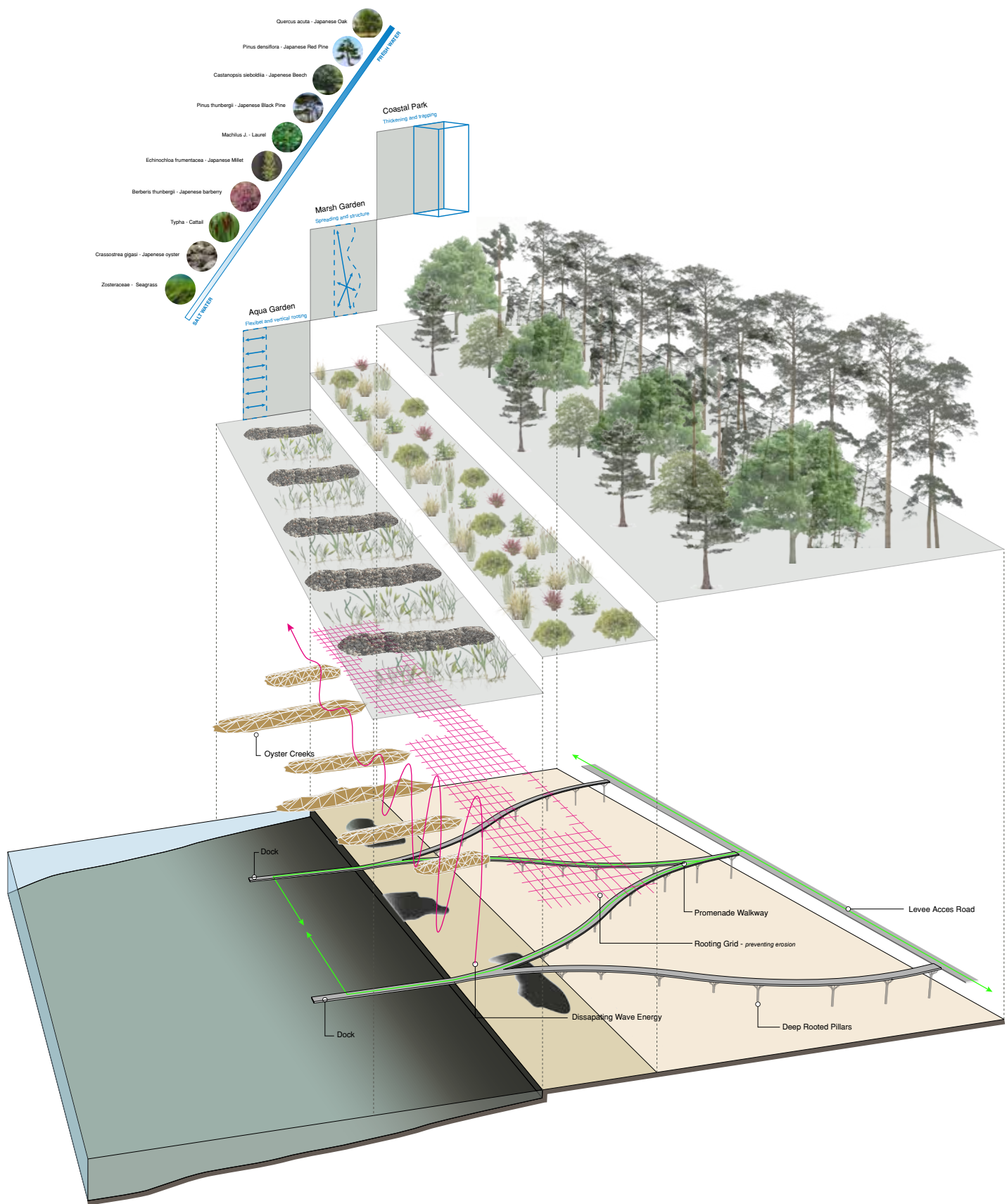


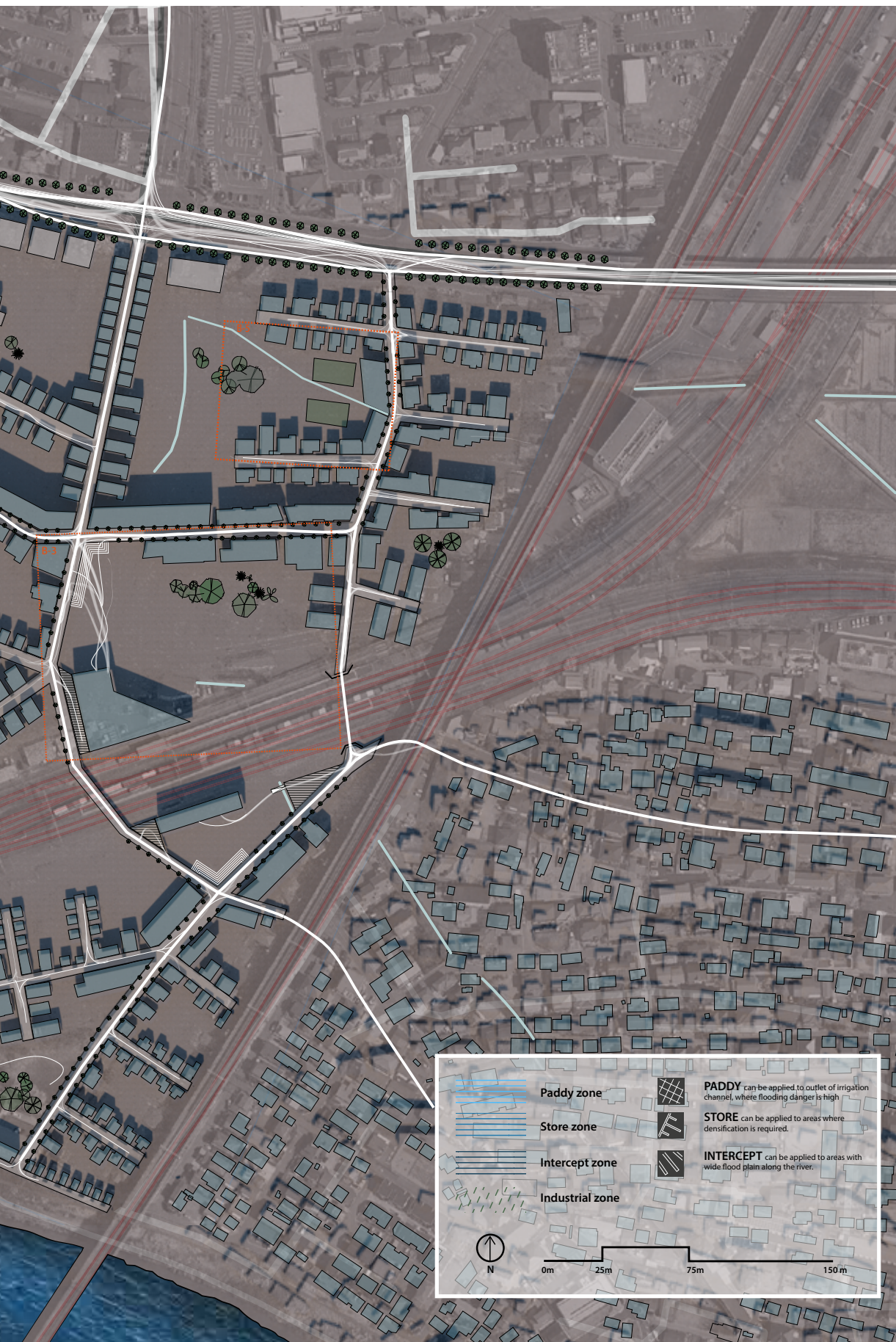
Image 41: Rotated principle of the coastal forest, Source: Author



LOCATION 2 - TOD

The location is favourable due to its arterial infrastructure. To ensure the safety of the investment two designs are implemented in the area. The first one is the paddy zone, it functions as a green space between the river and the up-built area, able to be remodelled if its necessary. The store zone, a densified zone with a maximum buffer capacity within its own urban pattern. The intercepting zone is derived on the eco-jetty with functionalities specified to its location.





INTERDISCIPLINARY / TIL

During our interdisciplinary meet up an overlap of observations and design measures between the transport (Robert Mohring) project and urbanism was established. Both acknowledged in their analysis phase that the growth around Sendai combined with the future shrinkage in the region affects the weaker (and older) society in the region. Integration of both projects will refine both strategies in their results.

To implement the TOD development some requirements are established:

- Better walking infrastructure and network
- Better cycling infrastructure and network
- Better connected quarters by walking, cycling network and public transportation for longer distances
- Better infrastructure, coverage and service of public transportation
- Reduced car oriented road design and parking spot supply
- Re-use of abandoned sites for inner cities or ground level parking lots for housing development of medium density
- Better functional mix of living, leisure, recreation, retail and soft industries.
- Reduction of occupied urban space.

These requirements are translated to demands that one specialisation is more experienced in (image 42). One will develop this principle and in consultation with the other a final design is converged. The design is based on the interpretation of both specialisations within their research. The results are therefore not final and should be considered as a suggestive image of what the potential is within this location.

The first three demands are based on development laws that favours walk ability and cycling based on wider paths. Road hierarchy is redistributed with driving lanes at a minimum, diverted or detached. Car use will be discouraged with a reduction of parking spots or parking away from the road. In compensation connectivity is improved with an optimized public transport network. The Iwakiri station is redeveloped at the heart of the neighbourhood improving travel times to Sendai and the northern cities (image 43). To fully optimize the transportation system a BRT (bus rapid transit) will be integrated in the region, bus use is a flexible system commonly favoured by the older society. The additional system will increase speed and directness and fully cover the service area (image 44). at the north side.

1. Increase walkability	(TS)	Road Design	Design of Build Environment
2. Increase bikeability	(TS)	Road Design	
3. Increase connectivity	(TS + LU)	Network Design	
4. Increase PT	(TS)	Network Design	
5. Support Transport Shift	(TS + LU)	Public Places	
6. Densify	(LU)	Urban Design	
7. Increase Mix	(LU)	Urban Design	
8. Build compact settlements	(LU)	Urban Design	

Image 42: Division of specialties, Source: Institute for Transportation and Development Policy
 Image 43: Train network Miyagi, Source: Robert Mohring
 Image 44: BRT system Miyagi, Source: Robert Mohring
 Image 45: proposal transport system Iwakiri, Source: Robert Mohring

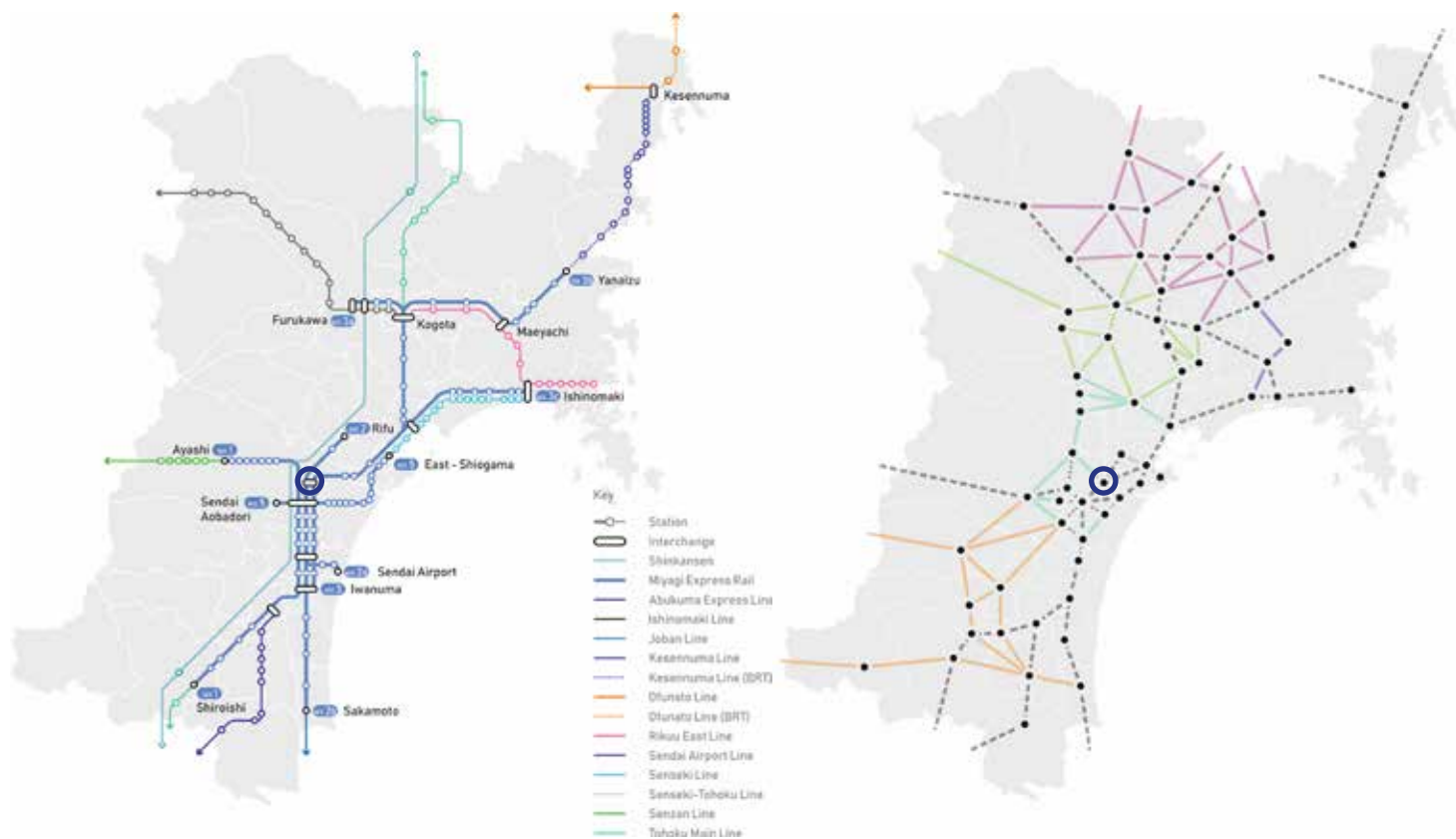


Image 45 is a representation of the impact area of the bike and walk network, with extra bridges to cross the river, reaching a national forest (upper left) within 10 minutes walking and a historical castle of Tagajo within 15 min of cycling (not on map). The bus network is redirected at the south side of the station creating a pedestrian zone

The demand of increasing connectivity is applicable on multiple levels. As TOD strategy is a multi nodal system that interacts with multiple developments along a transport-network. Researching the surrounding stations and their surrounding functions can distinguish what kind of development is suitable. Answering the amount of densification, building typologies and level of compactness.

The image below shows the Iwakiri station (A), Rikuzen-Sanno (B) and a cluster of the stations Shiogama, Nishi-Shiogama and Geba (C). The neighbourhood surrounding the stations have different favourable attraction and or services in their vicinity. These given elements will form the type development and role they play in the system.

A. Local center (i.e. Iwakiri)

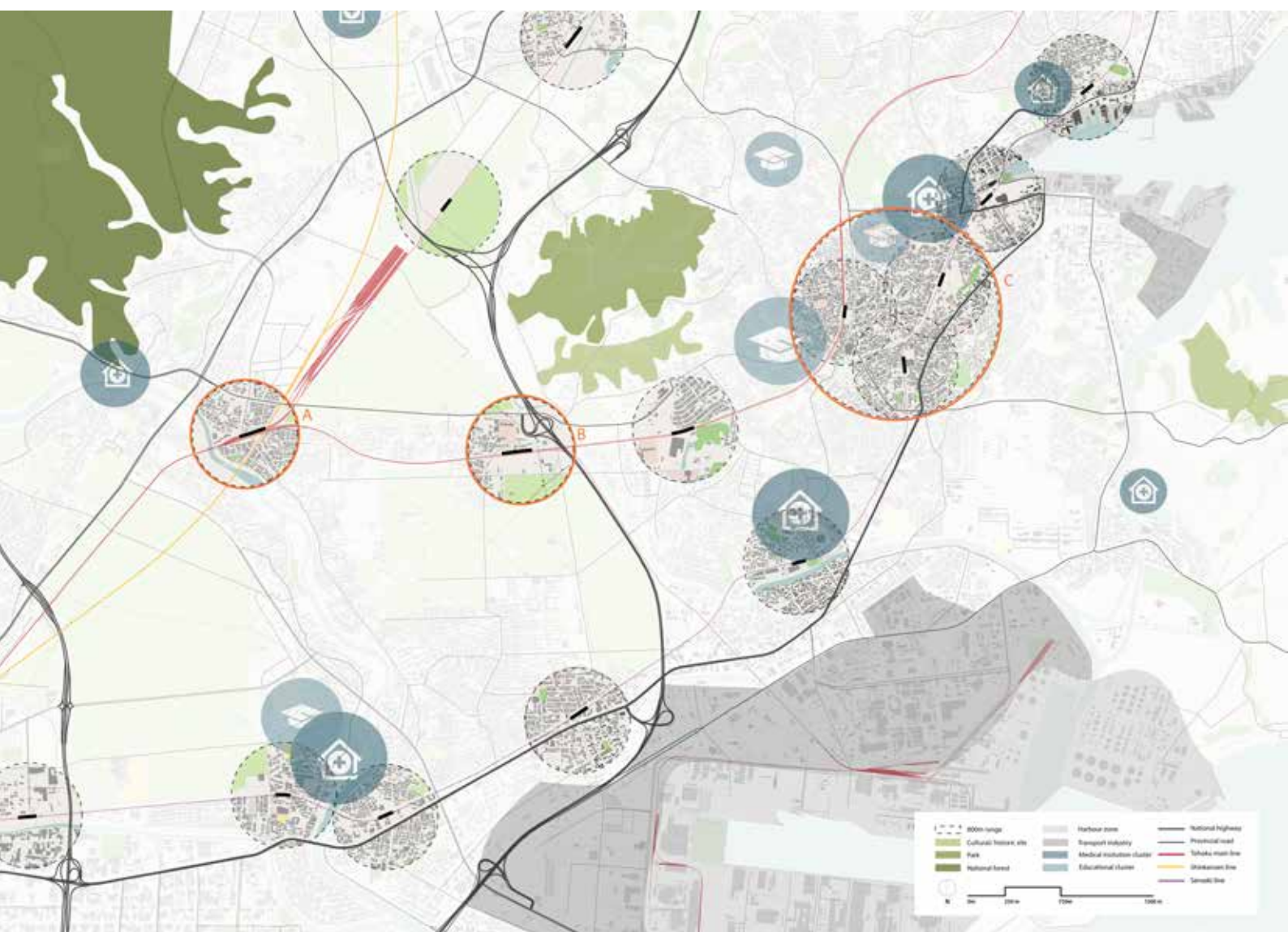
- School
- Sport facilities
- General practitioner (M.D.)
- Pharmacy
- Post office
- Bank office
- Basic Retail services (i.e. market, supermarket, Gas station)
- Local Political and Administrative Institutions

B. Village (i.e. Rikuzen-Sanno)

- Basic Retail services (i.e. market, supermarket, Gas station)
- General practitioner (M.D.)
- Post office

C. Municipality center (i.e. Shiogama) (with addition to A.)

- Further educating schools
- Public swimming pools
- Hospital
- Specialists (M.D.)
- Law and Tax consultancies
- Cultural activities
- Areas for shopping
- Municipal Political and Administrative Institutions



As mentioned before cycling and walking is the preferred type of transport in the neighbourhood. Therefore it has a direct car free north- south access as shown in the map on the left. Bicycle-parking placed on both sides of the station stimulates the easy use of this mode of transportation. The hierarchy of the road use is emphasised by installing a cycle and pedestrian bridge to cross the train tracks. An example of such bridges are the Moreelse brug in Utrecht and Dieren shown on the right. Motorized traffic will be redirected through a tunnel east of the station. The tactical placement of the bridge functions as a significant urban element that is used in traditional Japanese urban development (De Graaf, Hooimeijer 2008), ensuring a clear view of the Nanakita river and the squares on either side. Densification of the neighbourhood follows the access road, branches allow for more low scale housing. The station on both sides are enclosed with squares where offices and commercial activities can take place. Surrounding the neighbourhood light industries and small agricultural zones are places, creating a diverse mix of housing.

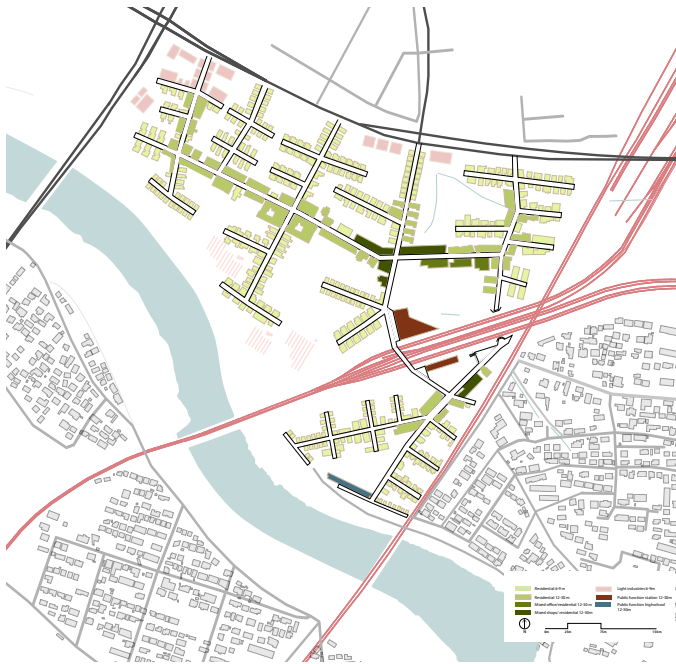
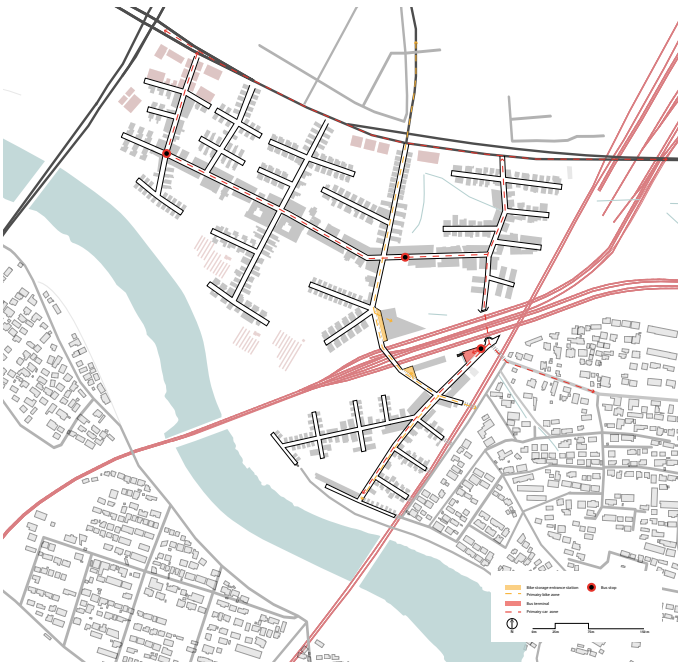


Image 47: Reference cycle bridge station
Diemen, Source: De Gelderlander
Image 47:Transport system neighbourhood,
Source: Author
Image 48: Housing typology, Source: Author

The transport and housing choices translate to different road configurations in the sections on the next page we work out several locations.

1- High density road. This road functions as an access road of the neighbourhood. Public transport and bike lanes have a prioritized lane optimizing their mobility within the neighbourhood.

2- Medium density with bike priority. The section shows the bike priority zone that connects the north and south side of the neighbourhood. The road is initially bike only but to insure less mobile residents can access their front door cars can enter as visitors, lowering the speed to 20 km/h.

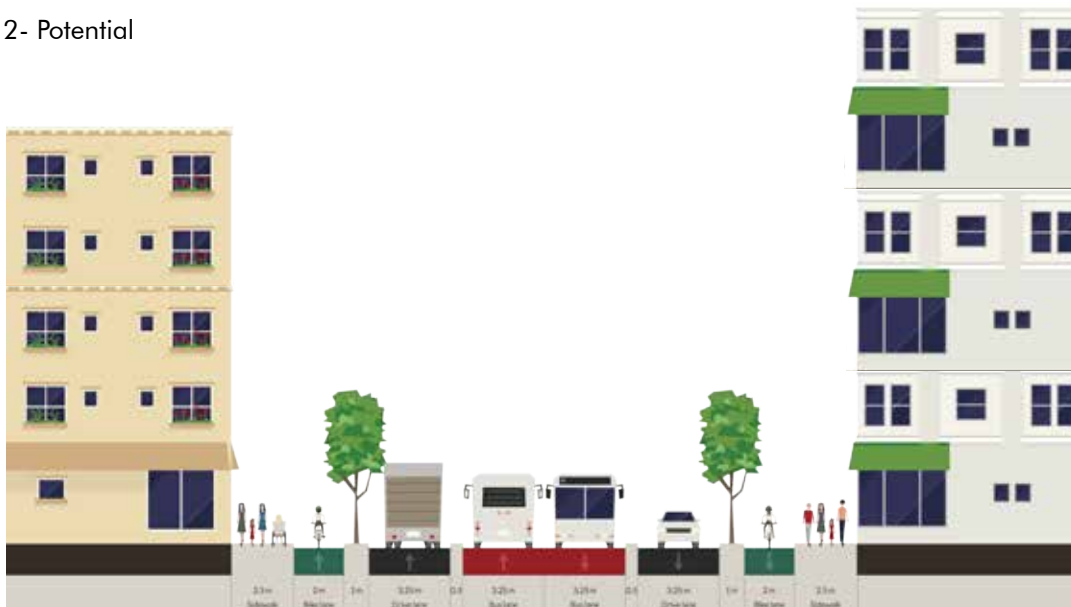
3- Low density. The tertiary branches offer detached/semi detached houses with dead end units. The narrow roads and sidewalks features classic proportions you will find in a 'cho' or 'machi'. Giving the smaller branches a traditional cellular feeling without the impervious development.



1-Current



2- Potential



2- Current



2-Potential



3-Current



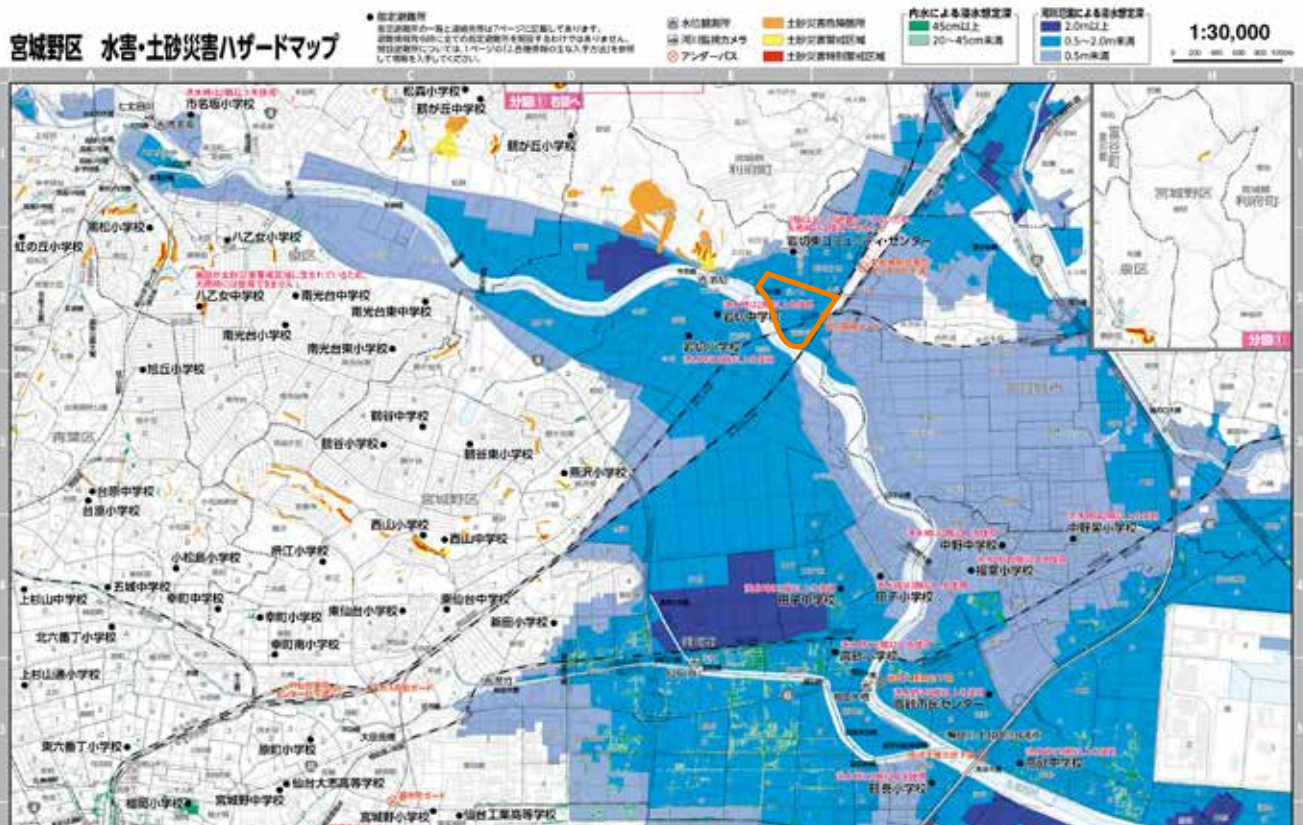
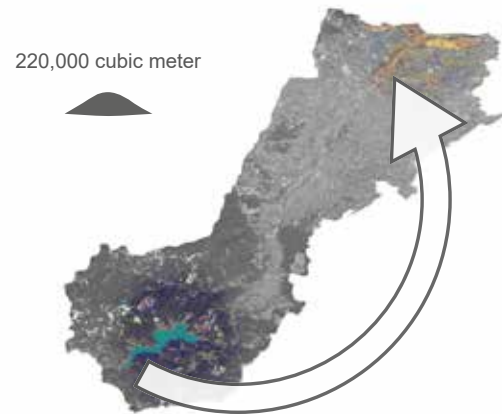
3- Potential



Image 49: Sections, Source: Robert Mohring
Image 50: Floodzone Nanakita river, source:
Sendai Flood hazard map

The location is proven a be optimal place to implement the TOD strategy. Though the river brings several noteworthy hazards. The river basin ensures a 1-2m flooding every 2-6 years. A phenomenon that will increase in frequency keeping in mind that typhoons and rainfall intensify due to climate change. Wedged between landslide danger and flooding this area needs to be equipped to these changes. The neighbourhood is at the moment over 88% percent impervious which has a drastic effect on the runoff that is over 55%(van de Ven, 2017).

Another is the sedimentation the river accumulates every year, around 220,000 m² meters. This interferes with the river mound causing it to close up and obstruct traffic between the canal and the river every 4-6 years.



FASE 1 - RELOCATION

The first step in the development is to Relocate and is to restrict the south area from any development temporary. Main components are primary and secondary dikes with agricultural landuse. Based on the original roads an elevation of 1-2 meters is introduced based on height of the highway and train infrastructure surrounding the location. The original station of Iwakiri will extend to the shinansken reducing the travel time to Sendai with 8-10 min. Unburdening the pressure of transferring on Sendai central station from travellers from the coast. With a increased connectivity the location can also be a great base for tourist as many attractions are centrally located within the Miyagi prefecture.



FASE 2 - DENSIFICATION

The following phase is to increase the density with a retail around the main street of the neighbourhood. And extend the development of residential and industrial blocks. Extra branches extending into the paddy's is possible if the total density within the blocks is maximised.



SITE A - INTERCEPT

Discontinuous banks are placed along the river with an angle to the river flow allowing the water to enter in the gaps in case of higher water levels. In this way sediments will be intercepted increasing the water capacity. Settlement ponds will be placed along the banks allowing the captured sediment to subside.

The ponds will be dredged to supply sediment for the raising of the storage zone. The flora surrounding the embankments are based on the jetty systems marsh garden.

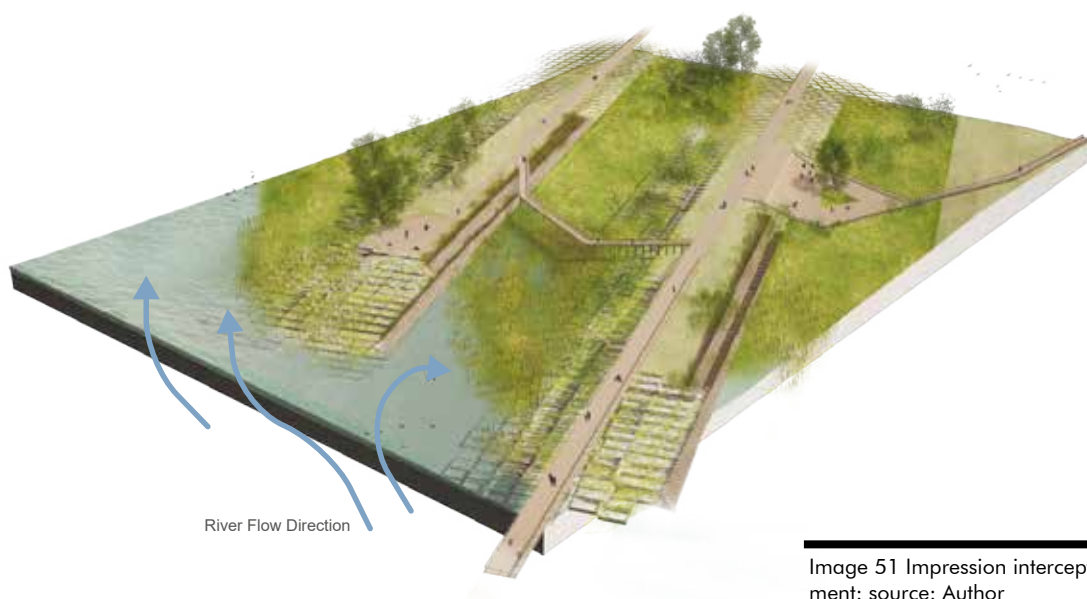
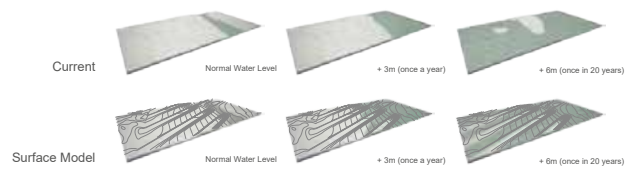
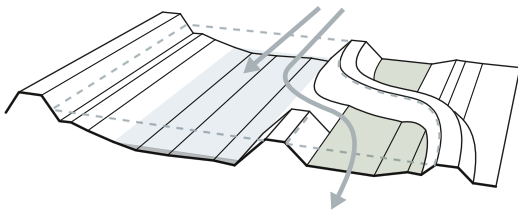
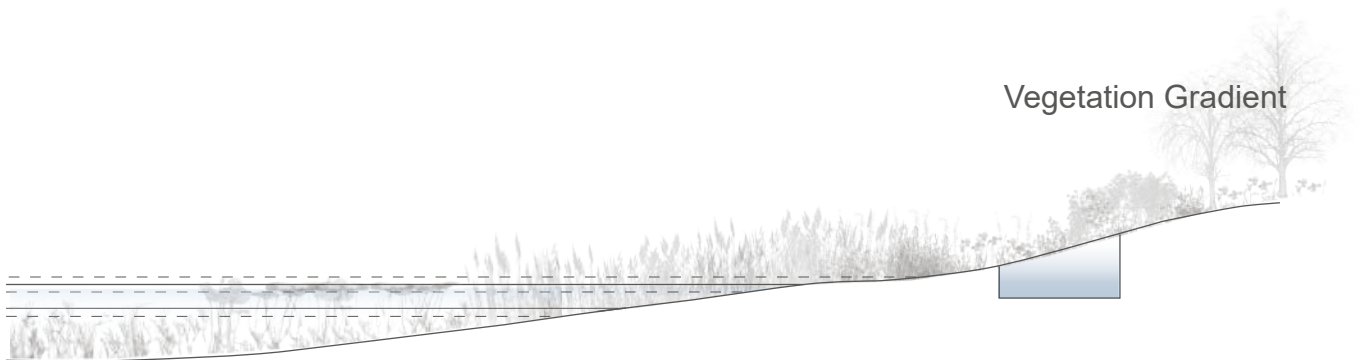


Image 51 Impression intercepting embankment: source: Author
Image 52: Functioning of the embankment. Source: Author
Image 53: Section vegetation embankment, Source: author



Vegetation Gradient



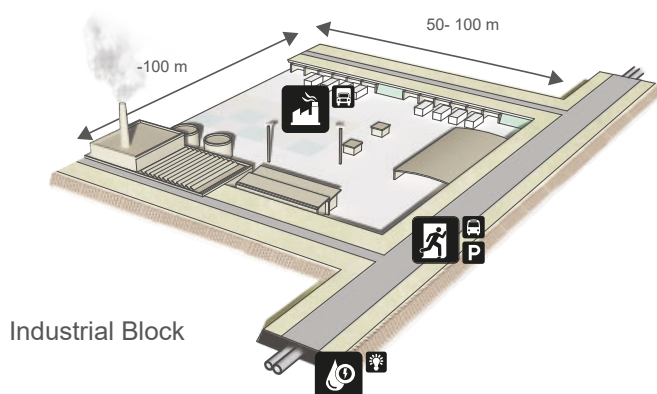
Submerged Plants	-2 m - -1 m Floating Plants	-1 m - +1 m Emergent Marsh	Riverine Shrubs	Settlement Pond	Riparian Forest
<i>Vallisneria asiatica</i>	Water caltrop <i>Trapa japonica</i>	Common Reed <i>Phragmites australis</i>	Snake's Tongue <i>Ophioglossum namegatae</i>		Japanese oak <i>Quercus crispula</i>
<i>Hydrilla verticillata</i>	Pygmy Waterlily <i>Nymphaea tetragona</i>	Manchurian Wild Rice <i>Zizania latifolia</i>	Violet <i>Viola raddeana</i>		Sawtooth Oak <i>Quercus acutissima</i>

SITE B - STORE

The storage zone function like a bathtub by strategic located higher grounds / infrastructures, flood resilient urban models can be envisioned by integrating a floodplain as part of the urban fabric. Able to maintain the necessary density by increasing the building height.

A TOD required a mixed land use in its redevelopment below are several possible configurations are shown in the images.

B-1



B-2

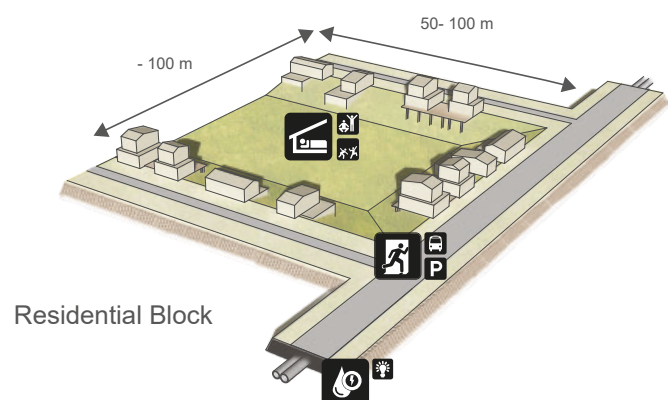
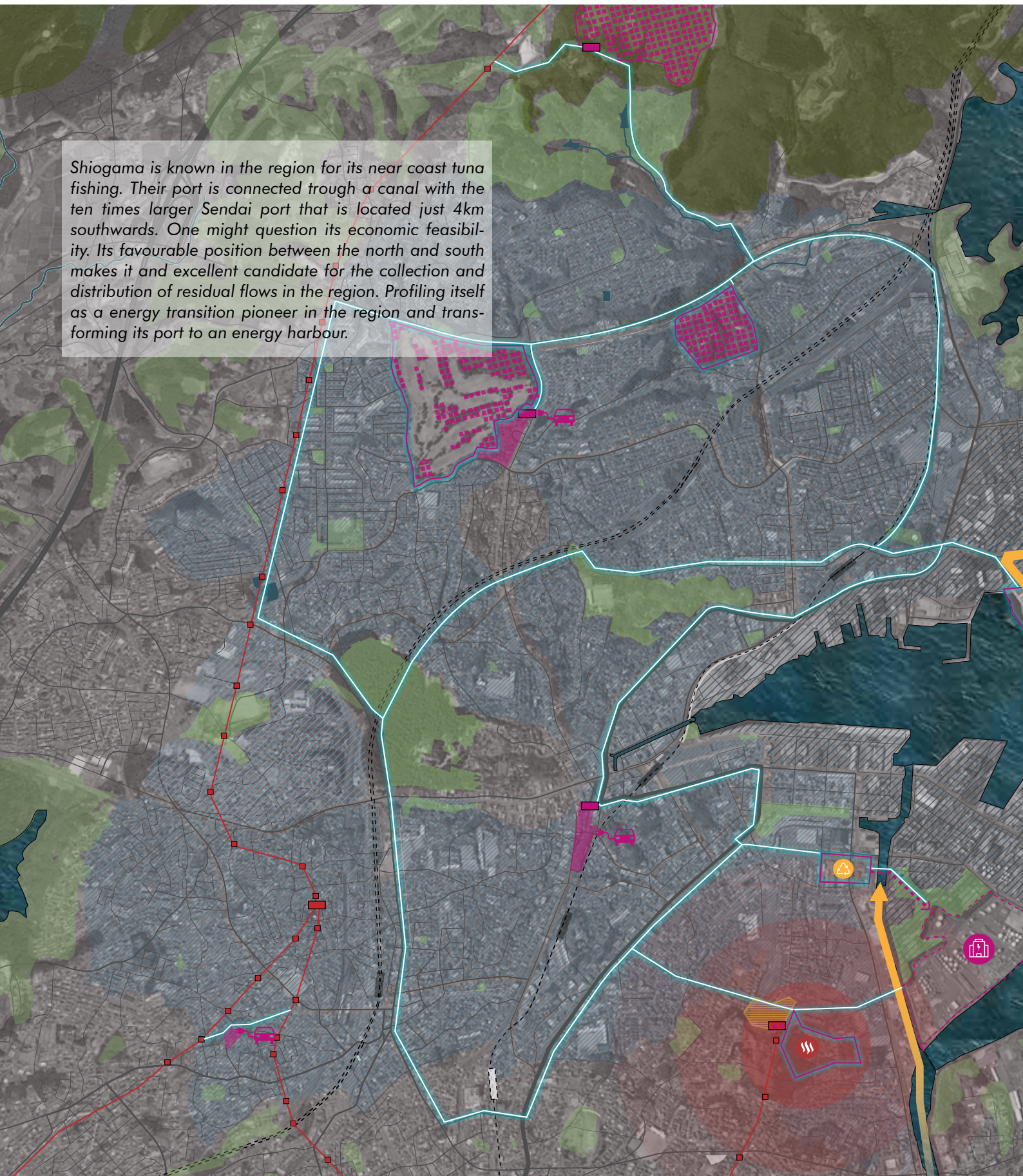


Image 54: Impression different functions within the store area, source: Author

LOCATION 3 - ENERGY HARBOUR

Shiogama is known in the region for its near coast tuna fishing. Their port is connected trough a canal with the ten times larger Sendai port that is located just 4km southwards. One might question its economic feasibility. Its favourable position between the north and south makes it an excellent candidate for the collection and distribution of residual flows in the region. Profiling itself as a energy transition pioneer in the region and transforming its port to an energy harbour.



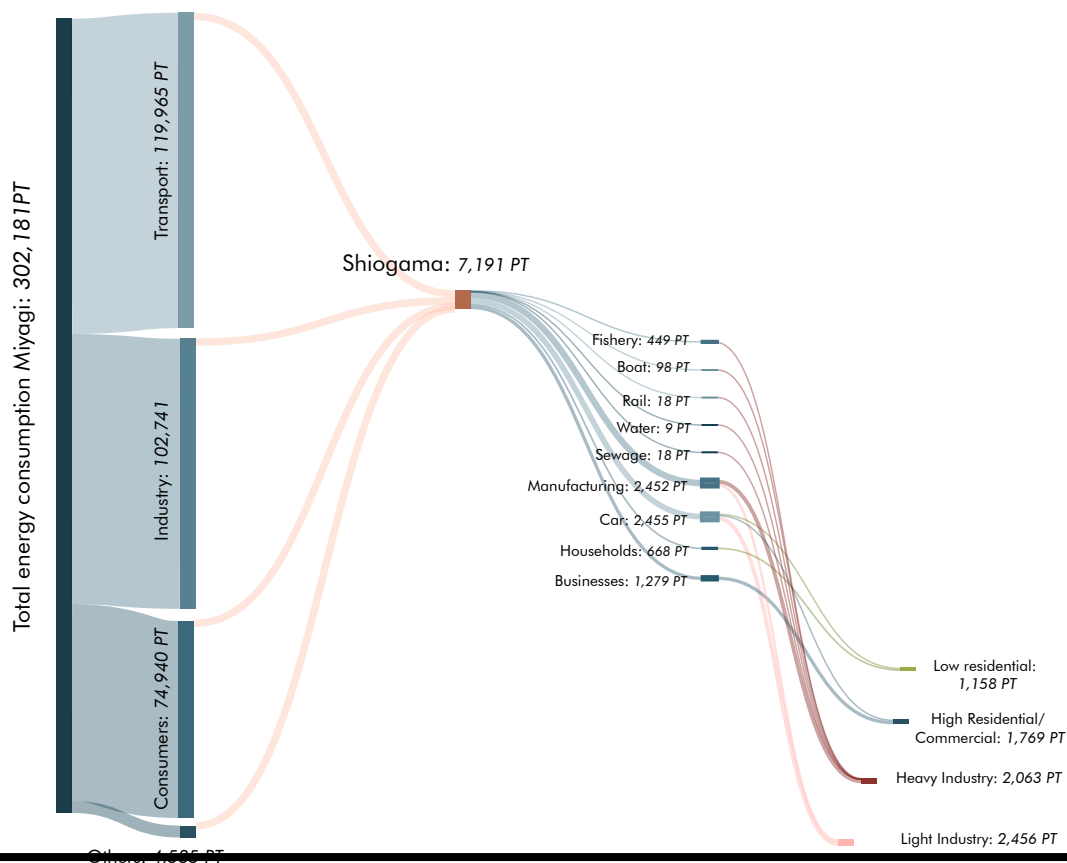


STRATEGY

A transition from fossil to renewable energy is a task that has effect on the spatial component of a city. This new generation of sustainable energy sources looks for a juncture in the natural potential of the local landscape. It requests a different approach than the traditional large scale methods of fossil resources. Meaning that next to equipping the area with modern installations there is also a transition or diversification of accompanying distribution and buffer systems. As renewable sources bring challenges in a constant flow of power, supply and demand should be suited conform its needs, even during disaster. To realise a new energy supply a diversification is needed in sources (heat, electricity or mobility) and how they are optimally combined based on the energy network, spatial configuration, energy need, ecological structure and natural structure. A summary of the current state will be made in the next chapter.

Based on the regional strategy a few principles are arranged:

1. Using local and regional elements as chances to develop the renewable energy system.
2. Use the introduction of new energy as a structuring measure for the spatial configuration of the city.
3. Use specific local features as an essential link for a safe and stable system.
4. Research possibilities where the future use of buffer-capacity can be maximized.



FEATURES

Energy:

In the regional energy balance we can see that the total energy consumption in Miyagi is 302181 PetaJoule (10^{15} Joule). A fraction of that is consumed in Shiogama, where the primary users are the industries within the harbour area and the petrol used for transportation for economical purposes and personal. This reflects on the sources of energy used in Shiogama, a mere 6% is renewable at the moment of which hydro power is the largest supplier.

Based on the regional energy transition maps in the driver analysis (page 34) and the energy dispersion map (page 75) Shiogama has a potential for biomass, geothermal and solar energy. Wind energy is not an option in this part of Miyagi as the area is highly urbanised. Based on the profiles Shiogama can be considered as a fragmented landscape the urbanisation is intertwined which could distort the theoretical possibilities within the municipality.

When we analyse the region further its clear that the port has a dominant production factor in the city. Pressuring the open space surrounding the coastal area. A clear distinction between the chemical and petrochemical business and the fishery and wood processing business is dividing the harbour in a north and south flank surrounding itself with transport industries. Interesting is to find that the main power source enters the municipality from the south side providing the heavy industries and dense neighbourhoods first as they are the most energy demanding. These elements will return in our contextual energy dynamics based on the previous principles.

On the next page we summarized the most important factors of Shiogama.

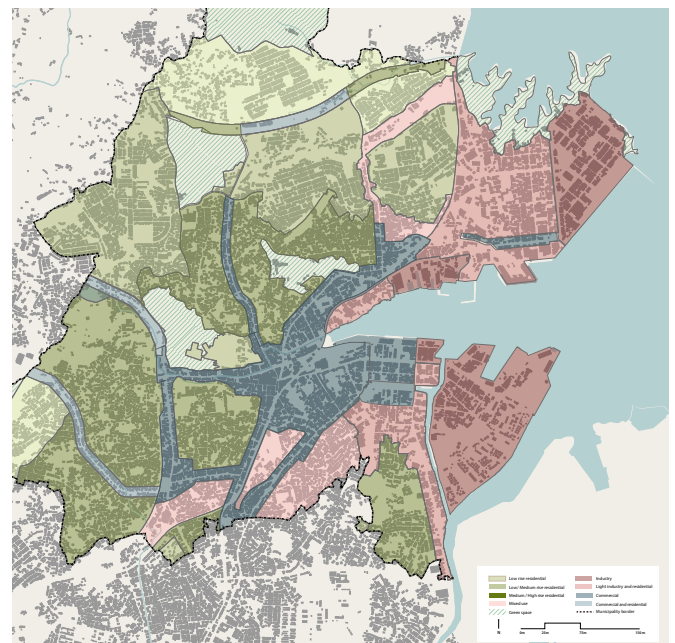
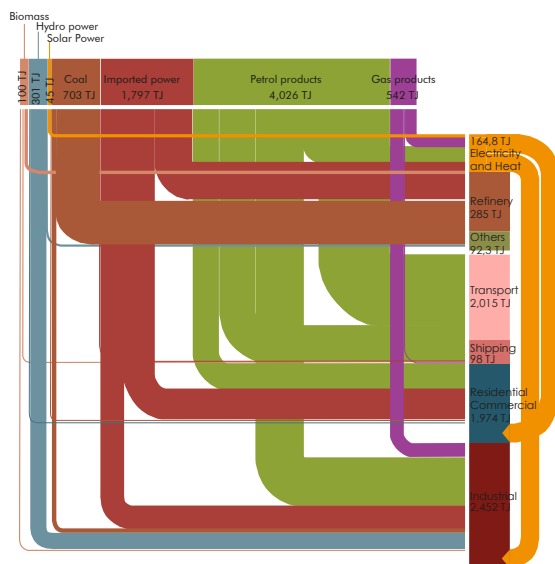


Image 55: Energy use Miyagi, Source: pref. miyagi.jp

Image 56: Flowchart energy type, Source: city. shiogama.miyagi.jp

Image 57: Spatial configuration Shiogama, Source: Author

Demographic

- 187.265 inhabitants - Population is shrinking.
- Middellarge city with limited expansion possibilities.

Energy

- South connection from the Tohoku trunk line.
- Solar farm 17.500 m² producing an estimated 250.000 Kwh/Kwp.

Spatially

- Intertwinded typologies.
- Low density housing in the north.
- No agricultural functions.
- Port is partially reclaimed land.

Economic

- Large petrochemical, transport and fishing economies are present in this municipality.
- These economies take up a large amount of available land.
- Shiogama has multiple transport lines going through its municipality connecting the north and south of the region.
- Port functions are very strained due to Sendai port expansions.

Protected

- *Fragmentated landscape is leading to low ecological value.*
- *Canal leading to the port of Sendai is a protected sight.*
- *Two historic centres are found in the municipality.*
- *Part of the port is redeveloped with a coastal park.*

Natural

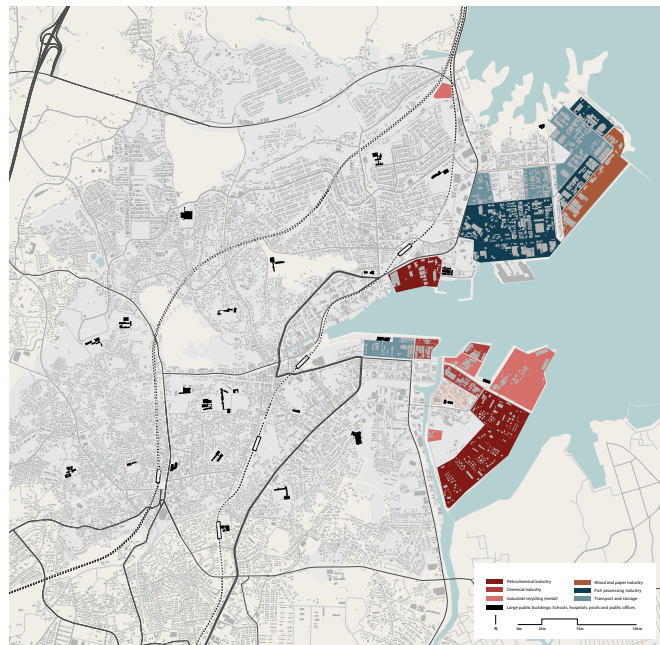
- Higher located areas are prone to landslides.
- The elevation in some areas are assisted with pump stations to insure the flow towards the river basin.
- Hillsides usually function as parks and or shrines.

Based on this analysis we can conclude that Shiogama is a municipality that is under spatial pressure by different land users. The challenge is how to implements these new energies in this urbanised landscape. The main components of the design are explained in the next chapter based on the above mentioned principles. It is important to mention that the result of translating the principles into a design is linked towards expressing a regional strategy into a finer urban structure. It is not a comprehensive structural concept for a city, though the proposed plan can function as an assisting component within that.

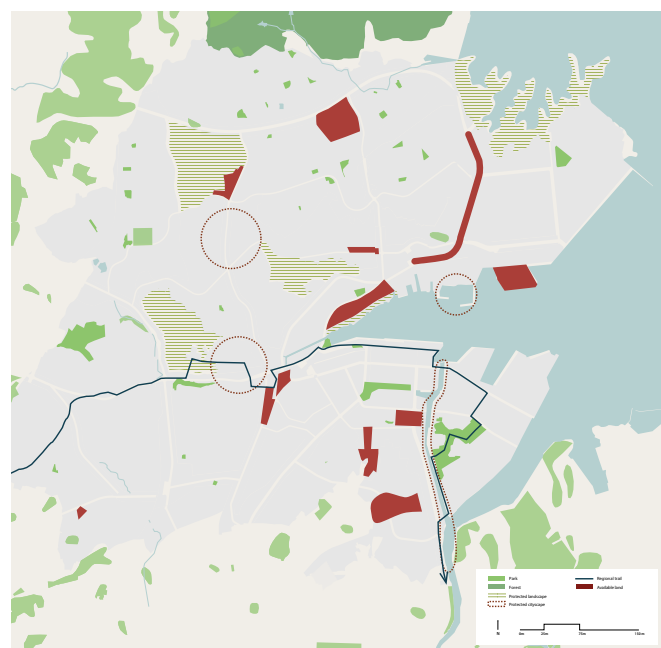
Energy network



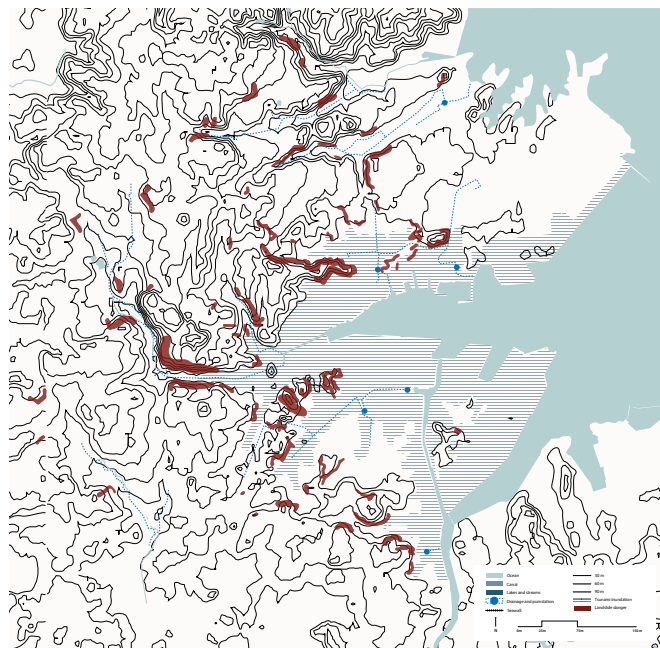
Energy demand



Protected structure



Natural structure



LOCAL AND REGIONAL ELEMENTS

Biomass is a collective name for a collection of flows that contain potential energy, the extraction of this energy differentiates and therefore limited in the variety of what it can process. In the chart below a summary is presented with possible fuel source and their energy yield.

A harbour is a location where many product flow enter and leave. The high production that takes place in that area not only demands energy but also is a source of waste flows. Collecting this waste we can reuse it as a biomass source. The central location of Shiogama and its proximity to the Sendai harbour, another big source of waste is a motivation to invest in a biomass plant. Transportation of large amounts of mass is possible via the canal that connects both harbours.

There are two ways to process biomass.

Fermentation: Anaerobe fermentation by bacteria is activated in a closed tank when there is no contact with oxygen, the process is applicable on a wide range of raw materials. The mixture and use of the end product is depends on the method of fermentation. During a stable fermentation a gas of a approximately 55-65% methane and 35-40% carbon dioxide is formed with some smaller particles of hydroxide, oxygen and sulphites. These plants do contain an explosion risk due to the flammable gasses.

Incineration

A more traditional method is incinerating biomass. The most accessible mass is wood and plant based residues. The heat generated can be used for a heat network or electricity through the use of a turbine and or generator (Stremke, Dobbeltstein, 2013).

As seen on the map on page 106 two biomass plants are placed in the industrial zone of Shiogama. The northern plant incinerates wood, rice and timber. The southern plant receives biowaste from kitchen and food processing waste the choice of location is based on the plants safety during an tsunami. The southern plant is outside this zone.

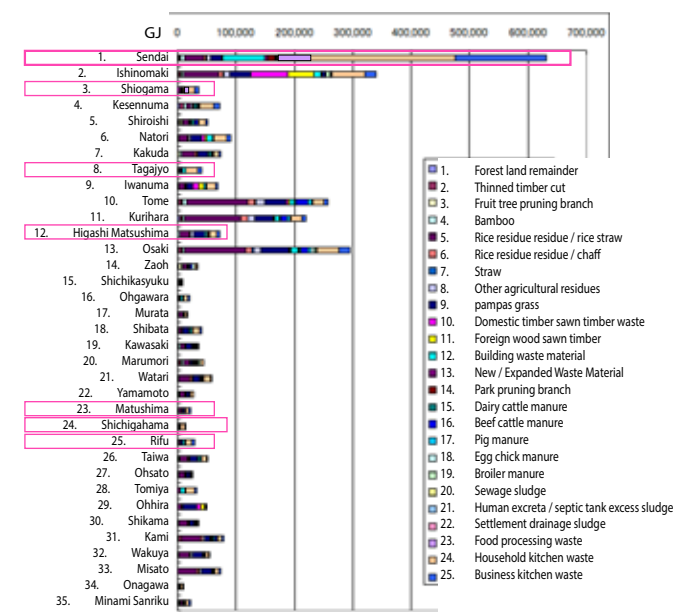
Combining the potential waste chart and the yield per category brings us to a potential of:

Northern plant: 135.000 GJ (37.500.000 kWh)

Southern plant: 454.000 GJ (126.111.111 kWh)

Biomass plant: 2000 GJ (theoretical)

Technic	biomass	yield
Combustion of biomass	wood flows	
boiler	wood pellets primarily waste	2395 GWh / year
-wood pellets and / or wood chips	wood waste wood forest	2225 GWh / year
Bio-CHP	energy crops	62 MWh / ha / year
-biogas	reprocessed miscanthus	
-bio-oil	bamboo short rotation coppice	
Fermentation of biomass	Green waste	799 GWh / year
	Household kitchen and garden waste	282 GWh / year
Pyrolysis of Biomass	Organic-organic fraction of waste	380 GWh / year
biological treatment		430 GWh / year
physical processing	Manure Sludge	4200 GWh / year
	horticulture	
chemical processing	professional origin Biomass flows from agriculture and	80 GWh / year
	used frying fats and oils (GFVO) household and	
	Organic organic (waste) streams from the food industry	3605 GWh / year



SPATIAL STRUCTURE

In principle we all use energy that never goes obsolete based on the laws of thermodynamics. The transition of energy goes from one form to the other and in there a quality loss is attained. This loss is known as entropy, often interpreted as the degree of disorder in a energy system. In the figure below we can see assimilation of such a extensive system increases the disorder and results in a increased volume of exergy.

Comparing the currents system trough a more exergetic efficient perspective we can understand why it is important to shift to a cascading system. Placing functions with a higher energy-profile on top of the chain of which the output van be a source for lower profiles. This can translate to a spacial composition when implementing this principle on the whole energy chain. On the next page the system is explained on the case of Miyagi.

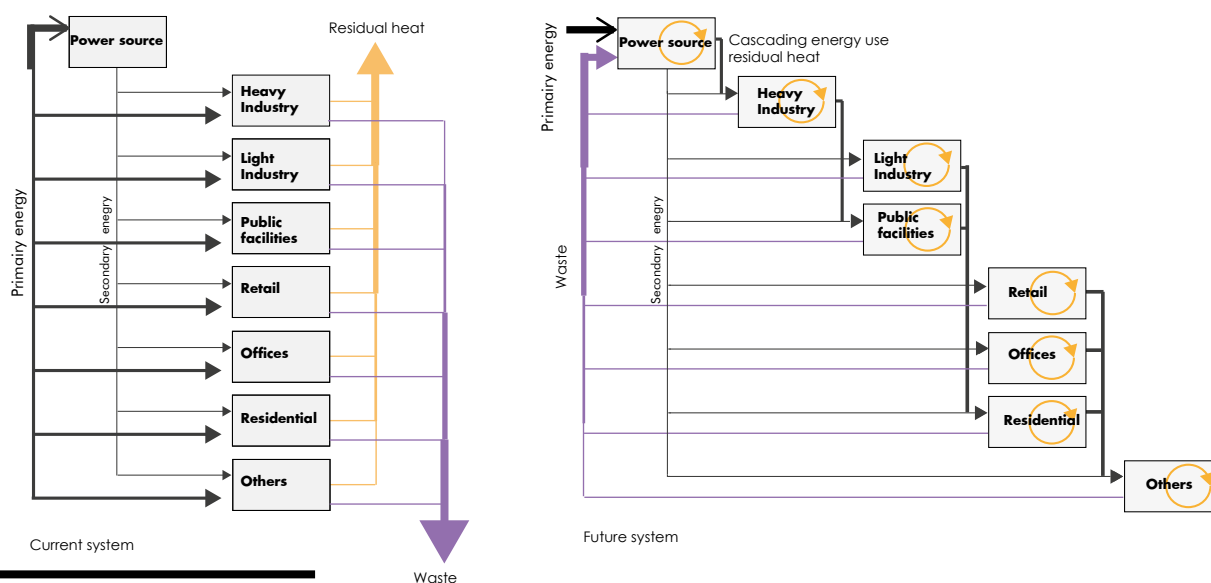


Image 59: Biomass energy sources, source: Vlaamse bouwmeester

image 60: Biomass sources Miyagi, source: area, source: Author pref.miyagi.jp

Image 61: Cascading system, source: Author

The geothermal and the southern biomass plant are located close to each other this energy hub is a good example in how a cascading systems interacts between several energy demander's.

Heavy industry will take the lions share of the produced energy in gas or electricity form. Returning their residual heat towards the residential area's that are folded around the industrial zones. The full system is seen on the on the map on page 106.

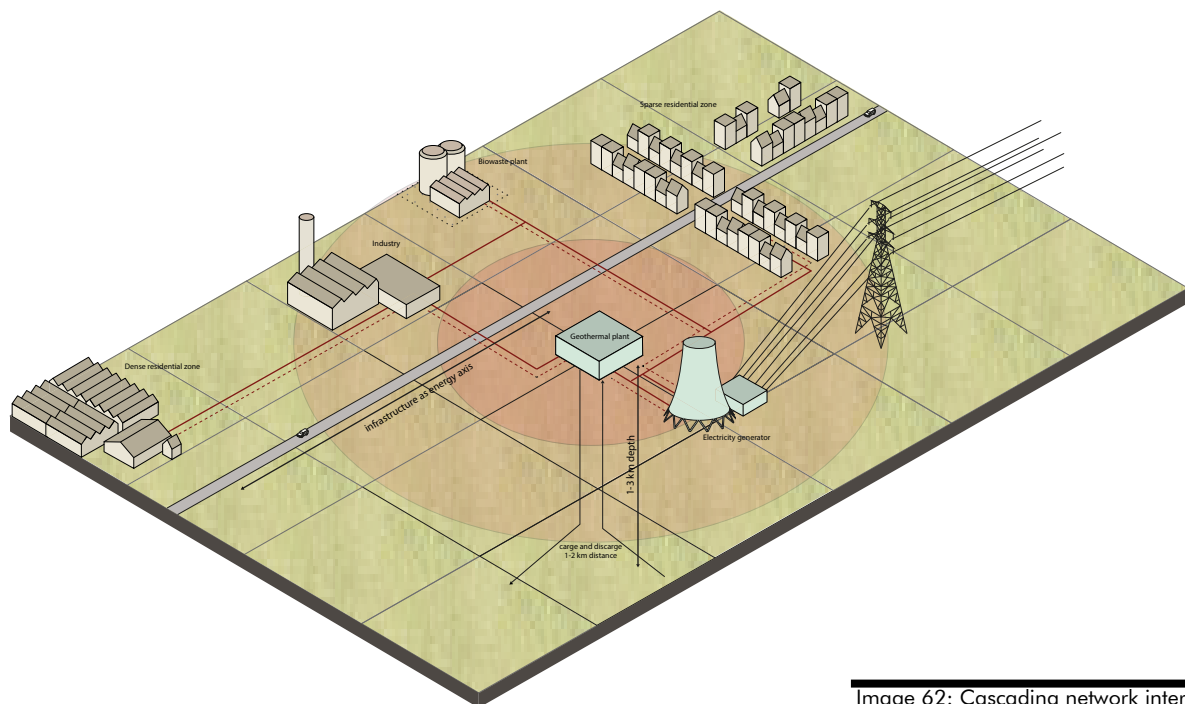


Image 62: Cascading network interaction, source: Author
Image 63: Pipenetwork on slabs, source: thetyee.ca
Image 64: High low system Shiogama, source: Author

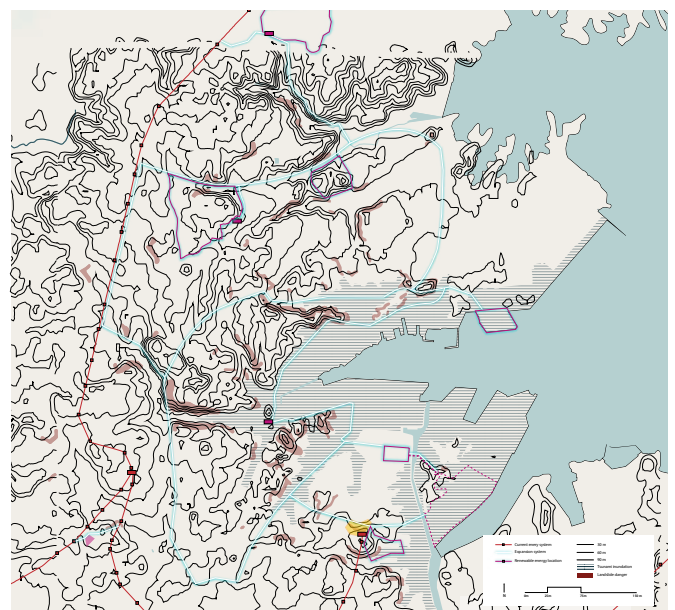
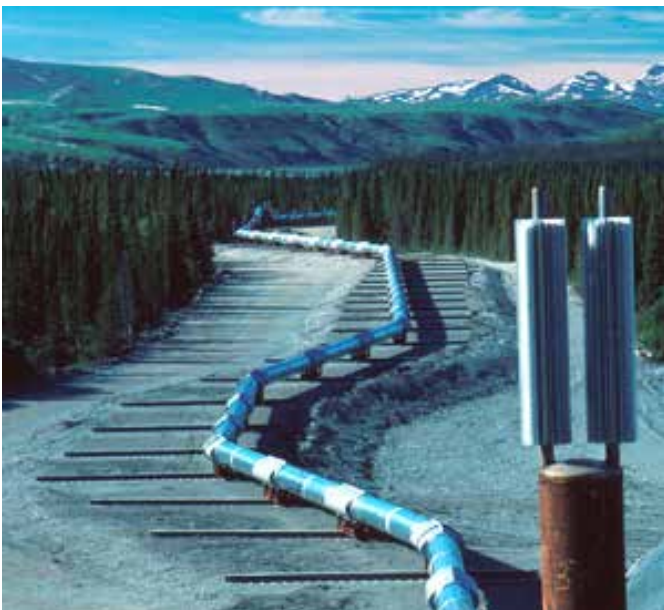
SAFETY AND STABILITY

Taking in consideration that the region is located in a earthquake prone area we should consider the type of network that is being used in Shiogama.

The previous mentioned installations consists of network pipelines, which transfer heat/energy to the consumers and then return back to the plant. The transportation pipelines are sized for the peak load demand, in order to respond to the worst case scenario. This type to compensate these pressure drops are composed of a closed loop, where the flow circulates to and from the plant and generator (Vallios,Tsoutsos, Papadakis, 2009).

The loop system is still vulnerable to shocks during an earthquake. From a risk mitigation perspective there are several methods to avoid or contain damage explosion risks. The first one is to lay the piping on slabs to absorb most of the movements during a quake an example is shown of the trans alaska pipeline. Of course this had a limited safety during heavier tremors. A network segmentation in the loop is therefore necessary. When a pressure drop is observed only a part of the network shall be disconnected containing the danger and minimizing energy supply loss (Meerkerk, Beuken,2017).

Next to network safety the power sources should also be protected against disaster. In our strategy a high low supply of energy sources was proposed. The map below shows the height and location of the new sites. Around the industrial zone some plants are located within the floodzone though there are multiple locations on high ground connected with an outer loop ensuring a source of energy when others are malfunction.



BUFFER

The current system in Miyagi is based on short burst of energy demand and a large base load. Renewable energy systems have larger fluctuation and is harder to adjust to these demands. It is of importance to take in account that these fluctuations should be collected, using a smart grid is an option to divide energy when production is high but when there is a lower production storage is needed to compensate the temporary shortage.

The petrochemical industry is an ideal location to transform to such a buffer zone. Assuming the transition will gradually lower the demand of these fossil sources the site will supply more space in the unused storage tanks.

The tanks will store the produced heat of electricity in a Vanadium Redox flow battery, this system consists of tanks of electrolytes, pumping the liquid through electrochemical cells. These batteries have an extreme large capacity making them ideal for large scale storage.

The vacancy of these tanks are based on a long term strategy and investments. To insure the a capacity during the transit between fossil and renewable sources, small scale solutions like vehicle to grid are applicable. The use of electric cars in Japan is increasing, to use their batteries as a personal power storage can increase the total capacity of the system. In the map on page 106 several location are assigned as car parks that supply the vehicle to grid system (Stremke, Dobbelsteen, 2013).

Production:

The idea behind the energy dispersion strategy is to test what the possibilities are within a comprehensive shift of an energy transition and which possible improvements can be made regarding safety, spatial, economy and ecological challenges. This scenario answers to the economic struggles of the port and remains ambitious on the front of producing a safe and robust energy landscape within the municipality.

Previous situation

$7,191 \times 10^9$ Megajoule a year of which 6 % is renewable and 250000 Kwh own solar production.

New situation

Solar:

Residential zones have an average of 30% of the rooftops that are suitable for solar panels. In Shiogama that is $2.738.500\text{m}^2$. Photovoltaic panels have a potential of 145 kWh/m^2 this sums up to a total

= $397.082.500\text{ kWh}$

The industrial zone has a 50% availability $1.252.956\text{m}^2$

= $181.678.620\text{ kWh}$

Several zones are available for solar collectors of which produce 400 kWh/m^2 the total floorspace of these zones is 486.670m^2 producing $194.668.160\text{ kWh}$ energy

Biomass

Northern plant: $37.500.000\text{ kWh}$ (135.000 GJ)

Southern plant: $126.111.111\text{ kWh}$ (454.000 GJ)

Geothermal:

At the moment is difficult to estimate the potential of the source based on estimations of the prefecture a minimal of $155.000.000\text{ kWh}$ is possible to extract in Shiogama.

Total: $3,393 \times 10^9\text{ MJ}$ renewable energy replacing 47% fossil fuel use within its own municipality.

REFLECTION

In this chapter the research will be summarized in answering the research question and providing recommendations on the process and results. The reflection will be presented in two phases. The first an overall assessment of the design process and framework. The second phase will be the evaluation of the research question based on the results of the design proposals.

As mentioned in the hypothesis chapter, the aim of this project was to improve the resilience of an delta region by introducing a regional design. This approach is based on layering themes that are adopted, through the evaluation of the top down and bottom up wishes and demands.

The regional design is based the values and methods used in the Dutch planning model of the Randstad.



Matsushima castle, Japan, Source: Author

PROCESS

The significant part of the design process is to understand the full impact the tsunami had in 2011 on the region of Miyagi. During the contextual analysis questions arised in why after the biggest economic reconstruction investment in documented history the region still is struggling with recovering.

A situation analysis concluded that:

- 1- Multiple factors where already present before the tsunami influenced the region, economy and aging population.
- 2- The centralized planning system before and after the tsunami heavily influences the possibility to nuance needs on a smaller urban scale or overlapping multiple scales.
- 3- To answer these complex problems we should categorize the issues in a project framework starting from theories.

A clear method was the layering method, by categorizing the main themes that play in the regions we can organize and overview and clearly pin point where strong influences are connected and most importantly where in the region. As most of these issues overlap boundaries of municipalities. To understand how several aspects of other specialities intervene in these layers, meetups are organised between other thesis students of different fields of study focused on the same location. In here we discuss our findings and overlaps in where we can co-operate. The research part did demand most of the time as data is hard to come by and presents itself in many forms. A notable observation is that most of the data concerning the themes hardly where found in the form of a map. Is is not in the Japanese tradition to visualize how planning choices have effect on the physical scale. Most are described in municipal documents in the form of text or quantified in excel sheets. Which made it hard to make the translation to an actual map.

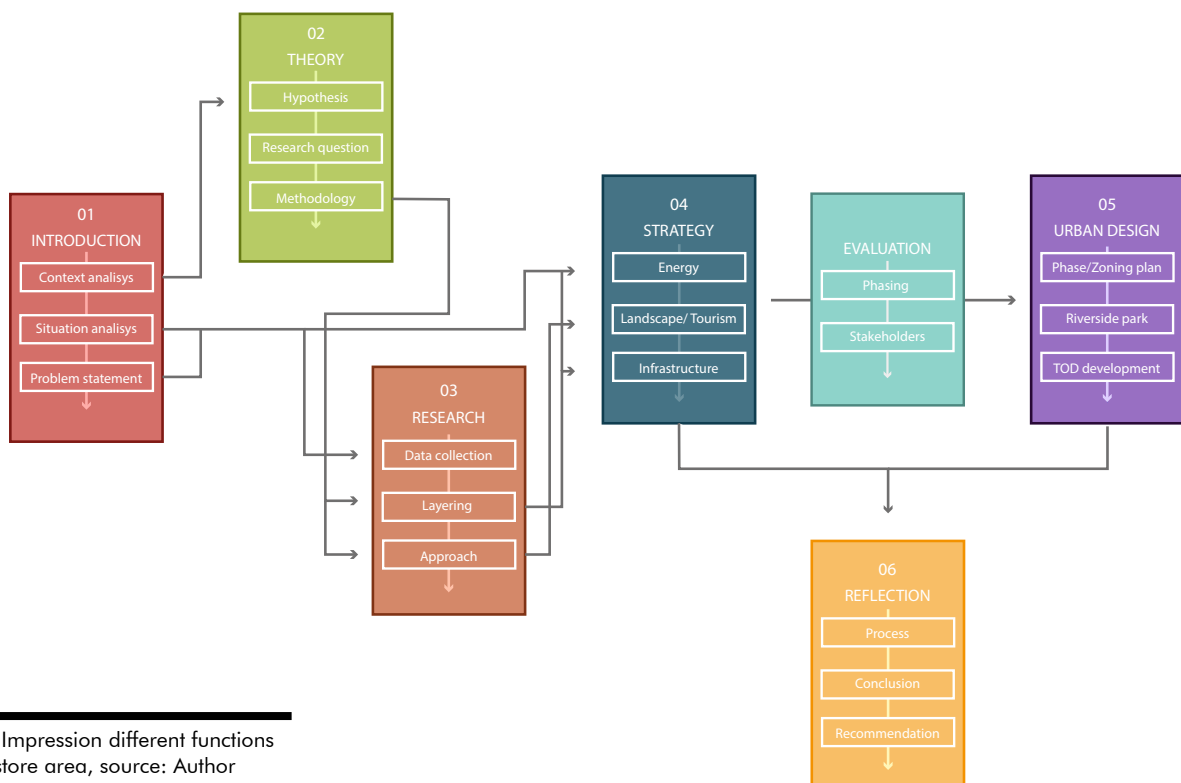
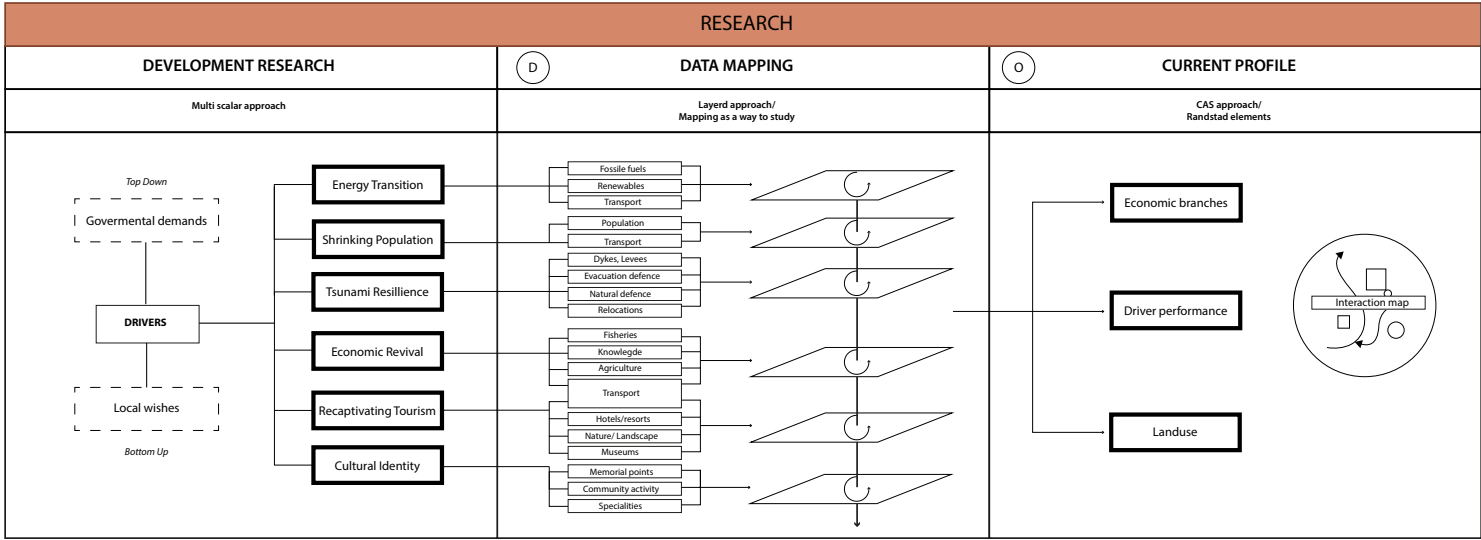
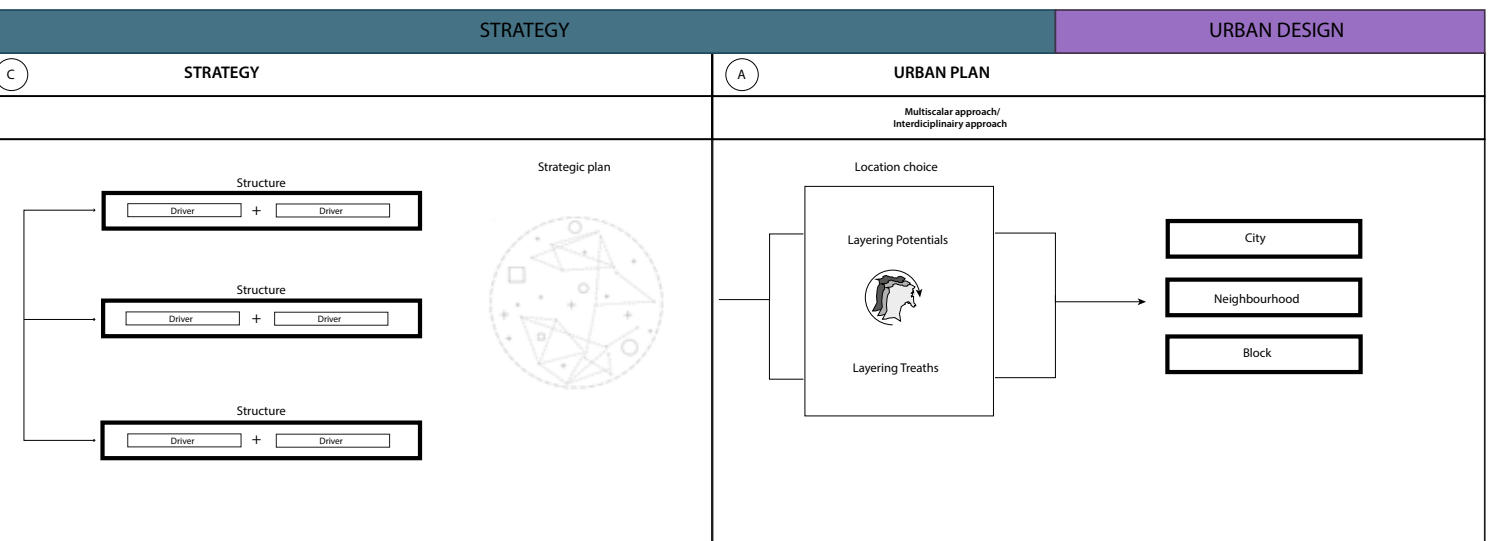


Image 54: Impression different functions within the store area, source: Author

The strategy phase was the most exploratory as we explore in what way the Randstad concept could contribute to the region and of these different layers could be envisioned in order to create a desirable future. This resulted in three categories that all sub-themed tsunami resilience. The categories tackle with different issues as energy transition that require a new network hierarchy and spatial re-organisation in the form of zoning. Landscape and Tourism is to promote cultural and heritage tourism with local benefits that improve the regional green blue infrastructure. The Infrastructure chapters deals with an exploded urban sprawl, and uses the network connections as an catalyst for an nodal densification structure. Combining findings and knowledge with a TIL student in the thesis group will open up possibilities to integrate elements of each others process. The design part is a concrete product of the strategy of the project. It illustrates the spatial impact of the strategy with optimal solutions specified to the location. The main design and projects will not define all the details but identify the local issues and visualize the main ideas in response to the objectives of the research. Important here is the mention that the regional design revealed strategies that respond on several scales in the built environment. Even though some strategies did not lend them ideally to be shown on a regional scale, it did contribute to a more comprehensive design process ending up in smaller of larger scale integration.

Recommendations:
Looking back on the design process there could be better method used to define the top down and bottom up demand. Aside it being time consuming to translate the documents, it was also still to broad ending up in 6 themes. A stricter elimination process is necessary in this phase. The second recommendation is the interaction of the thesis students from DIMI. As we are all professionals in our field, it is hard with the diverse agendas to interact. Its recommended to plan these interactions as set meeting at the beginning of the project.





RESEARCH QUESTION

Comparing the effects of the strategy on the resilience of the region one could say that one or more implementations will have a positive effect. Combinations could even amplify the effects.

Although this project is to point out and fill in the gaps of the urban design implemented via governmental planning. It is of importance to point out some limitations to the roll out the exact design.

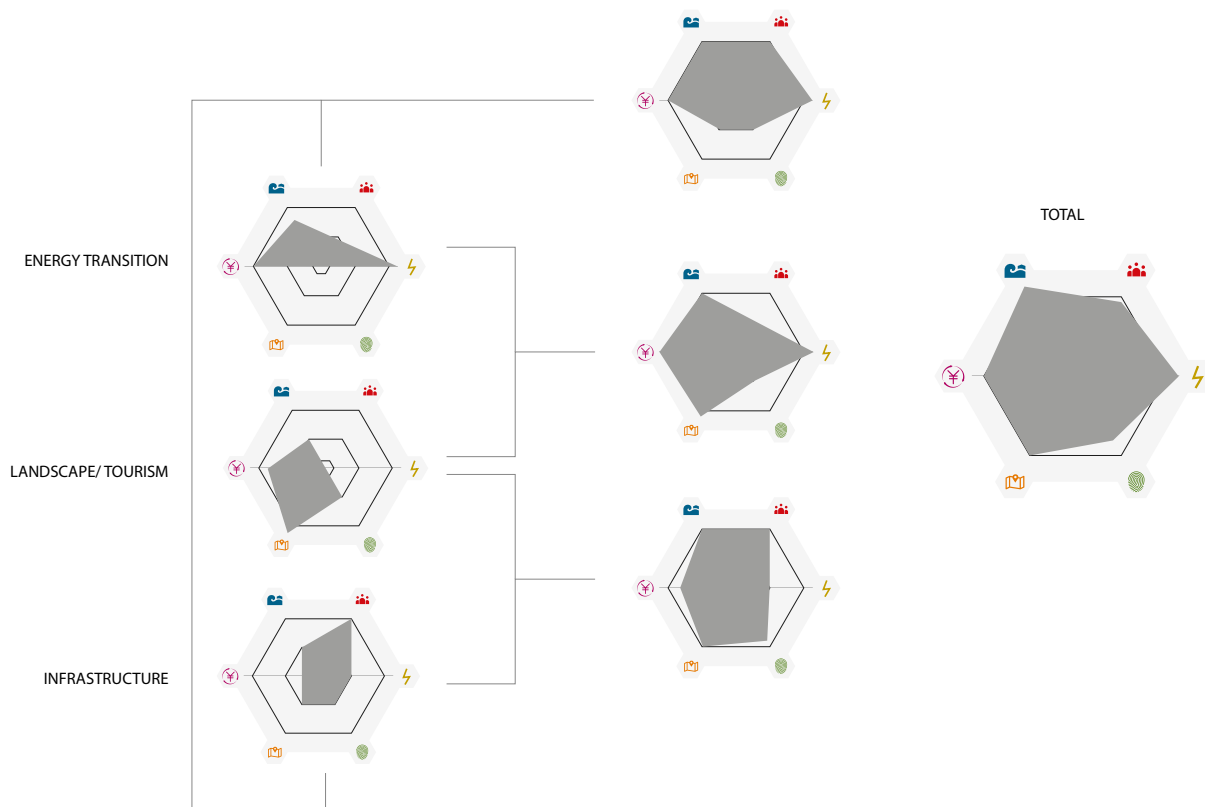
Japanese land is heavily constructed by land ownership which is handed down for generations (Kontar, 2016). Redesigning a whole neighbourhood shall bump wit ownership problems as land is scares.

The energy transition is a necessity that has top priority in the Japanese governmental agenda but development is highly dependant on the actions and taken the coming years. Just like the Netherlands, Japan has signed the Paris agreement but is also struggling to find the space and investments to put money where ones mouth is.

The investments in the tourism sector could also have a negative effect on the region. Tourism and travelling will expand the coming years due to globalisation and dropping prices but this is one of the most polluting activities individuals have. Japanese are itself very aware of polluting the public space, therefore there are hardly any bins te be found in urban area's, a need of massive city cleaning programs is therefore not necessary. Uninformed tourist will little and pollute the environment.

Another effect is the popularity of an neighbourhood after investment. A strong influence by the market could lead to gentrification affecting the local community and its life-style. Although less populated areas are in need of population increase and younger society, this effect should be closely monitored.

The importance of regional perspective is essential to counteract a stagnating system of competition and at the same time integrating a long term approach for water-safety and other large spatial transition (energy).



A regional design in essence does not give concrete actions but gives handles to a complex problem with the consideration of a wider scope of interdependencies that a single city does not perceive as relevant.

Revealing these problems and counteracting them with strategy enforces the municipalities to act upon it using the regional plan as a guideline. The guidelines are based on elements that have a continuous presence throughout the whole region. Basing strategy on transport infrastructure, green blue infrastructure and energy infrastructure creating a superimposition of joints where multiple strategies influence a single location. Strategies can also spread in an oil slick kind of matter as they cover large areas presenting new insights for municipalities to cooperate.

This deeper understanding of the interdependencies accelerated the process in pinpointing the fragilities of the region and how to improve them in an interlaced manner in order to avoid deficiency in the network. In that aspect a regional plan does improve the resilience of a delta region by acting on the consequences a tsunami has on the economy, environment, liveability and quality of life. It does however not stop a tsunami from reoccurring and affecting the region. The devastation of the GEJE is so massive that in the end that awareness and optimal evacuations systems are the best method to save lives which is the most important case.

In that respect urban design can play a more supportive role in cases where the region has been or will struggle with so that crucial life saving investments will reduce death tolls from 15.850 to 0 when the next big one strikes.

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