"Houraijima" – the Symbol of Otsuchi

KINTSUGI 金継ぎ

Integrated emergency planning

Hazard-scape

改善大槌町

Improving resilience capacities in a hazard-scape Otsuchi, Japan

Gayatri Mujumdar
TU Delft

Fall down seven times, get up eight

七転び八起き

Figures 01– Kintsugi: the Japanese art of precious scars, manifestation of resilience
Sources – www.lifegate.com

"The world breaks everyone and afterwards many are strong at the broken places."
- Ernest Hemingway

KINTSUGI

Improving resilience capacities in a hazard-scape, Otsuchi Japan

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AR3U100 Graduation LAB: Urban Transformations & Sustainability
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Keywords; hazard-scape, critical capitals, resilience capital model, disaster preparedness, emergency planning

testimonials

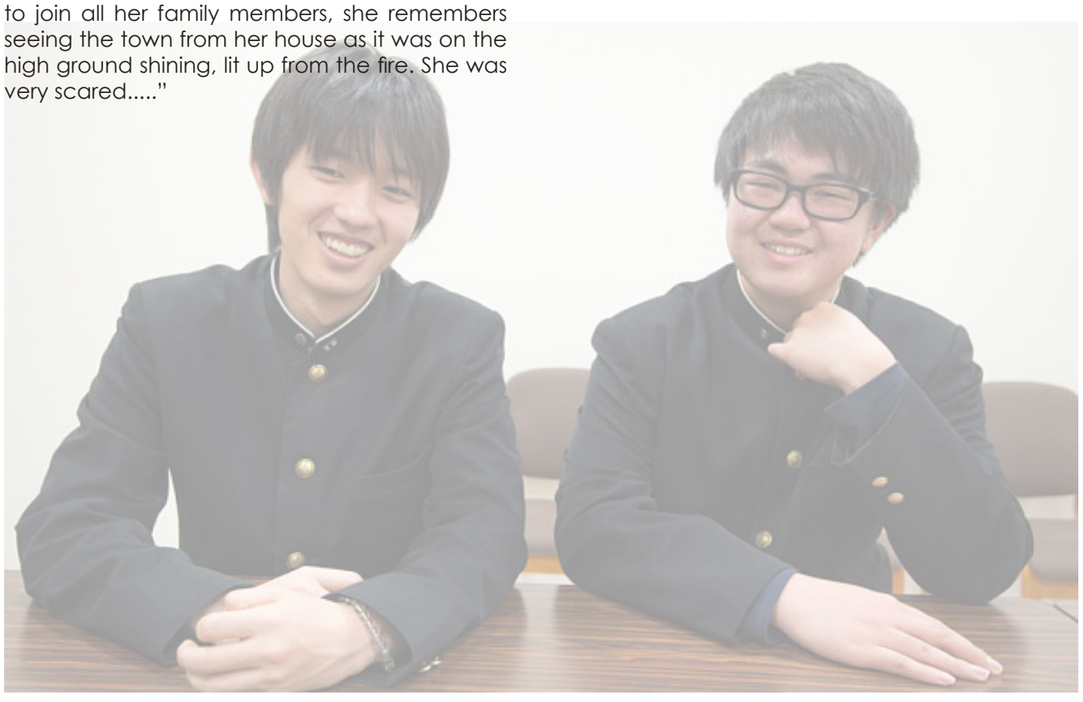
Memories of the disaster

Ankuu, 16 yrs, high school girl, 2018

"At the time of disaster she was at Kita (North) school, near the river and so underwater then which now caters to a temporary shopping centre. It was during her science class, the earthquake warning went off and so they hid under the table. After the earthquake stopped, the teacher gathered the students in the play ground, but the tsunami warning had been issued and so the teachers had made groups of the students and lead them to the high hill which was also the designated evacuation centre of Otsuchi. Since they were not allowed to look back and down they heard the panic cries of the adults and so many like her were crying while sitting in the playground. Though she was able to join all her family members, she remembers seeing the town from her house as it was on the high ground shining, lit up from the fire. She was very scared....."

Shinya, 16 yrs, high school boy, 2018

"He was in the elementary school then, after the disaster of 3/11 he remembers all the adults had gathered at the Kirikiri village as it is the most isolated village of Otsuchi, so the assistance from outside was also received after 3-4 days. So then they had to make do till then on their own. And so the adults were trying to make way and move away the rubble and trying to find the missing people. He was too young to join them and so he participated in sorting of different material and distribute food at the evacuation centres when the self defence forces arrived. But he remembers many junior high school children as they were all helping out and he admired them for it....."

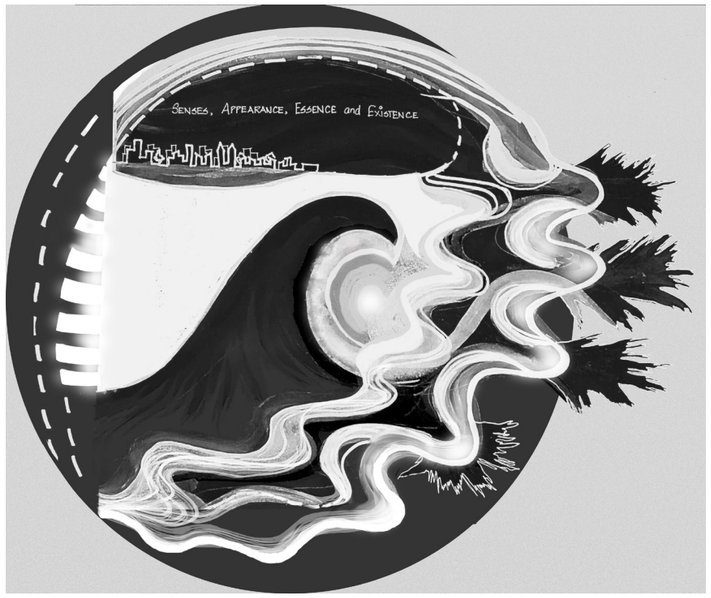


Masahiko Haga, Founder of Kiri-kiri NGO, 2018

"We can't keep on living here anymore we have to move to someplace else. But his wife replied," I want to live here again, just like my mother and father did I want to continue living here protecting the unsafe at this place. If another wave of tsunami comes, we just have to escape, if we escape, we survive, that all we have to do." Those words of my wife made me realise and it brought me back and I was really ashamed of my thinking to leave this town. I admit that I was the very 1st person in town, trying and wanting to leave Otsuchi after the tsunami. And from that point on they started living in the elementary school gymnasium which was the evacuation centre.
Later that night I went into the town and heard some voice in the pitch darkness of an old lady over 80yrs calling out for her family members, a loved one probably, very loudly, looking for the person. And it was really cold on that day at night, like in a snow storm. He realised it was the only thing she could do then, look out for her loved one, and he realised he had seen what true sadness is..... I lost my house but all my family members were OK, so I should not feel down because she is what sadness is all about. I am OK because my family is OK, so I should not be feeling down..... And so from next day onwards I started looking for people were missing along with the other people, that time we did not have help from outside no fire fighters, no police, no self defence forces, nothing....."

Mayor, in-charge of reconstruction 2018

"I was appointed as the leader of the local government to make the reconstruction plan after the disaster. We never expected this level of tsunami destruction. After the earthquake and between the tsunami, the headquarters for the disaster was held in front of the community centre building, which was against the disaster management manual that they had. Within the 12 coastal districts of Iwate prefecture we are the only town that did not issue the tsunami evacuation orders, the town evacuation orders, all other towns had issued that.
We lost close to 1300 people in the tsunami and we also had about close to same amount moving out of the town right after the tsunami which we were not expecting..... One of the barriers we faced during the reconstruction phase was that it was very prolonged process to start with. They had to get all decisions sanctioned from the national government, had it not been the case the reconstruction would have happened much faster. What we would like to change is that the national government should also trust the decisions of the local government and the funding for reconstruction should be used for what was lost in the tsunami and not to build new things....."



Figures 02– In the age of anthropocene
Sources – author's illustration

"SENSES, APPEARANCE, ESSENCE and EXISTENCE"

"The world we see with our senses is very different than the world we see through our essence. Our senses perceive the world of appearance. Our essence perceives the deeper layers of existence. The first step of perceiving the world of essence is to have no goal other than to understand. "Understanding" has to be the ultimate goal. Only then, can we solve the problems." — Petek Kabakci

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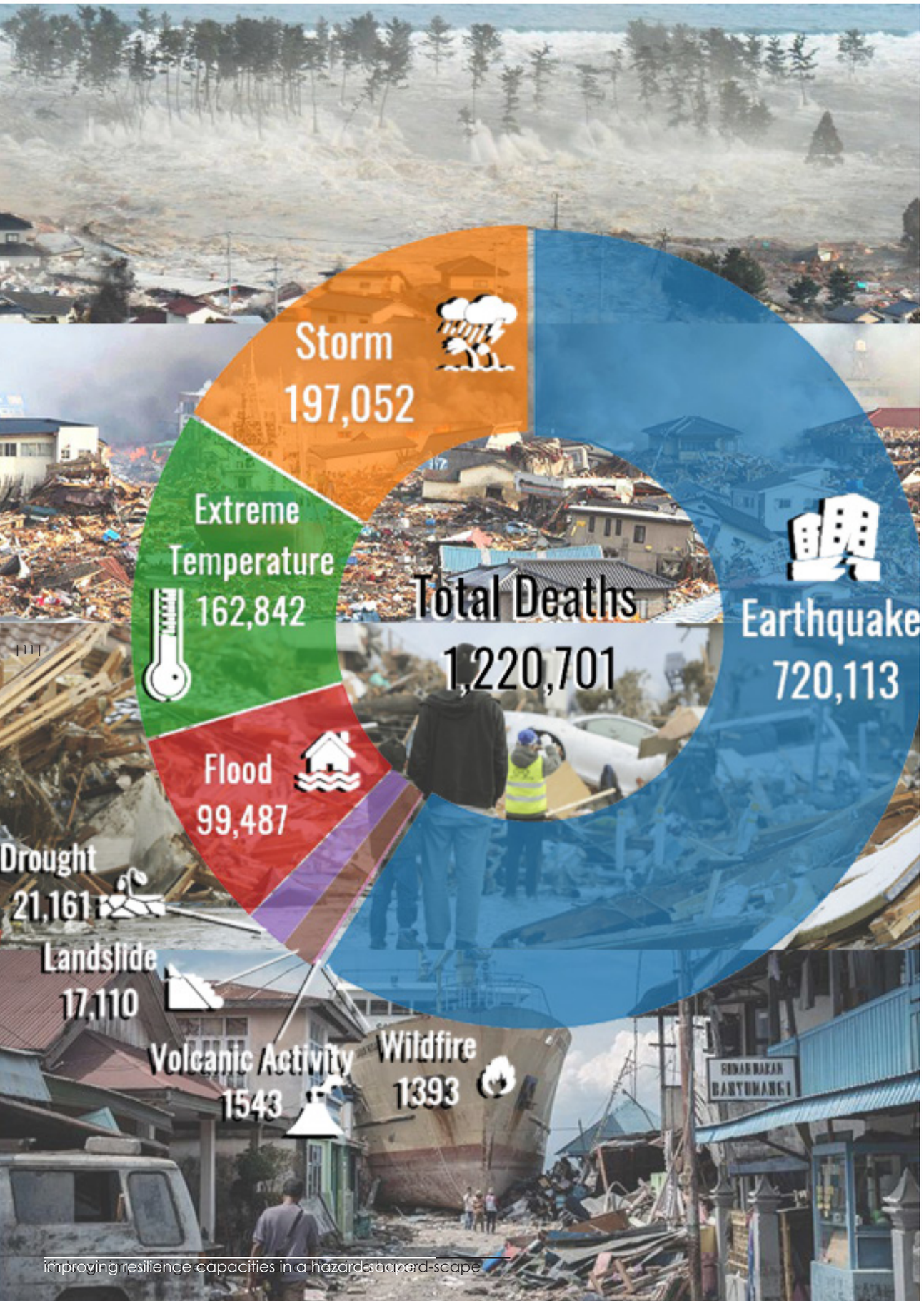


Motivation

The 21st century has seen increase in the number of biophysical and climate change exacerbated disasters. Recent decades are witnessing large scale urbanisation growth that is changing the face of the earth. While the occurrence of these hazards has increased in recent decades, the intensity and exposure has also escalated, resulting in the vulnerable population being constantly at risk of adversities affecting their very essence of survival.

While this heightened global urgency caused due to natural disasters like, earthquakes, landslides, floods, tsunamis or hurricanes all across the world is posing a challenge for any kind of development to happen. It has become an utmost necessity to have collective action focussed towards disaster risk reduction, building resilience to progress towards a sustainable future.

We have reached the epoch of anthropocene, where the human impact over earth is at its maximum and it is greatly affected by certain and uncertain risks that are interconnected over a dynamic, multi-level and multi-dimension manner. Urban designers and planners are wrecked with the idea of designing for a risk reducing urban landscape that copes to the uncertainties while absorbing, adapting and simultaneously transforming to become resilient to future such events.

Planning in a disaster landscapes is critical as many times they are not just governed by the spirit of the land and traditional beliefs of the society but are also a continual reference of the degree of the disaster. Dealing with the psychology of the people while building back better requires making difficult but simplistic, and risky but sensitive choices that need a lot of critical thinking, negotiation and a balance between bottoms-up and top-down approaches, which is the essence for the projects outset. It not only puts in forth questions regarding spatial planning in the context of a hazard prone region but also critically analyses the choices within operational dimension. The project augments and supports studio choice by posing a question;

How does the scope of spatial planning change under the influence of disaster cycle in a region, vulnerable to natural hazards?

Japan, which is among the most earthquake-prone regions of the world, has a long history of responding to seismic disasters. However, despite the advances made in earthquake related safety technologies, the destructiveness of the magnitude 9 earthquake and tsunami that struck the country on 03/11 raised profound questions on how societies can deal effectively with seismic hazards. While recurring natural hazards is a normal for the country like Japan, climate change triggered floods, draughts, sea level rise, demographic problems of shrinkage, aging and resulting socio-economic loss is downscaling the capacities of the country.

An academic year of urbanism along with annotation IE (infrastructure & environment) helps in understanding this dimension. The integration of other disciplines within the multidisciplinary project brings to attention the socio-temporal scales, scope, challenges and limitations within the operational domain. Having first hand experience of the chaos that earthquake created during the 2001 Gujarat earthquake in India, further motivates the research and helps to be sensitive while critically analyse the re-constructive approaches and methods followed in the disaster cycle. The studio domain of transitional territories accommodates this the best and assists in directing the graduation project.

While the project is the reaction to the upheaval caused due to recurring disaster and losses around, it is also a tense topic for research and analysis as to what constitutes for the future of the vulnerable society and the world that is less exposed but will endure the repercussions of these intense and catastrophic events.

Figures 03– death tolls in 21st century, 2000-2018
Sources – EM-DAT, CRED and author's illustration

terminologies

Hazard-scape
"The physical environment determines the physical susceptibility of the place, the human environment dominantly influences vulnerability, and together they not only govern the intensity of different hazards but also the response of the community. This relationship defines the core of the concept of "hazard-scape"(Khan, 2012)

Resilience
(Longstaff, Armstrong, Perrin, Parker, & Hidek, 2010) adopted the definition used by scholars at the multi-disciplinary Resilience Alliance "the capacity of a system to absorb disturbance, undergo change, and retain the same essential functions, structure, identity, and feedbacks". It can be a characteristic of individuals, small groups, networks, organizations, regions, nations, or ecosystems

Community Resilience
Community's perception and factors which made them resilient to disasters opens up ventures to improve resilience building process and to make community able to cope with disasters and consequent adverse circumstances (Ranjan & Abenayake, 2014)

Critical capital
It is defined as community assets i.e. social, human, financial, natural, physical, and political capital are the tangible and intangible resources that help communities to meet their basic requirements in the aftermath of a disaster.

abbreviations

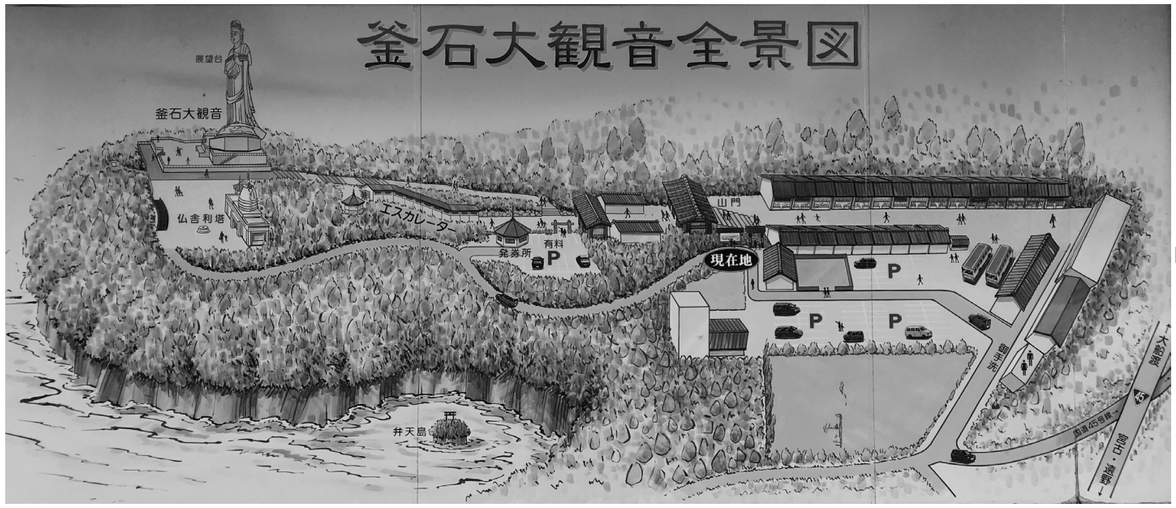
DRR	-	Disaster Risk Reduction
ISDR	-	International Strategy for Disaster Reduction
IDNDR	-	International Decade for Natural Disaster Reduction
HFA	-	Hyogo Framework for Action
UNDRR	-	United Nations Disaster Risk Reduction
CCA	-	Climate Change Action
CRED	-	Centre for Research on the Epidemiology of Disasters
EM-DAT	-	Emergency Events Database
FAO	-	Food and Agriculture Organization of the United Nations
GDP	-	Gross Domestic Product
IRDR	-	Integrated Research on Disaster Risk
PPE	-	Population Potentially Exposed
SDGs	-	Sustainable Development Goals
UN	-	United Nations
UNISDR	-	United Nations Office for Disaster Risk Reduction
IFRC	-	International Federation of Red Cross and Red Crescent Societies
FEMA	-	Federal Emergency Management Agency
OECD	-	Organisation for Economic Co-operation and Development
DFID	-	Department for International Development
OCHA	-	United Nations Office for the Coordination of Humanitarian Affairs
CRA	-	Community Resilience Assessment
NUA	-	New Urban Agenda

list of figures

“ Irony in the place, while the ‘miracle lone pine’ at Rikuzentakata symbolises reconstruction, the immediate measures for reconstruction involved building the sea walls along the coast and raising the landform, rather than a long-term solution despite the knowledge that such short term measures cannot be 100% relied upon and should be accompanied by long term protection strategies involving the people and considering the natural environment. ”

Figures 04– The miraculous lone pine tree a symbol of reconstruction at Rikuzentakata, Iwate Prefecture, Japan
Source – author

Contents



Figures 05– Kamaishi Dai-kannon Temple
Sources – author

01 | executive Summary

21st century has encumbered cascading risk scenarios not just of resource depletion and climate change but the natural hazards have also increased in its frequency and intensities. This has not just exposed humanity and environment but at many locations, the susceptibility of this has resulted in decreasing resilience capacities that has made recovery and reconstruction in case of future scenarios difficult. The project aims at contributing towards this change in the hazard-prone region of Otsuchi in the Iwate prefecture of Japan. Japan a country that has a history of tsunami's occurrence on its pacific coast is now dealing with its long term impacts of ineffective reconstruction which is challenged by urbanization consequences of ageing, society shrinkage and economic stagnation. The project understands gaps between the strategies in place and the shortcomings in the reconstruction measures that are adopted in the hazardscape of Otsuchi.

The project was initiated through a multidisciplinary understanding, workshops and collaborations to develop a strategy for urban renewal of Otsuchi by the faculties of architecture and built environment and the faculties of civil engineering and geosciences from TU Delft Netherlands and the faculties of coastal engineering from Waseda University and faculties of social sciences from university of Tokyo Japan. This interdisciplinary approach created awareness and interaction not just about the project but also about the diverse approaches that are followed by institutions to address recovery from disaster in the different deltaic countries.

While the project introduces with the discourse on preparedness within the landscapes that are vulnerable to hazard risks, it also questions if evacuation is the only possibility and whether it is enough? Research further focuses on understanding the nature of tsunami scapes at Otsuchi and measures were undertaken that affected in an unholistic recovery from the disaster. The nature of exposure and vulnerability within the hazardscape guides the project to realise the role of emergency planning in forming a methodology that supports and strengthens the 4 aspects of disaster cycle which are preparedness, mitigation, recovery and response. The nature of a seismic hazardscape with a resultant tsunami is very different than any other geological hazard and the certainty of its occurrence makes any kind of planning for development very complex as well as difficult. This understanding proposed for community resilience as the performance domain that can integrate the methodology of emergency planning and scope of disaster redevelopment to form strategies that mitigate and improve the capacity of resilience within the region.

The research framework for the project addresses firstly to analyse the existing condition of reconstruction, secondly to assess if the reconstruction and recovery measures are sufficient, thirdly to formulate a narrative based on historical data, sensitivity analysis, fourthly simulating evacuation efficiency and finally to assess the nature and scope of critical capitals within the hardscape. The integration of all these analyses directs in making a strategy for the hazardscape in the form of design fiction. This is divided into 3 stages that are the current stage, the assessed stage for a pre 3/11 (the great east Japan earthquake tsunami) stage and a post 3/11 stage. Through the process of design fiction, it is understood that hazardscape populations have inherent resilience capacities. The assessed stage based on the guidelines of emergency planning and by the strategies of collective capacity action a reconstruction plan is envisioned that can bear the impact of the 3/11 scenario. The post 3/11 stage being high in resilience is effectively able to manage with the reconstruction.

The design vision for the reconstruction plan forms guidelines that are based on emergency planning aspects and are fundamental for reconstruction and recovery of the tsunami hazardscape. It addresses the inherent resilience capacities of the populations in the hazardscape by proposing intervention in the morphology of the urban fabric, creating spaces that contribute towards social memory and forming strategies that integrate with the community lifestyle that can minimize the state of chaos and manage effective evacuation in the event of a tsunami. While the proposed strategy does not change much of the effect of the destruction and damage from the tsunami, but by enhancing the political, social and human capitals causes more effective and holistic recovery scenario. Thus, changing the graph of decreasing resilience capacities of the populations towards increasing and trigger collective social uplifting that can result in changing the current population dynamics. Moreover, by including the dynamics of the natural capital within the recovery process it generates capacities for the economies within the area to adapt and sometimes transform in the aftermath of the disaster. The concluding urban design built on the concept of social memory, co-designing and socio-technical factors enhances the effectiveness of preparedness for a future tsunami at Otsuchi. This can further change the demographics of the town of Otsuchi.

Conclusively, the project creates awareness in the domains of tsunami recovery strategies and the necessity of emergency planning that is integrated with the other forms of planning essential for the nature of the hazardscape. This research is limited to the disaster tsunami only. For a holistic recovery within the hazardscape, the overlaying nature of climate change, sustainability needs to be also understood. The idea of what is termed as complete recovery needs to be discussed and clarified before planning for any reconstruction and recovery in the hazardscape.

This graduation report serves in a detailed time-line fashion the process and making on this masters thesis project "improving resilience capacities in a hazard-scape" planning community resilience for a constant change: tsunami reconstruction methods, processes and strategies at Otsuchi, Japan. The graduation project is conducted under the studio of transitional territories and collaborates with delta infrastructure and mobility at department of Urbanism in TU Delft.

The project is a culmination of both individual as well as multidisciplinary understandings from faculties of engineering (geological, structural, hydrological, transport), architecture, landscape, management (water, and policy) and urbanism. These faculties are part of both civil engineering department and architecture and built environment departments of TU Delft.

It has been evolved from the intense workshops and methodologies happened at the field-visit at Otsuchi in Japan and at TU Delft in Netherlands. The workshops were conditioned based on the charette method of inquiry by design wherein mentioned departments underwent scoping exercises based on the theoretical outline of balance of the 4Ps and site understandings for a holistic and coherent roadmap for the recovery process and planning at Otsuchi.

The research and analysis which is the integral part of the report, has been entirely based on site understandings, nature of the problem, testimonials from the people, review papers, multidisciplinary contributions and simulation studies which comprehend the nature of the project framework. The outcome of this analysis and research leads to the formation of the design and strategies to plan a better future that takes into factor all aspects of planning and development required within the disaster cycle while working towards the resilient recovery process not just of the place but of the people and their surroundings all together.

The project proposes a collaborative focus of interdisciplinary understandings through a social perspective which has been spoken and discussed a lot within the academic, scientific and professional community around the world within the disaster studies and other allied disciplines but not practised in effect. This project collectively brings forward this attributes and further fields of studies that are required for resilient planning and recovery to become implementable and plausible.

"The weakest link determines the chances of survival..."
Disaster awareness campaign currently on Dutch TV

03 | introduction

Aging to cataclysm

While the intention of the chapter is to put light onto the array of problems and contexts that together form the ground for the project scope. It also forms the evidence and direction for the research and analysis carried further in the project. The chapter creates understanding of the various discourses about the hazards, disasters and catastrophes that have overturned the normalcy of life for many communities around the world. It brings into focus the nature of the disaster as well as the changing state of risk in our environment while planning for the future ahead.

Figures 06– Ongoing reconstruction at Rikuzentakata, Iwate prefecture, Japan
Source – author

03 | Introduction

3.0 Sections

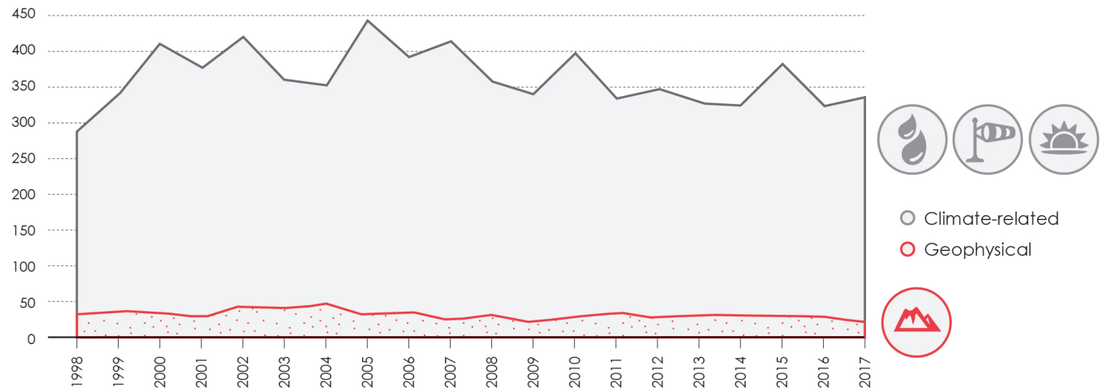
3.1 Setting the stage

Overview

As we know the industrialization of the 1950's marked the beginning of the great acceleration. Globalization, marketing, tourism, investment and migration to cities resulted in cities becoming powerhouses of creativity. In a single life time the well-being of human beings changed and so did the Earth's natural systems. Green house gas levels reached all-time high, temperatures across the world soared so high that it created holes in the ozone layer . Simultaneously due to rising population's demand, we are fast losing biodiversity. Many of the world's deltas are sinking due to damming, mining and other causes upstream of the river. While threat from sea level rise is increasing, ocean acidification is making the matters worse. It is apparent we have entered the 'anthropocene', a new geological epoch dominated by humanity as cited in (Steffen, Broadgate, Deutsch, Gaffney, & Ludwig, 2015).

In this anthropocene, not just pressures from the human impact are rising, there is also rise in the geological activity within the earth's crust, leading to sudden seismic movements causing earthquakes, landslides and volcanic eruptions. Modern earth science has evolved and revolutionized in its capacities and techniques to "analyse in detail the trends and cycles in these earth events over the course of millennia, and also to predict with increasing accuracy future trends of most natural disasters like: earthquakes, hurricanes, floods, tidal waves, tornadoes, droughts, famine"(Webre & Liss, 1975). More importantly with the emergence of the plate tectonic theory it can help in deeper understanding of the origins and mechanisms for the most catastrophic of "earth disturbances (termed by United nations in the Report 'Assistance in Cases of Natural Catastrophe'), the earthquake and its attendant phenomena: tsunamis (seismic tidal waves), volcanoes, landslides, fires, and floods". But much of the science is still maturing and much is unknown, due to which policymakers are unprepared and uncertain about the course of future.

While the pressures from human impacts are unmanageable, and it is also known that this can affect the geological activity within the earth's crust. The development in modern earth sciences till now has resulted in anticipating the rate, time and location of the earthquake, prediction of the earthquake is still not possible. But because of this development, it has been possible to locate the tectonic plates around the world that have been the cause of these earthquakes. Due to which, many of the countries bordering these plates have been considered as vulnerable and susceptible to high earthquakes and tsunami possibility. While there is a lot of research going in the cause and processes related to its natural occurrence, further advance research is required in the field of disaster risk over the methods to prepare and mitigate the impact of the disasters in the years to come. The figure below gives an overall global number of natural disasters reported by its type of phenomenon, from the year 1970 to 2018.



Figures 07– Number of disasters by major category per year 1998-2017
Sources – EM-DAT, CRED and author's illustration

Discourse on disaster preparedness

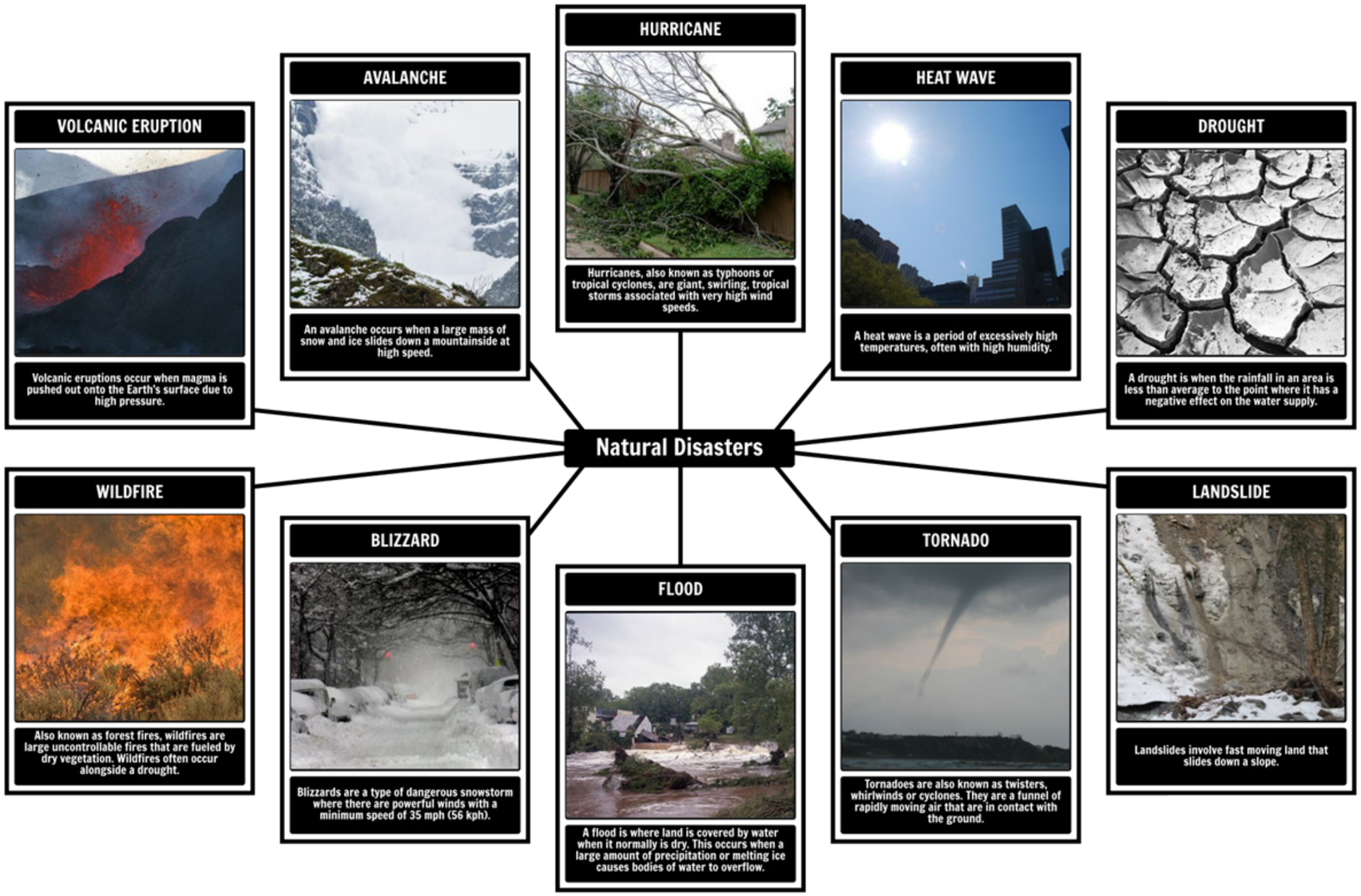
Nature of disasters

The recent devastating disasters like 2004 Indian ocean Tsunami, 2007 Hurricane Katrina, 2010 Haiti earthquake, 2011 great eastern Japan earthquake and tsunami have been the most disturbing and disruptive events for man and his works. These disasters not just revived memories of the bygone calamitous earthquakes of the late 18th and 19th centuries but also brought to focus the dim lit memory of those disasters, the changed nature of human population in dealing with these disasters and the decrease in coping capacities of the vulnerable population towards disasters of such magnitude.

During these catastrophic events the shock and stress was accompanied by contexts of massive number of affected, injured and dead, with total wipe-out of many urban centres, serious disruption of local societies and economies as seen in the figures below for the year. While the statistics show an increased number of the impact of disasters, but it should be understood that previously earthquakes happened of such serious dimensions but with relatively less loss of life, considering the exposed and at-risk areas were not so populous and industrially developed. "There was a general scientific agreement that the earth's climate during the period from the early years of the 19th century till 1955 was extraordinarily benign and balmy and foreseen to change radically and exponentially due to changes in earth's climate"(Webre & Liss, 1975). It was further noticed and now very well realized that, due to large scale industrial development, rapid population growth, changes in land use, high and surplus food production and irresponsible management of waste changed the stable and benign state of climate which aggravated the climatic conditions of earth.

Disaster management and planning

With the advent of the human civilizations in regions susceptible to earthquakes, measures to mitigate, prevent and respond to disasters

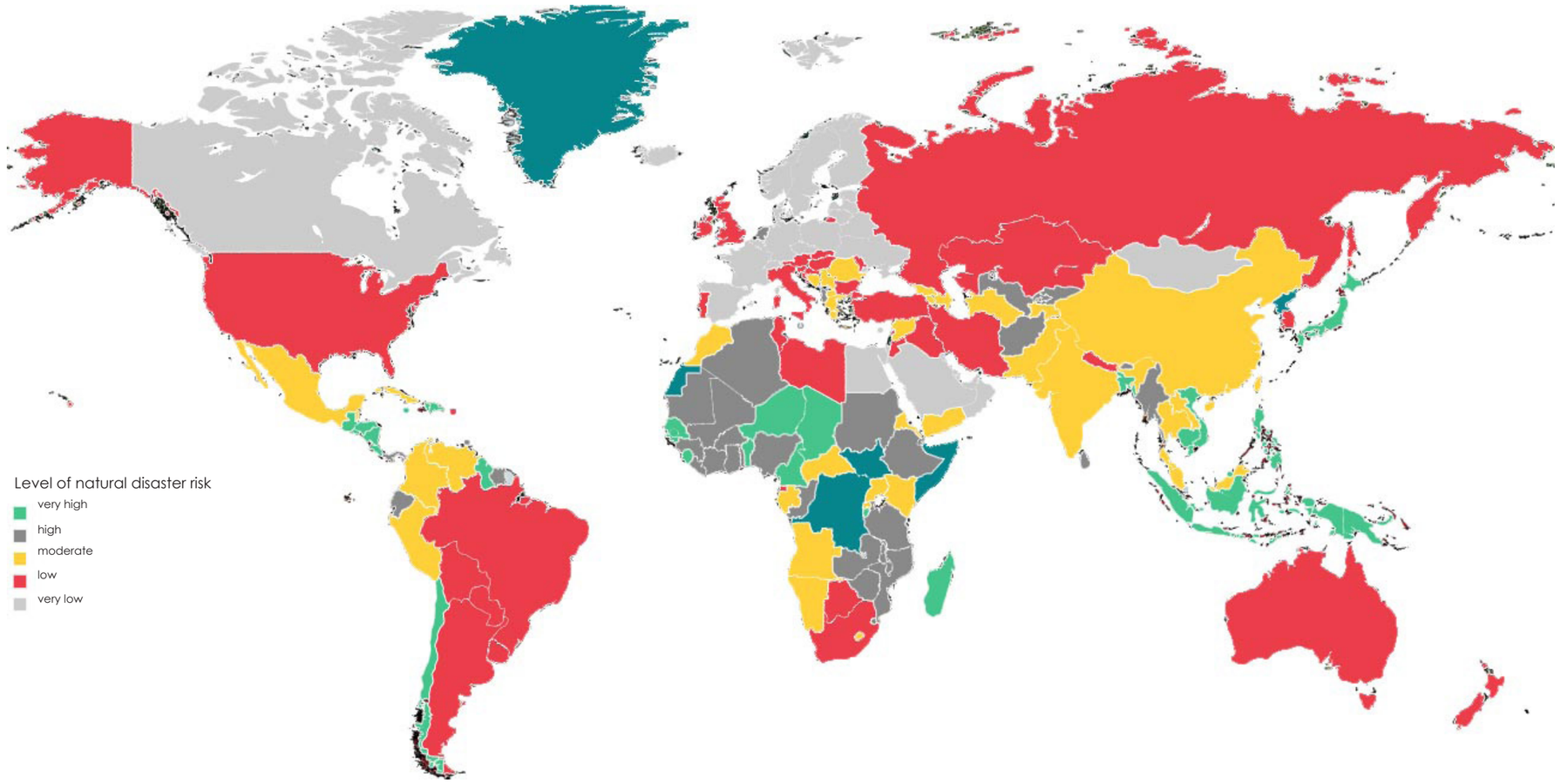


Figures 08– Natural disasters storyboard
Sources – www.google.com

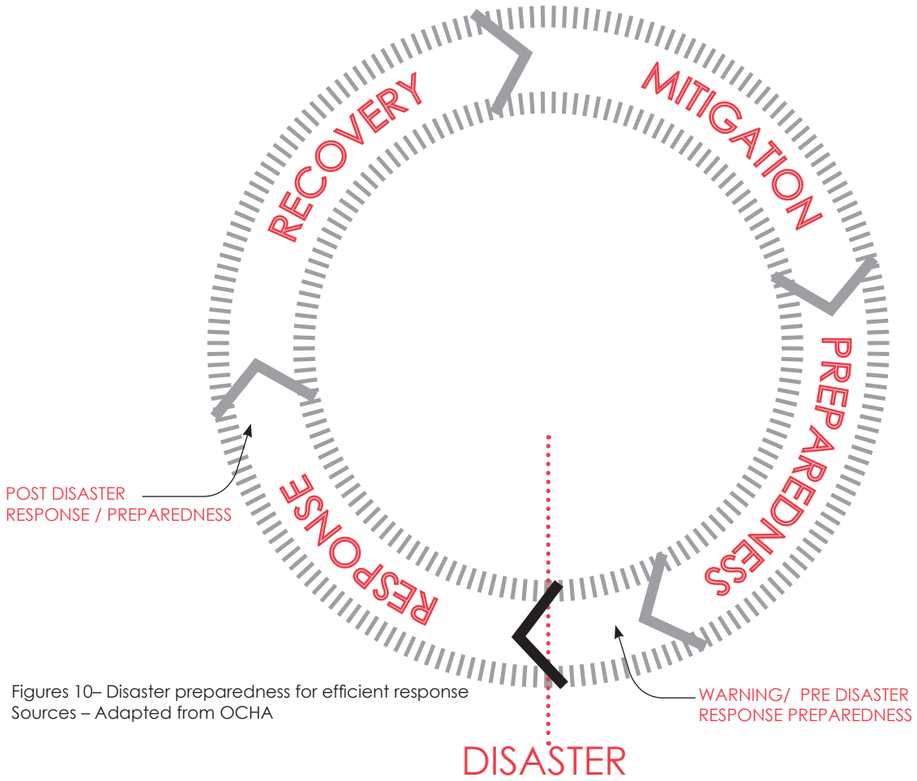
in their local capacity was noticed in history. As Gaillard stated "The differential capacity of responses of traditional societies in the face of natural hazards and the amplitude and duration of cultural change are influenced by the context of the disaster" (Gaillard, 2007). It was seen that these traditional societies had inherent resilience capacities to manage and recover from the disasters. Gregory Smits in his book "Seismic Japan" clearly states "The life history of a disaster begins prior to the appearance of a specific event- focused agent." Disasters become part of the profile of any human system at its first organizational moment in a relatively fixed location or area. So, the existence of disaster relief work and standards was distinct to a selected region and its people, who adopted the disruptive nature of earthquake as a part of their life system. But by the 20th century with globalisation, increased anthropogenic activities and population growth at these vulnerable regions changed the nature of the hazard categorizing it as disaster. According to available data, it is noticed that these susceptible locations showed decreased resilience capacities largely due to unawareness not only of the possibility of the coming earthquakes, but also of the nature of community response necessary to avoid large scale devastation.

As cited in (Webre & Liss, 1975) Charles Richter notes in one of the few commentaries available on the proper steps to take in earthquake: "Lately, a serious problem has been created by the arrival in California of many persons who have no experience of earthquake. . . ." panicky and thoughtless actions by frightened persons may add to the disaster and may interfere with relief work.

Over the last few decades it is noted that with the advancement in technology and



Figures 09– World Risk map for natural hazards
Sources – United Nations University World Risk Index 2014



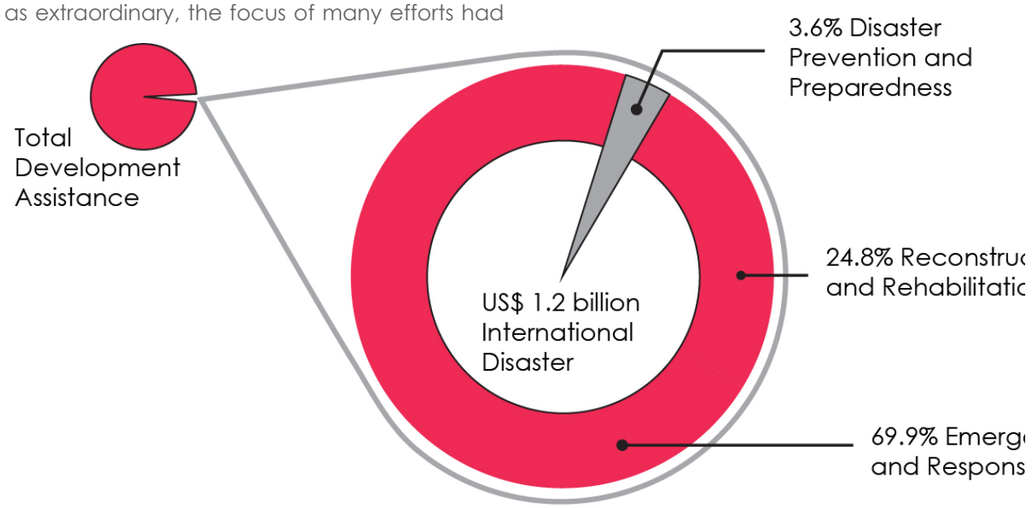
Figures 10– Disaster preparedness for efficient response
Sources – Adapted from OCHA

policy measures of the government at local, regional and international levels standards and guidelines are developed to recognize the areas susceptible to the various range of earthquakes which are categorized as zones, methods of construction have been accepted to absorb earthquake resilient constructions to minimize the material destruction of resources. While these physical measures have resisted the scale of disasters, changes in resource mobilizations like development of effective land-use policies to minimize the destruction in time of earthquake; development of adequate emergency evacuation and shelter plans; development of an equitable way of sharing the cost resulting from the destruction, and of rebuilding; agreements for the orderly cooperation among the many levels of governmental authority that inevitably bear responsibility even in a single disaster (Webre & Liss, 1975) have changed the approach towards disaster mitigation, management and recovery.

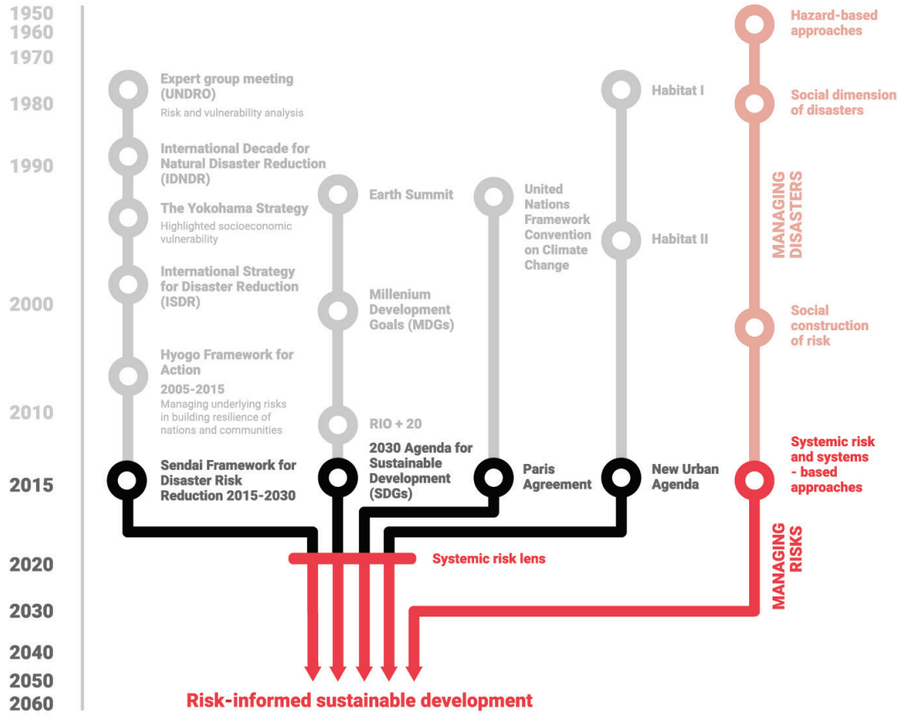
All disaster management studies until the early 21st century focused onto the 4R's i.e. reduction, readiness, response and recovery (Ministry of Civil Defence & Emergency Management, 2009) while classifying responses for both the natural and technological disasters as shown in the figure-9. But since the early 21st century, as the intensity and frequency of these disasters increased, in addition to sea level rise by climate change resulting in a large scale economic, environmental and societal disruptions the approach towards reconstruction planning also changed. Moreover, the unsustainable consumption of resources and the growing demand of public interest within the society led to the conceptualization of sustainable development and its relation to disaster management, disaster risk reduction and emergency planning (Ministry of Civil Defence & Emergency Management, 2009). The recent governmental studies on disaster planning stress the need for an informed and patient public, both in the period of emergency during the actual disaster and during the tedious time of reorientation and rebuilding in the aftermath (UNDRR, 2019).

Adaptation of standards

The evolution in the modern earth sciences led to rise in research and investment in engineering techniques. Earthquake prediction and prevention was a very important aspect within the disaster community of academics and scientists. While this led to a lot of awareness within the general masses but till recent years disasters were still considered a part of weather systems and as such were treated as singular events ("acts of God") rather than symptoms of a larger trend. Because disasters were treated as extraordinary, the focus of many efforts had been on the response to such crises and the ways in which citizens and communities should prepare for disasters, rather than the ways in which disaster impacts can be mitigated and recovery can be shortened or made easier (Webre & Liss, 1975). Engineering and land use involved zoning of the region under the category of most to least magnitude of earthquake impacts. This also triggered and changed many building by-laws towards earthquake resistant construction to absorb the effect of the earthquake. For example, in New Zealand the uplift of a structure from its foundation and rocking during a strong earthquake is a commonly observed phenomenon which must be accommodated by design and may also offer the potential to dissipate seismic energy. Special studies are recommended where dissipation of energy is to be accommodated by rocking of foundations, because dynamic interactions between foundations and the soil are non-linear, and neither the structural deformations nor the associated redistribution of forces can be modelled using conventional linear elastic analysis (Ministry of Civil Defence & Emergency Management, 2009). Over the last few decades these guidelines and standards have addressed the gap between science and practice and are used in mainstream civil defence emergency management planning.



Figures 11– Share of development aid allocated to disaster prevention and preparedness
Sources – GFDRR, 2012b



Figures 12– Risk reduction – a journey through time and space 1950-2060
Sources – GRA, UNDRR (2019)

Public policy and preparedness

While the climate change increased the occurrence of the number of hazards, it also changed the global fragmented and sometimes fatal policy and governmental measures to respond to natural hazards. Before the late 20th century there did not exist an intelligent world response system for earthquakes, neither did they have standards for reconstructions, if such an event occurred, save a few countries like Japan and republic of China. It was later to1970's when United Nations formulated a global system for disaster relief, planning with measures and standards for response and recovery.

An international framework for action was developed in the International Decade for Natural Disaster Reduction (IDNDR) initially, that worked on the methodology for risk and vulnerability analysis. In 1994, it adopted the Yokohama Strategy for safer world: guidelines for natural disaster prevention, preparedness and mitigation, containing the principles, the strategy and the plan of action. This strategy played a pivotal role in emphasising the role of the socio-economic vulnerability in disaster risk analysis and the role of human action in reducing vulnerability of societies to natural hazards and disasters. The IDNDR was succeeded by international strategy for disaster reduction (ISDR), which would propose for communities to become resilient to the effects of natural hazards, and related technological and environmental disasters, thus reducing the compound risk posed to socio-economic vulnerabilities within modern societies and management of risk by integration of risk prevention strategies into sustainable development activities. The figure-10 shows the journey of risk reduction methodologies and policies evolving and adpting through time and space towards a sustainaible furistic scenario.

To fill the challenges and gaps (governance; risk identification, assessment, monitoring and early warning; knowledge management and education; reducing underlying risk factors; and preparedness for effective response and recovery) formed under the Yokohama strategy, Hyogo framework for action 2005-2015: building the resilience of nations and communities to disasters (HYA) was developed. This framework of action was introduced to catalyze national and local efforts to reduce disaster risk and to strengthen international cooperation through the development of regional strategies, plans and policies, and the creation of global and regional platforms for disaster risk reduction (DRR) (UNDRR, 2019). With this, the United nations also adopted the United Nations Plan of Action on Disaster Risk Reduction for Resilience. But since the 21st century demonstrated advanced state of risk from a single hazard to multi-hazard, HFA was neither able to withstand the limitations arising from political, environmental, and socio-economic contexts in terms of capacity, technical, organizational and financial resources across scales and sectors, nor the resultant problems that would arise from the risk informed decision making. This resulted in the upgrade from HFA to the current Sendai framework of disaster risk reduction, whose core focus is on managing risk than on managing disasters.

Planning with disaster risk

As noticed comparatively, with hazard exposure increasing much faster than rate of vulnerability decrease, seen in both higher and lower income group countries with newly developed risks generating faster than the reduction of the existing risks. While this uncertainty is increasing with increase in risks directly and indirectly affecting the functioning of daily life, government activities, safety and security, it's become utmost crucial to focus from just protection of social and economic development against eternal shocks and stresses to transforming towards managing risks with growth and development that unanimously promotes social well-being, safe, secure and healthy environment that strengthens resilience and stability.

With this conclusion being the basis for development of the Sendai framework 2015-2030, planning by being risk-informed for sustainable development was established that will create opportunities to build international coherence, foster risk-informed policy and planning, promote cross-sectoral and multi-level hazard risk assessment while simultaneously encourage a deeper understanding of socio-economic and environmental vulnerability across different sectors and levels of governance (UNDRR, 2019).

Human perception of disasters

Evolution in the modern earth sciences and awareness within the society led to hazards such as droughts, fires, hurricanes, and earthquakes recognised as natural occurrences; they become disasters only when they interact with human systems and the built environment. The research prior to it has been clear that the level of awareness and mental state of the stricken population are the key to the success of any social measures to minimize destruction and quickly resume normal life. There is much to suggest, however, that the general level of awareness of the nature of earthquake and its causes and mechanisms is abysmally low in our society, even in areas of high and well-established seismic risk. One cannot underestimate the effect of an educated and tolerant populace on the mitigation of destruction during an earthquake and the recovery after. An earthquake is by its very essence terrifying, more terrifying than nature's other dreadful outbreaks, since more than any other it sets the stability of the underlying basis of human life itself in question.

3.2 Anatomy of disasters

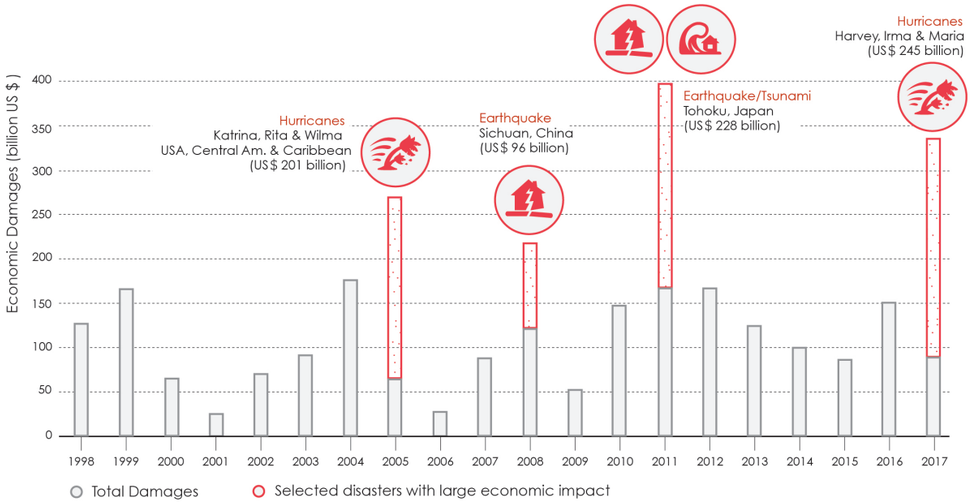
Hazards and Disasters

In general, EM-DAT classifies disasters according to the type of hazard that triggers them. This report focuses on hydrological, meteorological and climatological events – which collectively are termed weather- or climate-related – plus geophysical disasters. CRED defines a disaster as "a situation or event that overwhelms local capacity, necessitating a request at the national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering"(Kishore et al., 2018). Between 1998 and 2017 climate-related and geophysical disasters killed 1.3 million people and left a further 4.4 billion injured, homeless, displaced or in need of emergency assistance. While the majority of fatalities were due to geophysical events, mostly earthquakes and tsunamis, 91% of all disasters were caused by floods, storms, droughts, heatwaves and other extreme weather events (Pamela Forward, 2017). Disasters occur when society is exposed to the intensity of the hazards and so exposure and vulnerability turns a hazard into a disaster. When the society becomes susceptible to the nature of the hazard, it becomes vulnerable. And vulnerabilities arise (and increase) due to or many social, environmental, economic, physical, historical, demographic and political reasons that includes and worsen due to population growths, urban development in risk-prone locations, land use changes, environmental degradation, weak governance, poverty and inequality, and climate change.

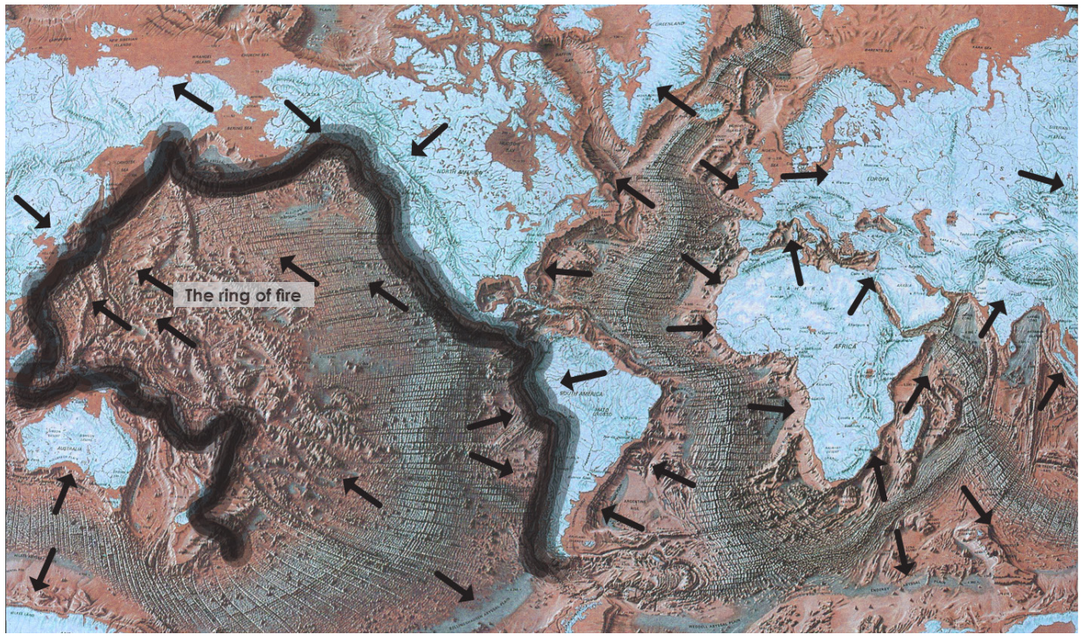
United nations DRR describes risk as the consequence of the interaction between a hazard and the characteristics that make people and places vulnerable and exposed.

Risk = Hazard X Exposure X Vulnerability

And the structure of classifying a region vulnerable is complex, as there are many underlying drivers that influence the state of vulnerability. But it is also understood that while being exposed to any hazard it is possible to remain insusceptible to natural hazards. To understand the nature of risk in the context of tsunami, in this thesis the focus is only on the natural hazards arising due to seismic activities.



Figures 13– Total reported economic losses per year, with major events highlighted 1998-2017
Sources – EM-DAT, CRED and author's illustration



Figures 14– World ocean floor map, alignment of tectonic plates
Sources – www.earthlymission.com

The chaotic phenomenon- Earthquake

Gregory Smit in his book 'When the Earth Roars' "argues that earthquakes are so chaotic as to be unpredictable, not only geologically but also in their social and cultural effects". "Earthquakes are dynamic rupture propagation along fault planes, starting from the elastodynamic instability within a small region"(Yang, Yang, & Zhang, 2012). The figure-12 of the ocean floor shows the fault lines of the tectonic plates all around the world. Earthquakes originate due to tectonic movement (fracture and friction) of these fault planes that triggers shaking and chaos in the environment. They are an everyday phenomenon across the world. However, the earthquakes which occur most frequently are often too small to cause significant damage (whether to human life, or in economic terms). Significant earthquakes are those which are large enough to cause notable damage. They must meet at least one of the following criteria: caused deaths, moderate damage ($1 million or more), magnitude 7.5 or greater, Modified Mercalli Intensity (MMI) X or greater, or generated a tsunami (ourworldindata.org).

Research and investment in innovations to predict earthquake have continued to fail, as the sciences to ascertain the earth's timetable are still in fancy. The geological time and human time simply do not match and them seems to be little achieved from assigning temporal characteristics to major earthquakes. But while prediction of such events is limited to an extent, identifying the underlying vulnerabilities can at least help in reducing the impact from further such events.

Although earthquakes are unpredictable, unique phenomenon whose timing and social trajectory is un-knowable, the record of past earthquakes provide a valuable insight and guidance to the range of potential natural hazards and at least some possibilities about how those hazards might interact with society. As is known from the past earthquakes; M9 subduction zone earthquake are possible; tsunami wave heights of more than 38m in some areas of Japan are possible, M7 class or stronger earthquakes can shake up any city like Tokyo on the ring of fire in the Pacific Ocean. The seismic danger has been an impetus in the development and innovation in both building design and other potential tsunami earthquake resilience structures.

Geographies of disaster

In the history of earthquakes, it is perhaps inevitable to focus on problems. The last decade shows the massive surge of natural disaster occurrences. Year of 2017 itself accounted for 335 natural disasters that is as much the number of disaster occurrence seen during the period from 2007 to 2016 which are 354. With increasing occurrences, the statistics also show increase in the number of deaths, economics losses, people affected (both short and long term). What is staggering is global south, for that matters particularly Asia, seemed to be the most vulnerable continent for floods and storms, with 44% of all disaster events, 58% of the total deaths, and 70% of the total people affected yet America reported the highest economic losses, representing 88% of the total cost from 93 disasters, which means the burden was not shared equally (Kishore et al., 2018).

Nevertheless, what is noticed is that data reported suggests an emerging trend in natural disaster events demonstrating lower mortality but higher cost. And 2017 has been the most expensive of the year in terms of economic losses due to series of hurricanes occurrence. But till now 2011 with The Great East Earthquake Tsunami of Japan accounting for 228billion $ losses in addition to hurricanes, has been the most devastating in terms of economic losses, deaths, affected population, chronic health problems and environmental losses.

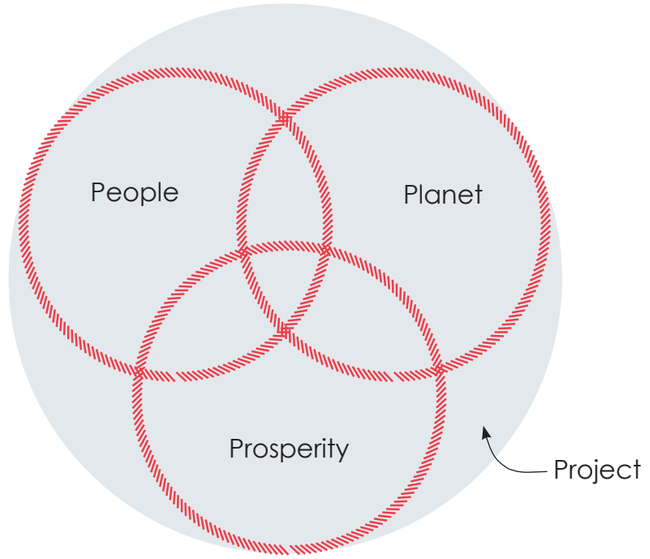
Scholars have historically categorized disasters by whether their origin is human or non-human. Climate change has disrupted this traditional classification system for disaster origins, into;
(a) hazards that are purely human in origin,
(b) hazards which are purely nonhuman in origin,
(c) hazards which are a hybrid of human and nonhuman influences.

Many scholars have written about the false dichotomy between nature and society, which remains powerful despite the way that human society and the non-human environment do not just coexist but in fact co-construct one another(Condit-Bergren, 2016). But nevertheless, any disastrous event is multifarious in making with the actual effects of the event intertwined and under scope of many disciplines. While earthquake as a hazard is a discrete, less affecting hazard phenomenon, but the resultant tsunami waves create most of the destruction within the near environments which needs a holistic response perspective.

Human geography has in many ways adopted the terminology, epistemology, and preoccupations of governmental approaches to hazard: a continued emphasis on individual choice models, a desire to identify spatial patterns, and above all a preoccupation with quantifying these varying degrees of vulnerability across spatial scales (Adger et al., 2009a; Cutter 1996; Cutter et al., 2000; Finch, Emrich, & Cutter, 2010; Mustafa 2005; Tate, Cutter, & Berry, 2010) as cited by (Condit-Bergren, 2016). The Sendai framework for disaster risk reduction takes into fact these considerations in addition to the technological assessment models and the differential distribution of disasters across the world. It is this discourse that resulted in its vision, principles and commitments that NUA explicitly mentioned DRR and resilience, and proactive promotion of risk-based, all-hazard and all-of-society approaches. It called for sustainable management of natural resources in cities to promote DRR by developing DRR strategies and assessing disaster risk periodically.

Reduction of risk and vulnerability on a global scale is a key message of the Agenda for Humanity, which calls for the anticipation and prevention of disaster and crises. It consists of five core responsibilities that are essential to achieve progress to address and reduce humanitarian need, risk and vulnerability, namely: political leadership to prevent and end conflict, leave no one behind, uphold the norms that safeguard humanity, change people's lives from delivering aid to ending need, and invest in humanity (UNDRR, 2019). The discourse on disaster preparedness and the above mentioned agenda for humanity recognises the systemic nature of risk and the required paradigm shift in the adoption of system-based approaches and collaborative means to reduce the creation of new risk and manage the exiting building risk scenarios.

With the non-linear change threatening the core dimensions and the goal of sustainable development; the triple bottom line that consists of social equity, economic and environmental factors under the phrase of 'people, planet and profit'. It has become imperative to understand the multifarious dimensions of risk and responses at the spatial and temporal scales. The triple bottom line assists to evaluate this risk on various scales and sectors depending on the performance on a larger scale for a greater ambition and accelerated systemic action. The triple bottom line is supported by the 4th P called the project, process or purpose that transcends to humanistic value and beyond by factoring in the resultant context and its capacity extends the concept to fourth bottom line. These 4Ps are also guidelines based on which the scoping exercises were carried out for the multidisciplinary aspect of the thesis.



Figures 15– Fourth bottom line, extension of triple bottom line goals of sustainability
Sources – Author's illustration

In order to understand disaster risk, it is essential to understand that the risk is;

- Understood as the damage and destruction to life and property within a period of time.
- It is continuously changing according to our ability to reduce vulnerability.
- Due to uncertainty of certain hazards it is many a times hidden within both high as well as low impact events.
- The distribution of disaster risk is differential around the world and reflects the pattern of social construction for exposure and vulnerability in different countries
- Overlap of emergent and complex natural as well as man-made processes are creating newer cascades of disasters

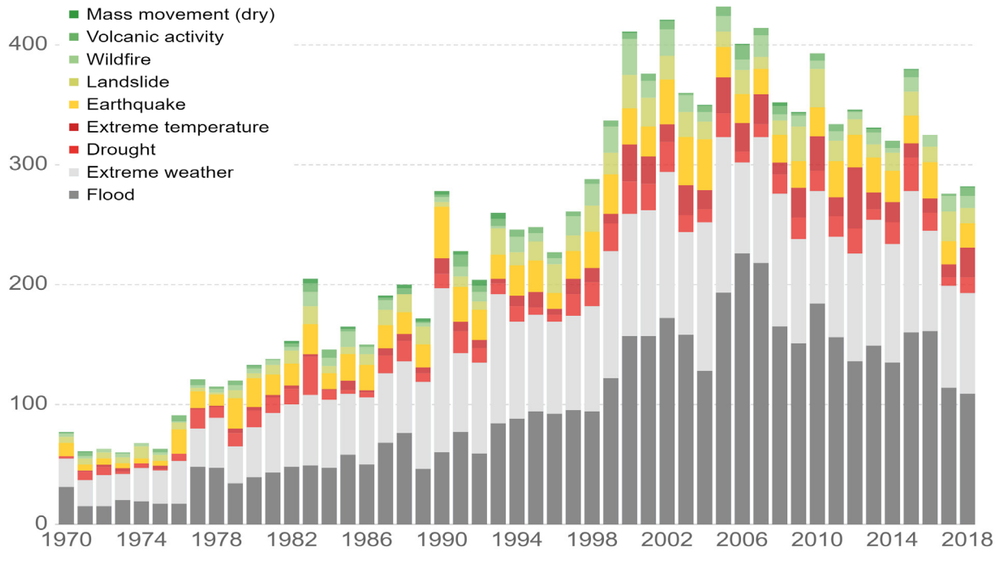
It is impertinent to understand that though disaster risk obstructs every kind of development and progress but as cited by (UNISDR, 2015a) "disasters threaten development, just as development creates disaster risk".

And therefore, for development to take place it is essential to understand the extent and measure of exposure and vulnerability the hazard will create in becoming a disaster. The following studies cater to the diverse states of exposures and vulnerabilities of seismic hazard-earthquake that is followed by a tsunami.

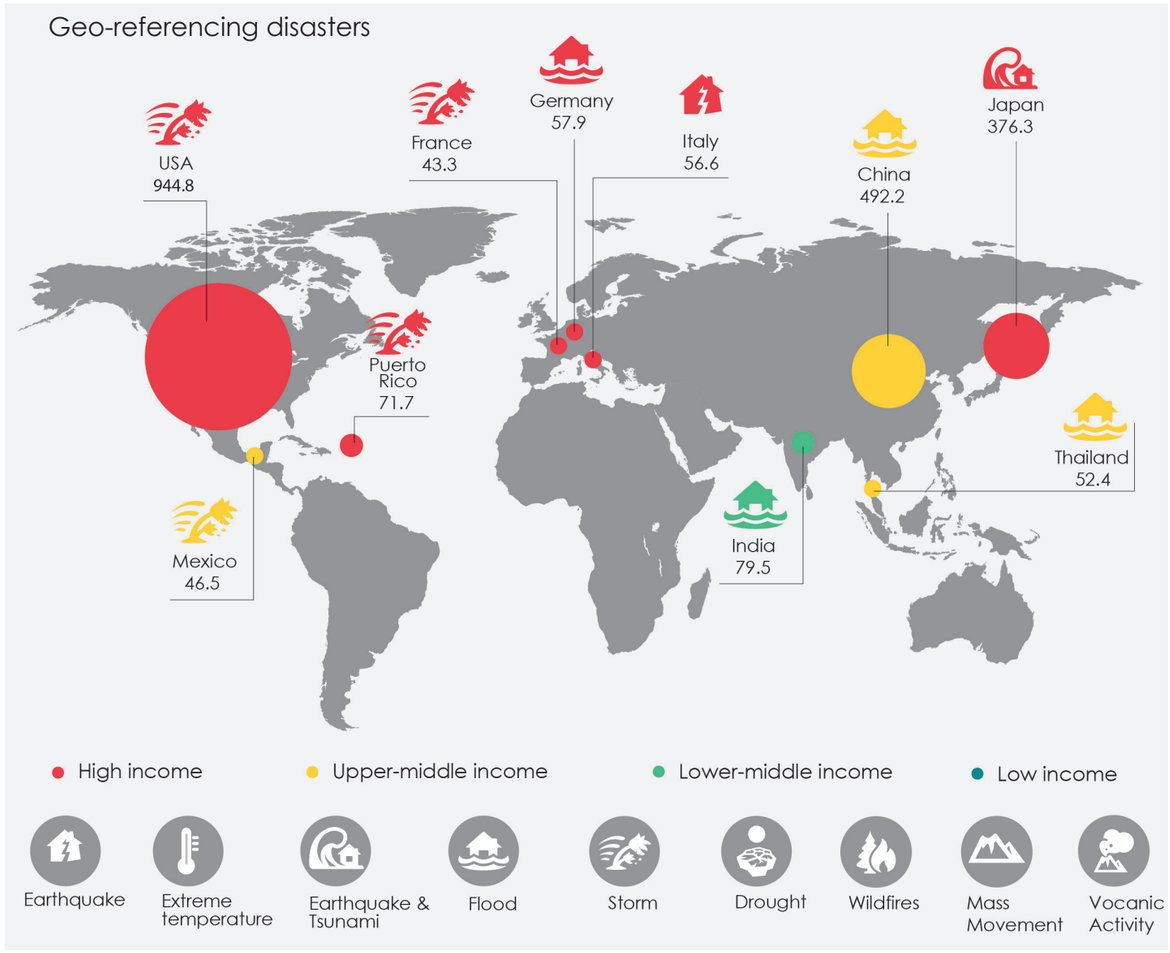
Exposure

While it is understood that the extent to which exposed people or economic assets are actually at risk is generally determined by how vulnerable they are (UNISDR, 2009), as it is possible to be exposed but not vulnerable (IPCC, 2012) and so, it is important to understand the situation of people, infrastructure, housing, production capacities and other tangible human assets located in the hazard-prone areas. The graphs in the figure 14 and 15 highlight the differential states of the hazard exposure in the world. It is noted that through history the extent of exposure has been on the rise not only due to the economic losses and increase in population but also due to changing intensities and frequency of the disasters.

It is well understood that many hazard-prone areas like the coastlines, volcanic slopes, flood plains attract economic and urban development, while also being significant to the cultural and religious of the people who live there. And when people and assets are concentrated and with time grow in such hazard prone regions the level of exposure increases. And with recurring disasters large amounts of



Figures 16– Global reported natural disasters by type, 1970-2018
Sources – EM-DAT (2018), CRED



Figures 17– Top 10 countries in terms of absolute losses (billion US $) 1998-2017
Sources – EM-DAT, CRED and author's illustration

capital and resources flow into such regions for development further continuing the cycle of exposure and loss. Such continual upward trend of resource consumption increases disaster risk to exponential levels which needs to be understood, acted accordingly and planned for which has also been the goal of this research.

How does the understanding of disaster risk contributes in the process of reconstruction for such hazard prone areas?

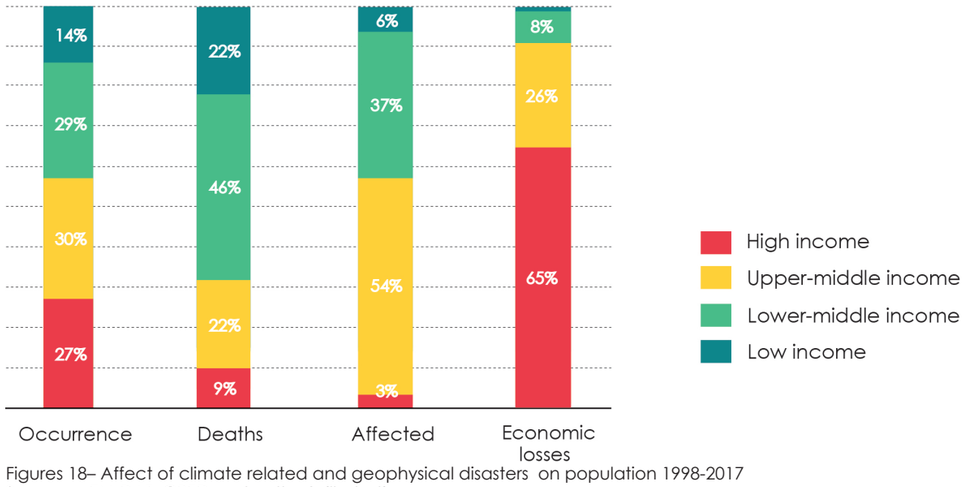
Vulnerabilities

It is important to understand vulnerability as it is defined as the characteristics determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (UNISDR 2017 terminology). Many a times vulnerability includes exposure and susceptibility, as in some regions exposed people are not susceptible to the natural hazards. To understand this in more detail the graphs in the figure 16 and 17 explain the disaster risk according to various income groups throughout the world and their valuation of losses incurred. The state of living changes the scale of being affected while for many regions the estimates vary as the losses are not even registered.

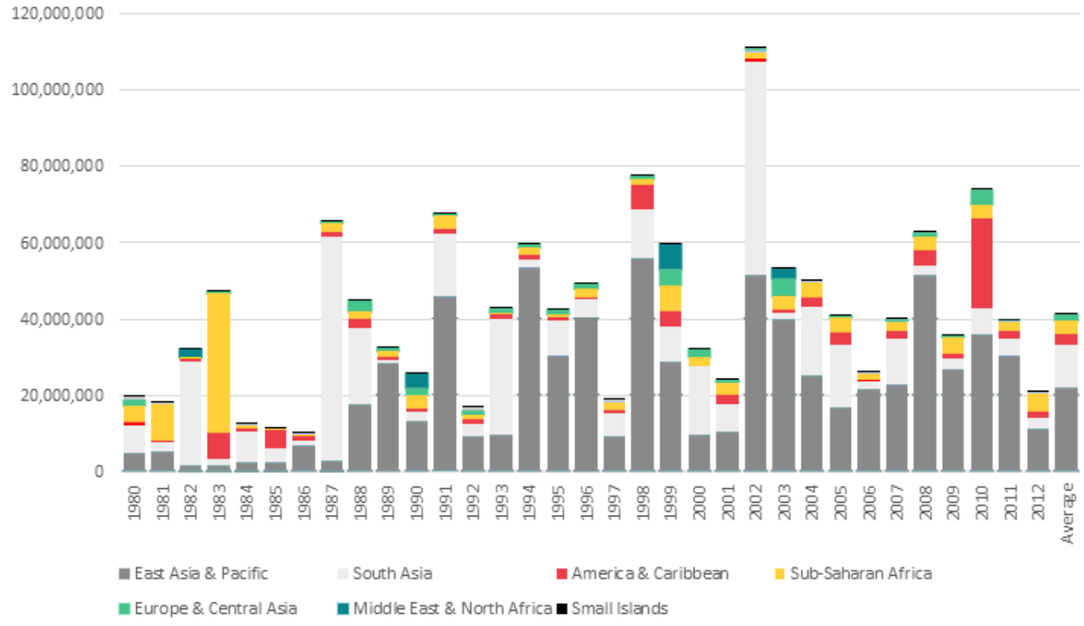
However vulnerability not only depends on the individual condition, it is many a times governed by the social, political, environmental and economic conditions constituting the hazard prone region. And to understand vulnerability it is necessary to understand not just the impact of the hazard but also the consequences and state of context. Study of vulnerability should be able to assess the nature of susceptibility of different constituents of the hazard region that directly and indirectly affect the level of disaster risk.

Contextual vulnerability features an important medium to assess and map the disaster risk at the community and local levels that helps in understanding the level of disaster risk generated by a specific hazard. But with climate change increasing the scale of risk that the hazard induces within any community the indirect and uncertain nature of the dynamics of the disaster risk created changes the way in which a hazard is analysed. And so understanding the context in its entirety is very important in the vulnerability studies.

The diverse section of communities that are susceptible to disasters are often, not always associated with the groups including children, women, elderly, disabled, migrants, tourists and displaced populations. And these groups changes the course of the extent of disaster risk within the hazard prone region. Here the region prone to hazards is often includes the exposed and vulnerable population. In the chapters that follow the landscape susceptible to this continuous nature of hazards is defined under a common term that forms the core spatial outlook further in the research carried for the project.



Figures 18– Affect of climate related and geophysical disasters on population 1998-2017
Sources – EM-DAT, CRED and author's illustration



Figures 19– Total lifeyears lost by regions
Sources – CEPR policy portal

Vulnerability is often related to factors such as;

Physical
E.g. poor design and construction of buildings, unregulated land use planning, etc

Economic
E.g. the uninsured informal sector, vulnerable rural livelihoods, dependence on single industries, globalisation of business and supply chains, etc

Environmental
E.g. poor environmental management, overconsumption of natural resources, decline of risk regulating ecosystem services, climate change, etc

Social
E.g. poverty and inequality, marginalisation, social exclusion and discrimination by gender, social status, disability and age (amongst other factors) psychological factors, etc

Historical, Political and Cultural along with natural processes affect in shaping the socio-environmental conditions for people (IPCC, 2012). These processes produce a range of immediate unsafe conditions such as living in dangerous locations or in poor housing, ill-health, political tensions or a lack of local institutions or preparedness measures (DFID, 2004).

Vulnerability analysis involves understanding the root causes or drivers of vulnerability, but also peoples capacities to cope and recover from disasters (UNISDR, 2015b).

By identifying the vulnerabilities and capacities, local communities identify strategies for immediate and longer-term risk reduction, as well as what they can do themselves to reduce risk and where they need additional resources and external assistance. In this context resilience of the hazard prone region and the vulnerable population exposed to the hazard is required to be measured for any action to take place.

3.3 disruptive as a new normal

Resilience as co-existence

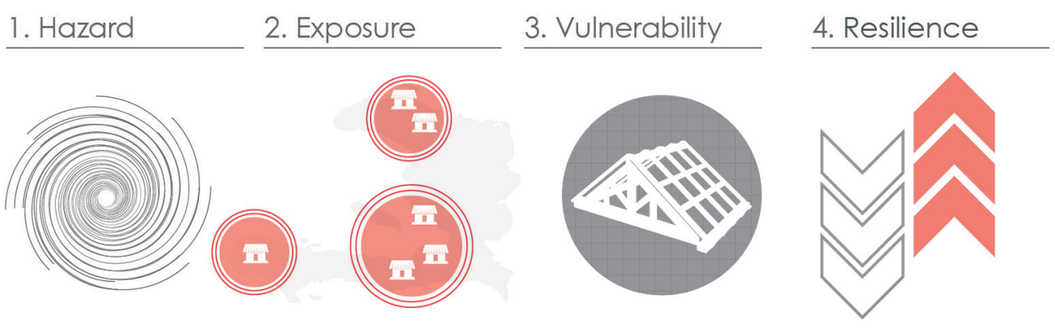
Natural disasters and the recovery process deals with the bounce back ability of systems and the adaptability and persistence of other systems. The term resilience is much associated to disaster and the emergency response that takes place after the disaster as the reconstruction process deals with the management of different systems recovery bounce back and to a state that is either old or transformed or new.

Resilience often gets categorised under engineering resilience or under ecological depending on the state and the magnitude of the disaster and the scope of the normal that each community and government decides, where in not always but social aspect attached to resilience gets missed or is not addressed.

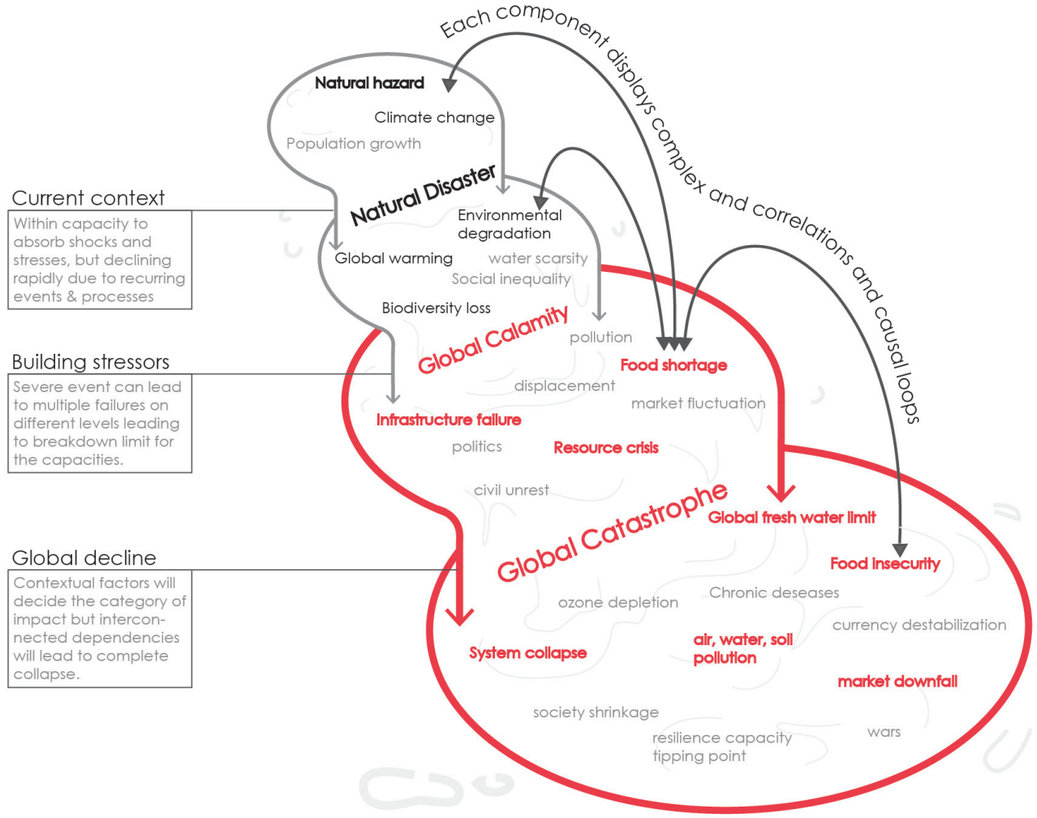
The scope of resilience becomes short term and in the recurring event the capacity to persist gets hampered. Planning for short term is necessary and so is for long-term. Therefore, adaptive capacities of all entities within the scope should be considered. In addition to this to build resilience assessment to reduce and avoid risk; methods to develop capacity to restore functions; adaptive to transformative capacity should be developed and enhanced. By planning and addressing these in the reconstruction processes every entity (individual, organization and group) within can be involved in the resilience building and can thrive towards a better future.

The strategy to go forward is integration and bridge-building that forms a collaborative process between the local decision-making bodies. This helps in exploring, regenerating and enhancing community vitality that further catalyses a change within the community. The place-based solutions that emerge from the collaborative development of contextual data lend themselves to self-organizing around actions that are co-created, with local ownership of data, risks and solutions (Davoudi et al., 2012). This generates connection, communication and action, which can address complexity in new ways. Local capacity can be increased significantly by drawing from collective intelligence and mutual learning.

Application of resilience in practice is carried forward by the disaster risk reduction (DRR) concept that lends itself to co-existence thinking. It does so by conceptualizing how it's constituent policies, strategies and practices are intended to manage risk arising from interactions between people, environment and hazards (Twigg, 2015)as cited by (Paxton, 2017). This interaction is conceptualized in terms of the capacity of the societies and citizens to co-exist with periodical hazards, but many a times beneficial environmental processes. And that development of co-existence is possible is evident from those knowledgeable of practices in many indigenous communities around the world. To be able to co-exist with periods of hazards, communities and individuals need to identify what they may have to contend with



Figures 20– Wellbeing losses, road to resilience
Sources – GFDRR



Figures 21– Cascading risks of tomorrow
Sources – author's illustration

when the disaster strikes and accept that they need to cope with, adapt to and recover from the dynamic hazard's consequences overtime. The challenge in this context is the improper ways in which the communities, environment and hazards interact that influences risk. Consequently, risk and its management differ from place to place and community to community over time.

This complex nature of risk and interdependencies arising from it within the social, geographic and temporal diversity means that people and groups must play a role determining their risk and what they can do to manage it. This calls for shared and participatory responsibilities that play an important role in creating a resilient society that is capable of coping with, adapting to and recovering from the disasters emanating from the environmental hazards.

Risk Informed Development

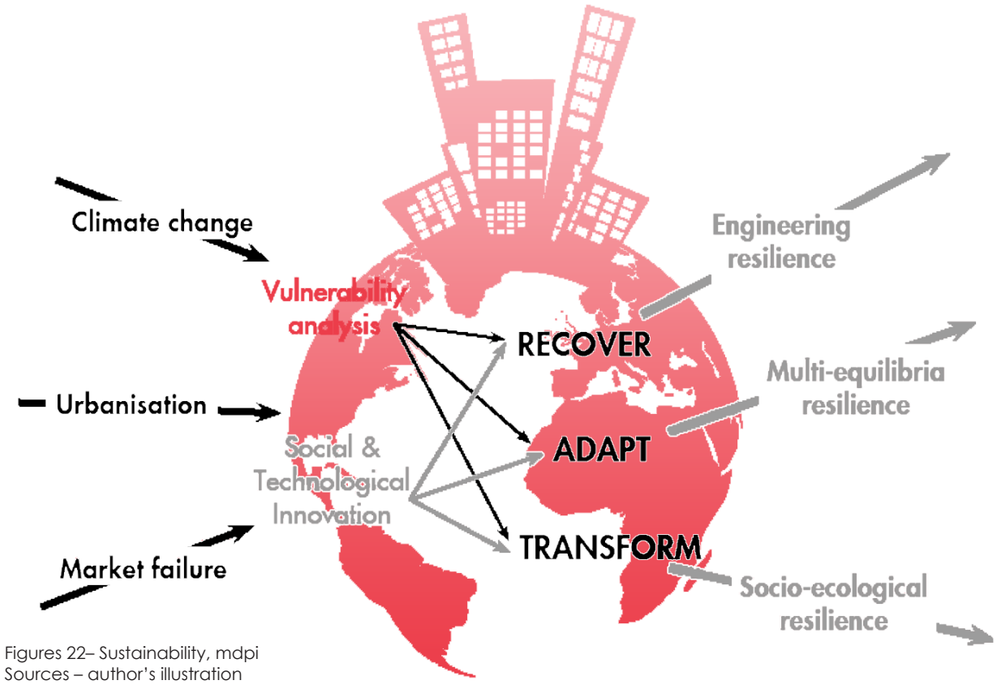
Risk evaluation process forms the basis for risk-informed development. While the application of risk information requires evaluating and distinguishing between risks that are unacceptable from risks of acceptable levels. The unacceptable levels of risks need to be addressed through structural and non-structural disaster risk reduction (DRR) measures, whereas residual disaster risk management (disaster preparedness, response, and recovery) focuses on acceptable levels of remaining risk. These risk assessments and interdependencies form the basis of risk-informed development planning, both generic (at national and sub-national levels) and sector-specific(UNESCAP, 2018). In planning for the risk-informed development key findings were reached which are as follows;

Need for collaborative governance framework.
"Risk-informed development planning requires a collaborative governance framework in which public policy makers, technical and scientific experts, and private sector and civil society organizations work together with an informed public that demands investments in disaster risk reduction/disaster risk management (DRR/DRM). Attitudes and underlying incentive systems need to change to reward resilient policy making and action, even if they do not generate clearly visible, short-term benefits. This is a long-term process and cannot be achieved through a one-off risk assessment or planning exercise"(UNESCAP, 2018).

Incentives to encourage risk reduction.
"Changing incentive systems to reward forward-looking investments in risk reduction needs to be based on a solid understanding of how and when investment decisions are currently made. An essential question is how development progress is currently measured, by whom, and how associated indicators influence investment decision making"(UNESCAP, 2018).

Baseline for current disaster risk reduction investments.
"Such an analysis can help to draw in individual sectors to better appreciate the relationship between their scope of work and risk reduction and to draw them into a collaborative risk-informed development planning framework that clarifies their current and future roles and capacity in DRR/DRM. It can also help to further prioritize and steer investments towards resilience strengthening" (UNESCAP, 2018).

No blueprint to institute risk-informed development.
"Depending on country contexts, it may, for instance, be more practical to prioritize highly exposed and vulnerable geographic regions or sectors, develop sector-specific risk information assessment tools and risk reduction and risk management solutions. Demonstrated evidence of the benefits of risk-informed planning/ budgeting in one sector may then motivate other sectors to follow suit. Similarly, such experience can provide generic development planning apex bodies, such as ministries of planning and finance, with guidance to develop risk-informed planning mechanisms and tools. Conversely, in other countries with centralized planning and stronger regulatory capacity, it may make more sense to start the process at the level of national development planning apex bodies. In more decentralized contexts with strong urbanization trends, risk-informed development planning may focus initially on urban areas and then spread to peri-urban and rural areas that share similar hazard exposure and vulnerabilities before defining intra-territorial and national planning arrangements and institutions" (UNESCAP, 2018).



Figures 22– Sustainability, mdpi
Sources – author's illustration

Hazard readiness and Building Resilience

A paradigm shift has occurred since the mid-twentieth century which has been enabled by increases in computational power and the availability and mobilization of vast streams of data and observations, models and narratives. Systems approach increasingly help make sense of the failure of linear constructs in a world where everything is connected. (Linear constructs refer to the pervasive extraction–production–distribution–consumption– disposal linear process of resource use in the current economic paradigm)(UNDRR, 2019). In order to understand the underlying risks, it is important to know about the different types of risks which have been explained below.

Systemic Dependent risks

These risks are not necessarily contemporary hazard risks but arise due to the cascading effects of hazards-disaster scenario. They result when the sequence of events over cedes the human controls and affects in every way possible. However, holistic approaches to achieving good health and happiness – and in many instances has inadvertently created new ills while curing old ones – traditional disaster response and mitigation capabilities are not the appropriate apparatus to increase community resilience or under- standing of systemic risks. These systemic risks change according to the hazard type too and are needed to manage

not just the environmental hazard but also to manage the climate change risks and the increasing problems of urbanization.

In such times, scenario building can help to facilitate thinking and decision-making if those involved are able to act in their capacity at local, regional and national levels. Exploratory scenarios start with the present situation in mind and explore the future impacts of various drivers, such as environmental degradation or climate change, shocks such as disasters, and trends such as urbanization and migration.
To fully understand the cascading risk scenario as well as built environments risks, it is necessary to understand the gap between global, regional and local risks, risk perception, and risk prevention and mitigation strategies, and to evaluate the potential impacts of financial market regulations and possible innovative financial tools about their impact on global resources and the environment.

Spatio-temporal characteristics of systemic risks

An understanding of systemic risk requires a time- dependent description of the interacting elements, the strength of interactions among elements, and the nature of trigger events. Modelling the systemic risk behaviour of complex systems is intrinsically difficult. The degree to which harm is caused depends on the temporal dependence of the under- lying processes and the severity of the trigger event, which are usually studied through numerical simulations(UNDRR, 2019). In other words, the impacts of systemic risk depend on the rapidity of interaction of different parts of systems and how extreme the event is that triggers the risk.

Time and timing are critical parameters that determine the properties of the impacts of systemic and spatio-temporal risks when realized, or, in more familiar terminology, when the consequences of hazard, vulnerability and exposure manifest. It is salient to mention here two aspects concerning timing in the context of systemic risk. The first issue is related to the poly- synchronous time signature of dynamic systems and the occurrence of risks; the second refers to the temporal evolution of how systemic risks build up and unfold, involving feedback loops of asynchronous operations of system components(UNDRR, 2019).

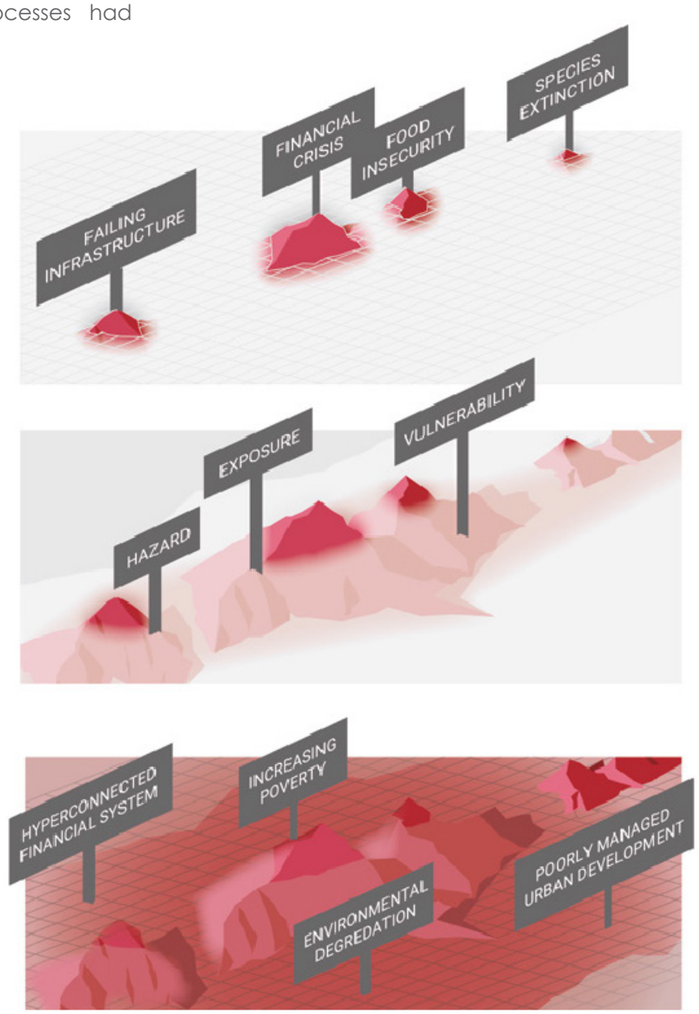
Systemic risk modelling may offer quantitative information to estimate spatio-temporal hazard exposures and potential catastrophic impacts. The design and computation of such models is typically a multidisciplinary endeavour with scientific challenges and important judgments as to what to include and what to exclude.

To make these complex, interconnected systems more manageable, a new view of risk is needed. The Sendai Framework proposes this in its strategies towards a holistic ability to embrace the characteristics- multiplicity, ambiguity and uncertainty of risks. There has been important recent work predicated on these concepts that suggests that the shape of risk is similar in very different systems. This “homo- morphism” of systemic risks in different domains suggests that as attempts are made to understand the effects of endogenous triggers and critical transitions, there will be more patterns apparent in different domains, which will allow the development of a consistent understanding of the fundamental characteristics of systemic risk(UNDRR, 2019).

To understand these critical aspects and disseminate new approaches for decision makers at various scales (in a simple-to-understand format) will require a more comprehensive understanding of spatio-temporal dimensions and the differentiated nature of complicated and complex systems. It is this perspective that gets addressed within the multidisciplinary project understanding for the case of Japan.

Developing the capability for contextual understanding and decision-making is a far more effective way of dealing with uncertainty and complexity than the present reliance on extrinsic frames of reference and categorical technical expertise, soiled into disciplines. In part, such capability can be built using a lifelong learning approach, to grow an aware, internalized ability to notice the relevance of context and the role of self; and in so doing, recognize and anticipate interdependencies and non- linear effects.

Human decision-making is emotional, not rational, and is therefore more successfully activated by mental models based on meaning attached to values and beliefs. Through history it has been seen that stories and meaning associated with the constant changing relationship of context and processes had enabled in building resilience, to develop rapid sensing, understanding and sense-making. In this way, collective intelligence becomes possible as an essential precondition for collective responsibility, which is at the core of systemic risk governance. Collaboration with and through that intelligence holds the key to building resilience. Further sections will unveil the relations these risks have with their landscapes and how the understanding the dynamics of the landscapes is important for the reconstruction process.



Figures 23– Typology of risks to today
Sources – UNDRR 2019

04| deltaic disasters

Geographies of anthropocene

While the intention of the chapter is to put light onto the array of problems and contexts that together form the ground for the project scope. It also forms the evidence and direction for the research and analysis carried further in the project. While the research narrows down to the multidisciplinary understandings observed, derived and assimilated during the field visit. The focus of the chapter lies in the hazardscape of Japan and the differential nature of disaster recovery measures that have intrinsic connections to the Japanese society.

Figures 24– Machikata Otsuchi , Iwate prefecture, Japan
Source – author

04| deltaic disasters

4.0 Sections

4.1 hazardscapes
tsunami-scapes

4.2 case of Japan
the Japanese setting
climate culture context

4.3 japan and disaster reconstruction
methods
state of japan after 3.11

4.4 field research
workshop proposal

4.1 Hazardscape of Japan

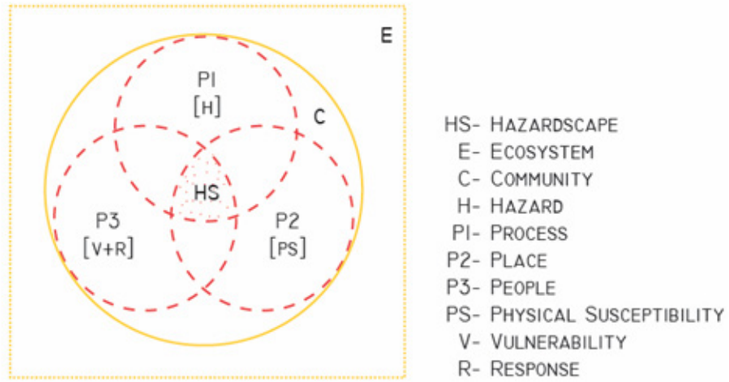
Hazard-scape

Natural hazards like earthquake are an unpredictable and sudden event, for which there is no preparation time and the only possible solution for it is to minimize the effect. Other disasters that also fall in this category are tsunamis, landslides, avalanche, volcano eruption and wildfires for which there is not much a warning or enough preparation time, it can only be mitigated by a certain degree. While other natural disasters like hurricanes, storms which give a day or two in warning and so preparedness for it is possible. This thesis focuses on the nature of the hazard that is certain of occurrence and possible of mitigation but cannot be predicted as is the case for earthquake and tsunami in Japan. And so, geographically due to such positioning of the tectonic plates, majority of the earthquakes occur near the coastal regions, around the pacific ring of fire. These coastal regions due to high level of seismic activity have been prone to recurring earthquakes which have triggers high level of tsunami waves on the coasts.

But nevertheless, civilizations along these coastal regions have continued to survive and adapt to the recurring disaster condition due to their associations with the environment because of its ethnic, demographic and economic conditions. As described by Khan, "the physical environment determines the physical susceptibility of the place, the human environment dominantly influences vulnerability, and together they not only govern the intensity of different hazards but also the response of the community. This relationship defines the core of the concept of "hazard-scape"(Khan, 2012). And so, overtime these characteristics of the hazard-scape impacts the evolution of the community considering all possible adaptations and adjustments opted by the community for the present as well as the future.

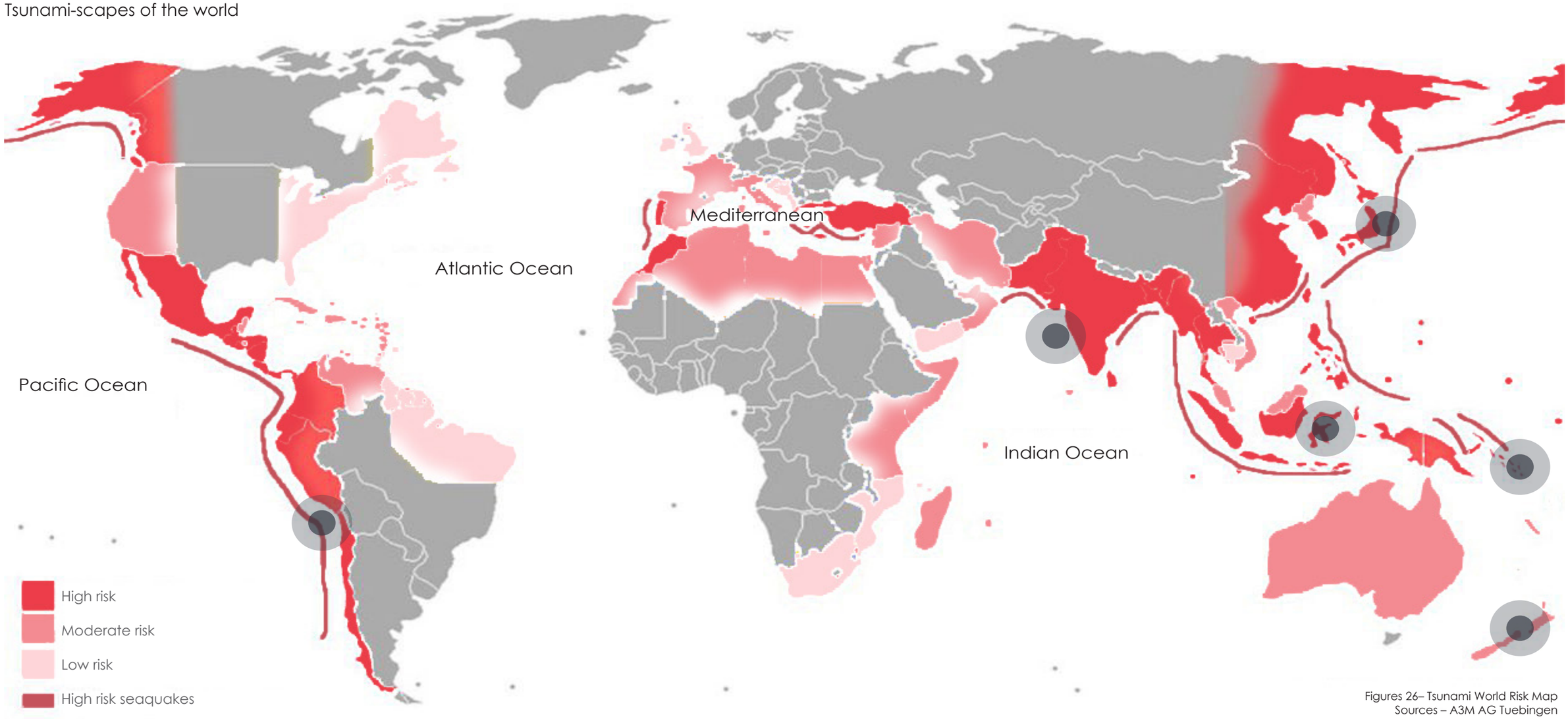
Consequently, when such hazard-scapes interact with the human ecological systems and goals of sustainability i.e. people, place, prosperity and process or project comprising of the community's survival, it brings to the front the interconnected nature of these processes and ingrained character of the different system that get influenced at the smaller scale but are triggered by global processes.

A hazardscape can be effectively called as, a landscape that is susceptible to disaster risk, wherein disaster risk is defined as the consequence of the interaction between a hazard and the characteristics that make people and places vulnerable and exposed.



Figures 25– Venn diagram of the hazard-scapes
Sources – (Khan, 2012), modified by author

Tsunami-scapes of the world



Figures 26– Tsunami World Risk Map
Sources – A3M AG Tuebingen


2010 Chile Tsunami


2004 Indian Ocean Tsunami


2018 Indonesia Tsunami


2007 Solomon Island Tsunami


2016 New Zealand Tsunami


2011 Japan Tsunami

Tsunami Formation and Japan

Earthquakes, volcanic eruptions, underwater explosions, landslides, glacier carvings, meteorite impacts among other disturbances have the potential to create a tsunami. In the earlier page the tsunami-scape of the world are highlighted.

Geographically these tsunami's occurred at many locations across the globe. The diagram on the adjacent pages explains the science behind Tsunami occurrence and the nature of Tsunami corresponding to the Japanese context. According to d.w.com tsunami's the 21st century have resulted in creating a massive impact within the disaster discourse due to excessive loss to humanity , environment and resources as seen from the brief description of the various tsunamis occurred .

Indonesia, 2018
On December 22, 2018, the small Indonesian volcano Anak Krakatau erupted, causing a tsunami in the Sunda Strait between the islands of Sumatra and Java. More than 200 people were killed, according to initial estimates, and more than 800 injured. Anak Krakatau is a small volcanic island that emerged after the devastating 1883 eruption of Indonesia's well-known Krakatoa volcano.

New Zealand, 2016
The 2016 Kaikoura earthquake was the second-worst in the country's post-colonial history. Ruptures occured along multiple fault lines, prompting about 20,000 aftershocks and a 7-meter (22-foot) tsunami. Two people were killed and dozens injured.

Japan, 2011
The 2011 Japanese tsunami was triggered by a massive underwater earthquake. Waves reached up to 40.5 meters (133 feet) high. The disaster killed some 16,000 people and injured thousands more, as well as destroying homes and communities. It also caused the meltdown of the Fukushima Daiichi Nuclear Power Plant, the worst nuclear disaster since Chernobyl.

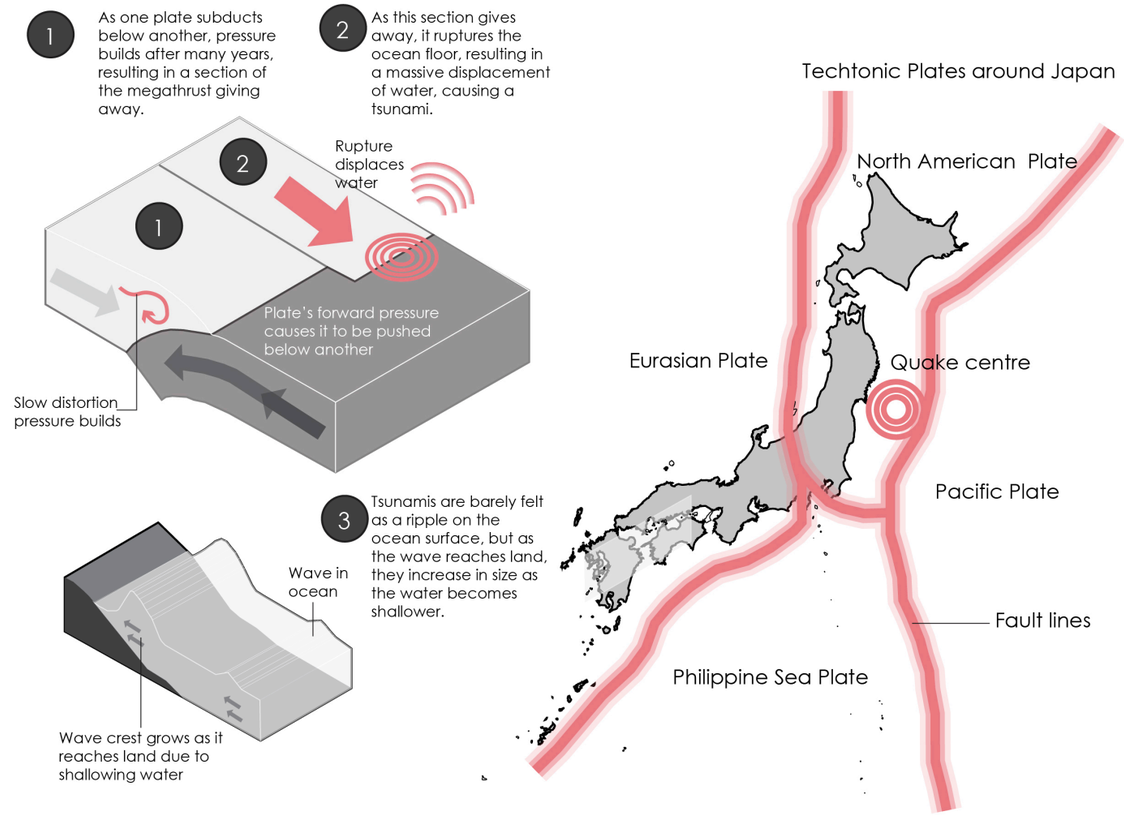
Chile, 2010
Chile is earthquake-prone, and indeed a 1960 earthquake there is still the strongest ever recorded. In February 2010, an 8.8-magnitude tremor prompted tsunami warnings as far away as Japan and Russia. A wave of several tsunamis hit the Chilean coast, added to the damage that left at least 525 people dead.

Solomon Islands, 2007
In April 2007, an earthquake struck the Solomon Islands and Papua New Guinea. At least 52 people were killed when a 12-meter (40-foot) tsunami completely washed away two villages. Around 900 homes were destroyed, as well as a hospital.

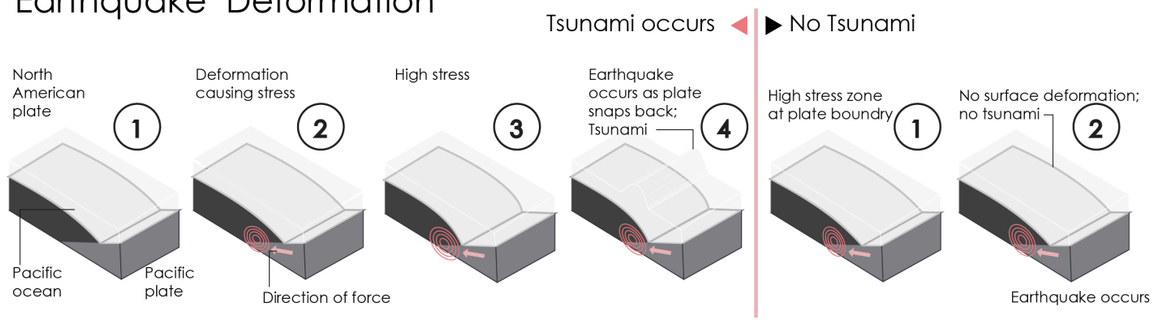
Indian Ocean, 2004
This picture from a beach in Thailand shows just a fraction of the devastation caused by the massive earthquake and 30-meter (120-foot) tsunami that came on December 26, 2004. Fourteen countries were affected, and about 230,000 people lost their lives. The earthquake is the third-largest ever recorded.

Human societies are complex systems. No two earthquake play out identically as geophysical events or as social events because of small variations either in the earthquake or in the society with which it interacts can result in vast differences in its outcomes. While the pattern of behaviour and the nature of disaster reoccurs and reverberate in the society as social effects that are almost unpredictable but provide useful insights.

How Tsunamis Occur



Earthquake Deformation



Figures 27– Tsunami Science and occurrence
Sources – Author's illustration

4.2 Case of Japan

Figures 28– A pagoda (tō), Mount Fuji (Fujisan), and cherry blossoms (sakura), three symbols of Japan all in one picture.
Sources – Reginald Pentinio

The Japanese setting

For generations, Japan has suffered the effects of earthquake generated tsunami's throughout the country. This country's geography has influenced the development of its society and culture in many ways. The location and positioning in world has effects on its inter-cultural influences. Size of the country affects its demography which shapes the social structure that changes its position in the international community. Furthermore, due to its topography that largely dictates where and how the people will live and work, the climate influences the way they live.

Composition, Position, and Relative Size

Japan

Japan is a shimaguni (island country): The Japanese archipelago (island chain) consists of four main islands-- Honshû, Shikoku, Kyûshû and Hokkaidô--and thousands of smaller surrounding ones. It lies off the Pacific coast of the Asian mainland; at the closest point, the main Japanese islands are 120 miles away from the mainland. The total land space of the Japanese islands is about 142,000 square miles.

Topography

The Japanese islands are covered by mountains, most of them heavily forested, and criss-crossed by short, swift rivers. Relatively little of Japan's land mass is suitable for agriculture -- only about 15 percent, the same land that is also most suitable for living. The population and areas of agriculture are therefore concentrated together.

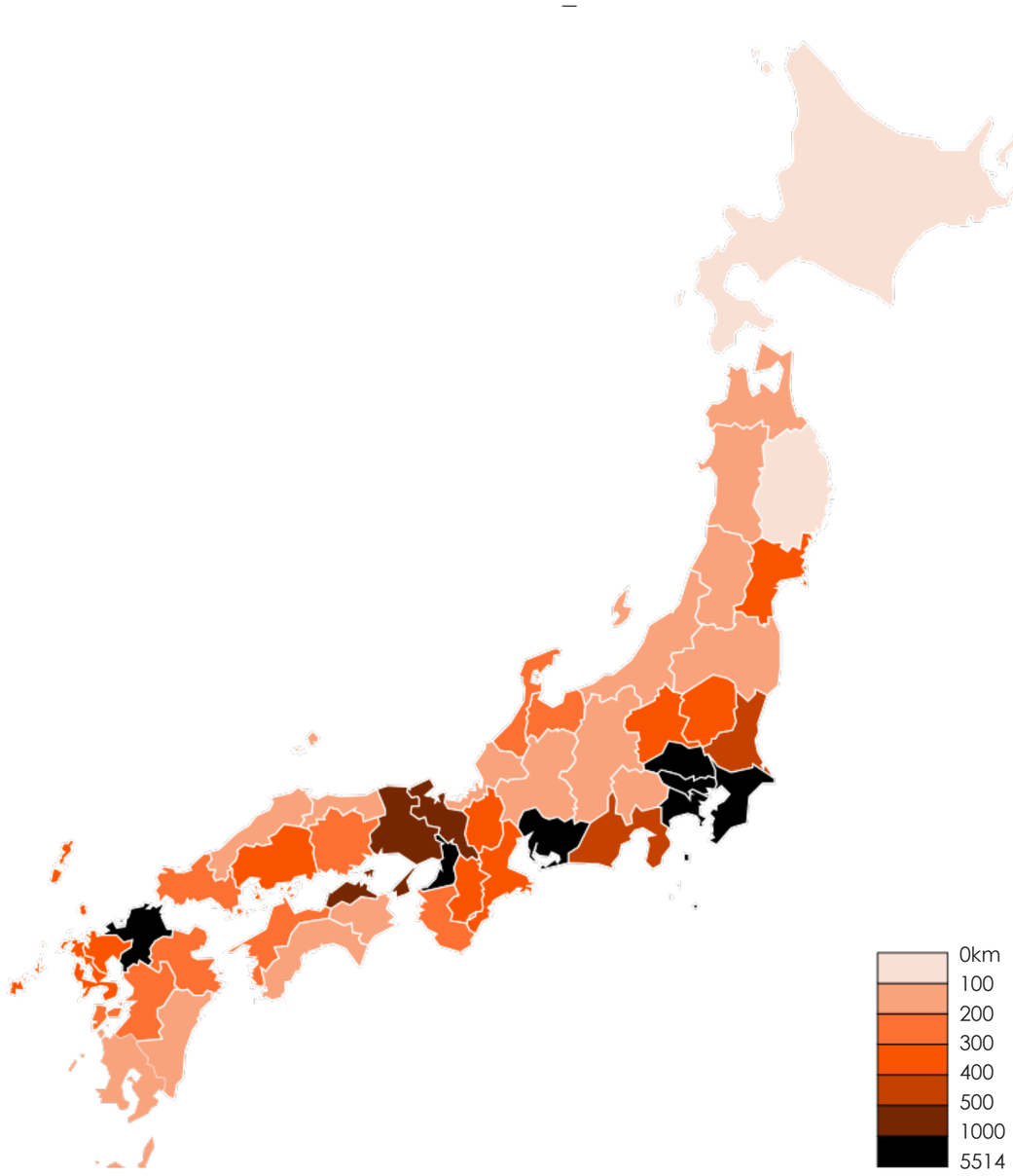
Japan's islands are very beautiful and varied, but they are treacherous too. Earthquakes are common and result from a fault that circles the Pacific Ocean, causing earthquakes on the west coast of North and South America as well. They are frequent in Japan, occurring more often than they are felt. The mountains of Japan contain 10 per-cent of the world's most active volcanoes. Mt. Fuji, Japan's most famous mountain and one of its most beautiful and revered, is a dormant volcano, which last erupted in 1707. Tidal waves occasionally result from undersea earthquakes, and typhoons sometimes hit Japan as they move north from the South Pacific.

Climate

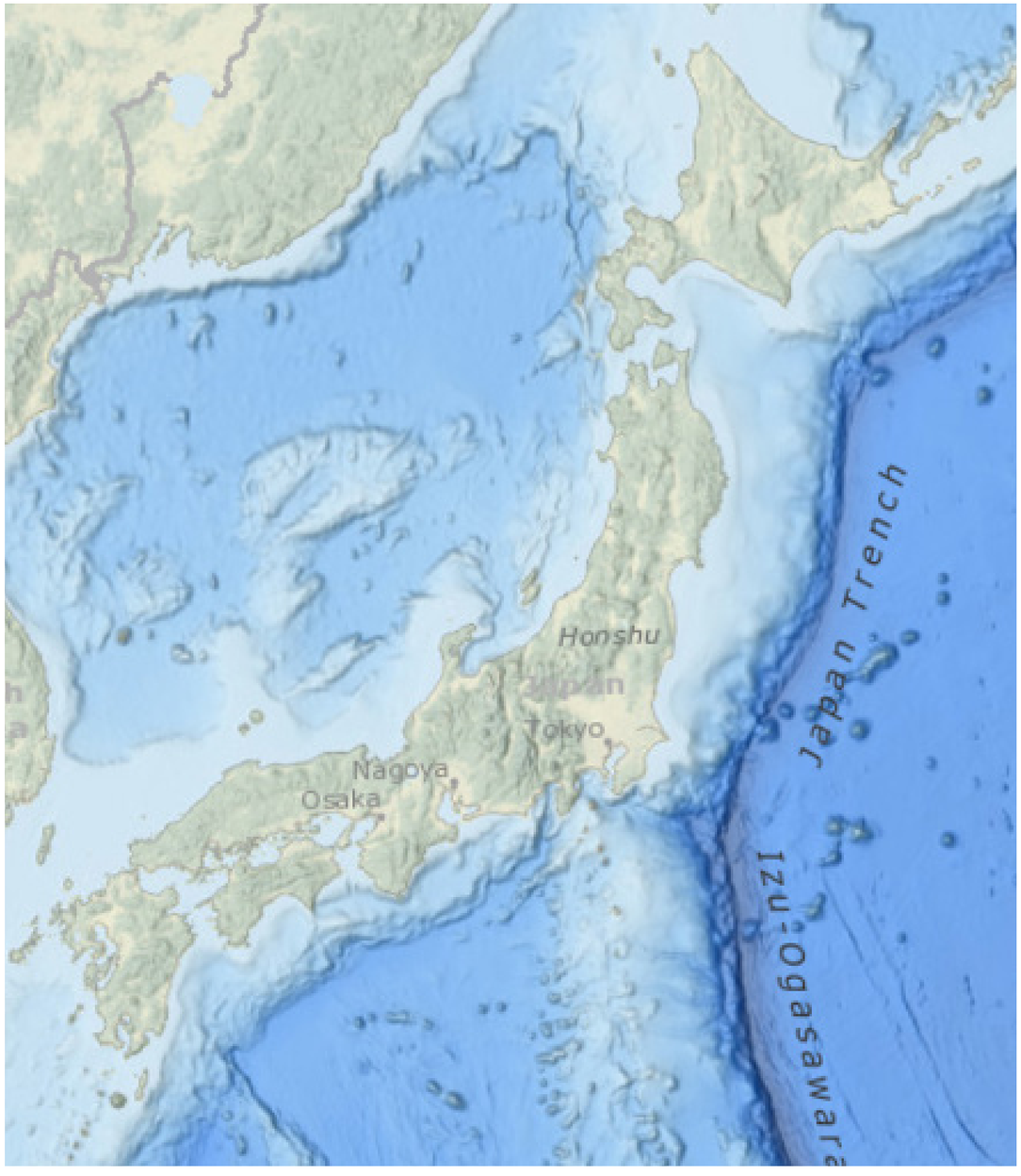
The Japanese islands are for the most part in the temperate zone. they stretch from north to south in latitudes similar to those of the eastern United States, from about 45 degrees in the north to about 20 in the south. Ocean currents, such as the Kuroshio and Tsushima currents from the south, warm the Pacific side of the islands and those near the Korean straits, especially toward the south, while the cold Kurile current, coming southward toward Hokkaidô, brings plentiful nourishment to the coastal waters and improves the fishing, which has a large economic foothold.

There is a marked contrast between winters on the coast facing the Sea of Japan, called Japan's "snow country," where people often have to tunnel under the snow to move from house to house, and the clear, crisp winters on the eastern shore, with little snow at all, leaving dry winters on the more heavily populated side of the main islands. Even on the eastern shores, however, Japan has abundant rainfall, since seasonal winds carry moisture into the country from its surrounding waters. In addition to the four seasons, there is a rainy season that lasts about a month in June, followed by a hot summer which is important for the cultivation of rice, Japan's traditional staple food. The following maps show the location, intensity and orientation of Japan's heritage as an earthquake country.

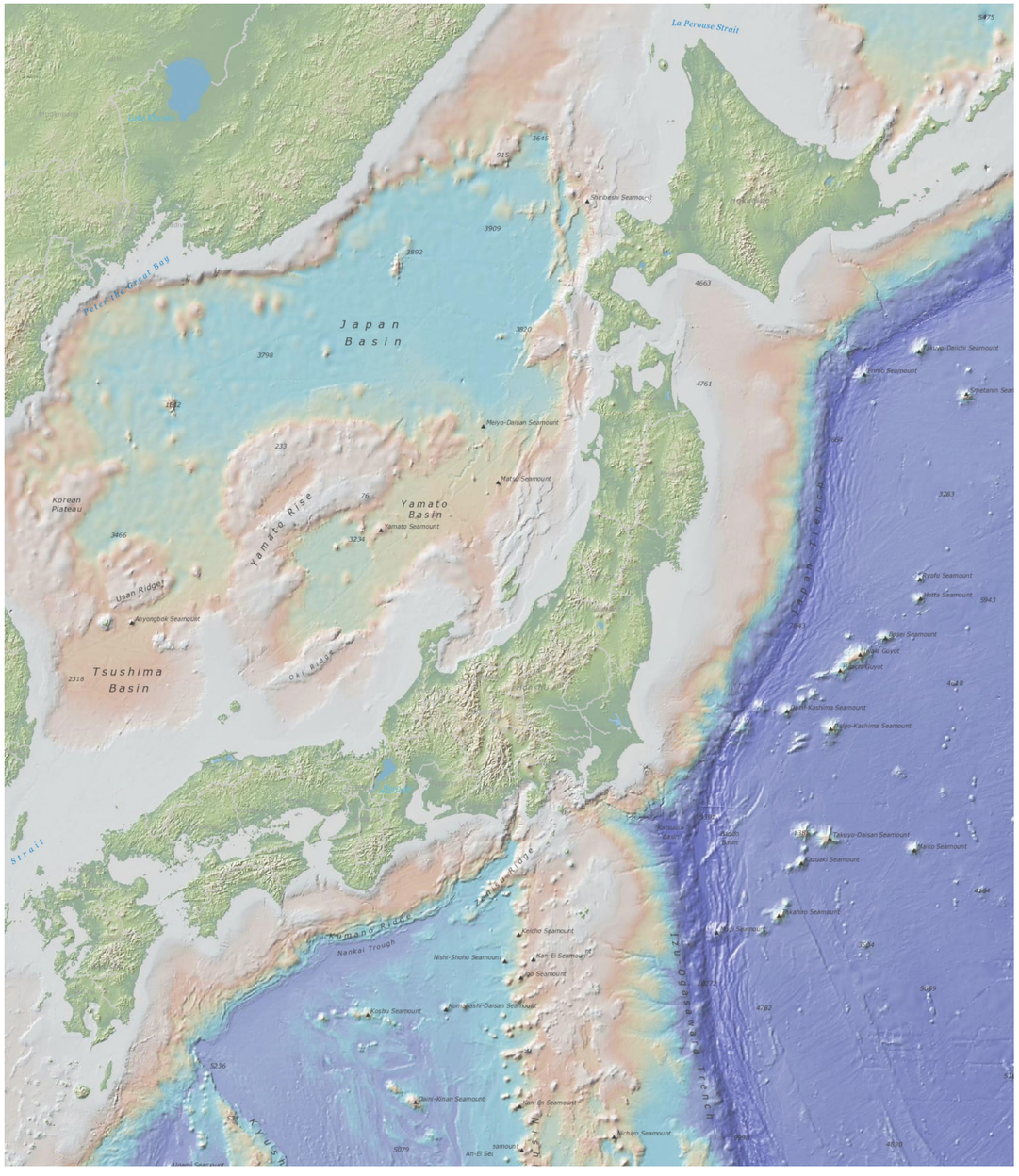
Figures 29– Japan topography
Sources – Google earth



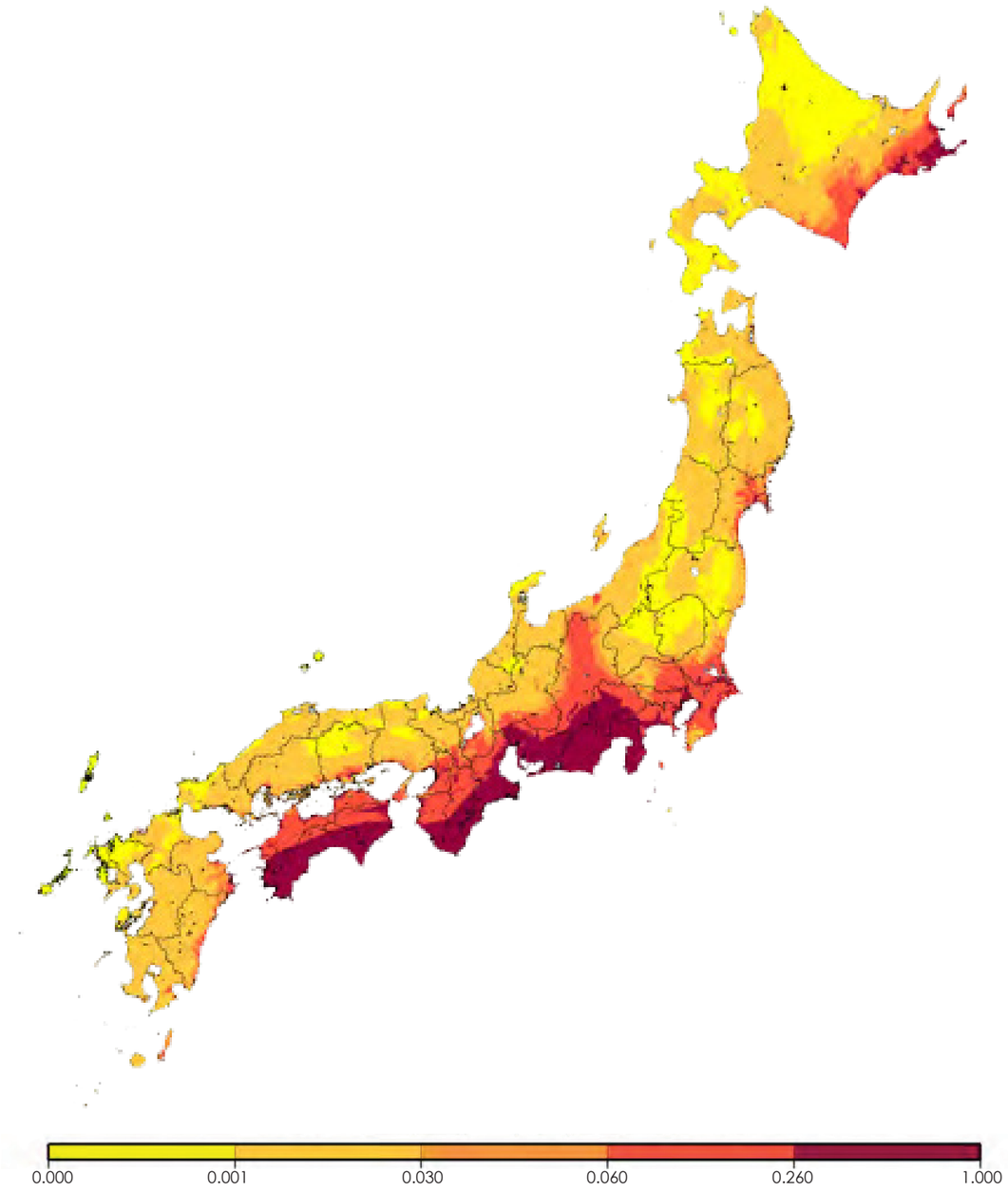
Figures 30– Japan population density, 2009
Sources – Google images



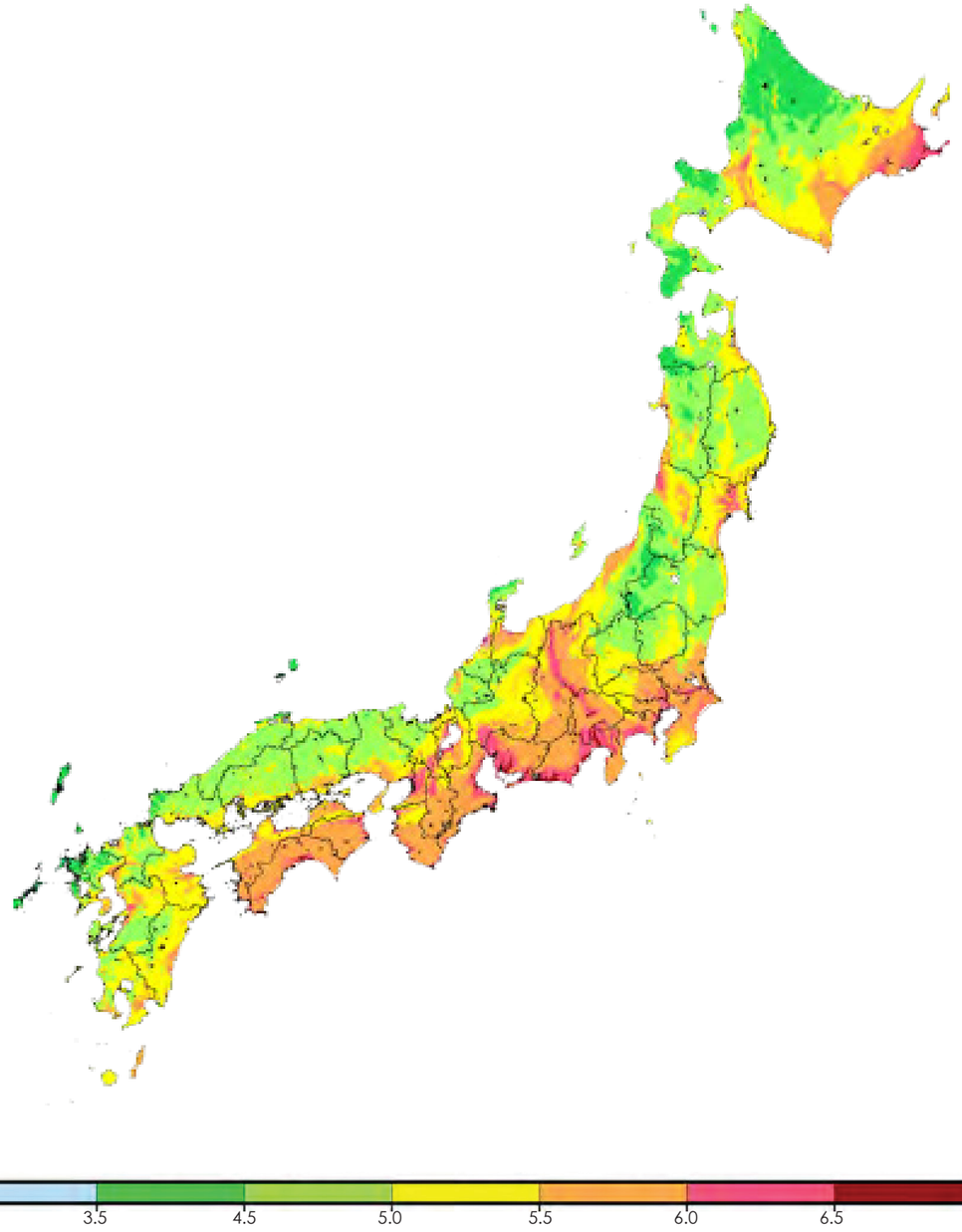
Figures 31– Ocean floor of Japan.
Sources – Bathemetry data viewer, NOAA



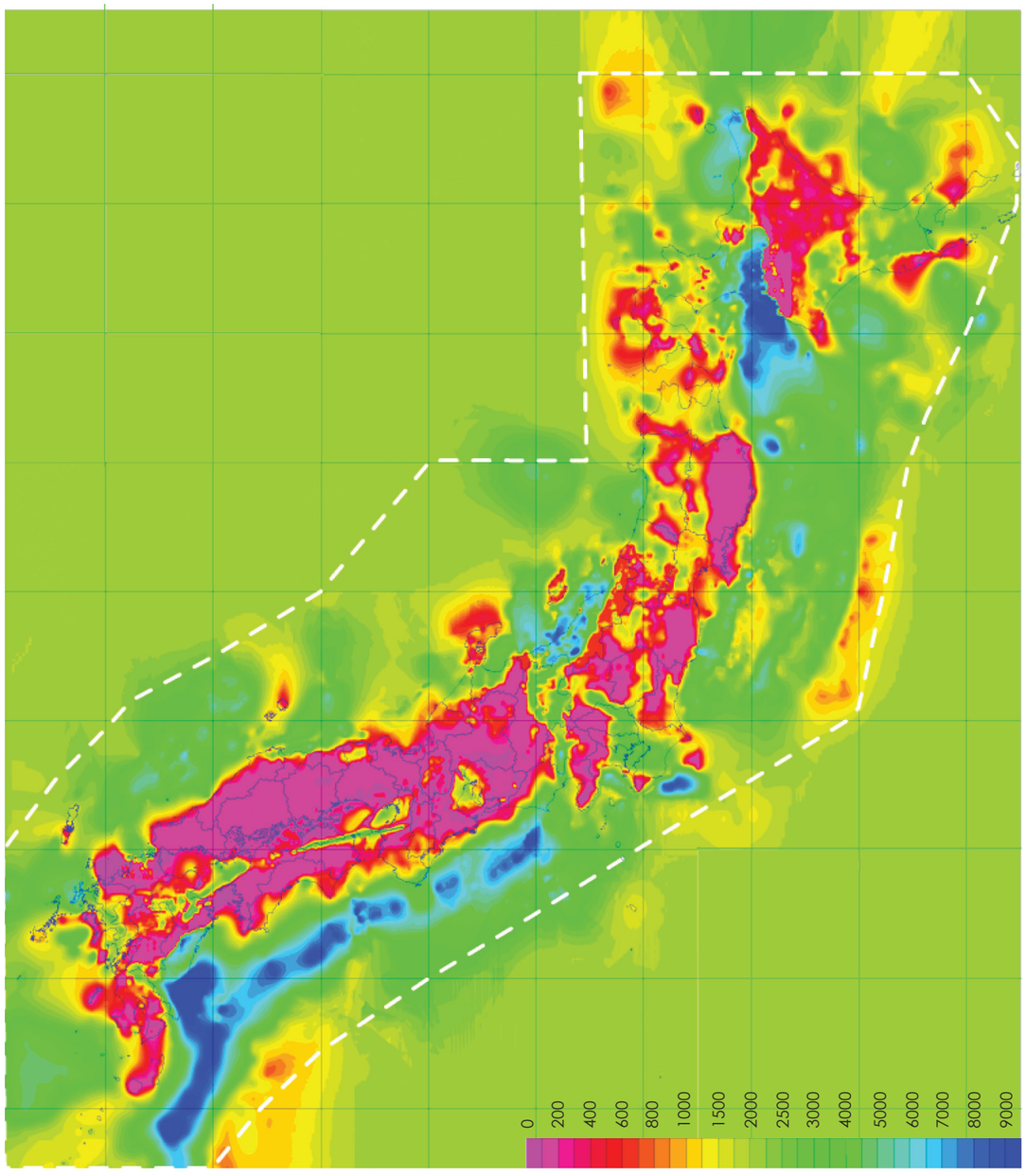
Figures 32– Topography of Japan.
Sources – Bathemetry data viewer, NOAA



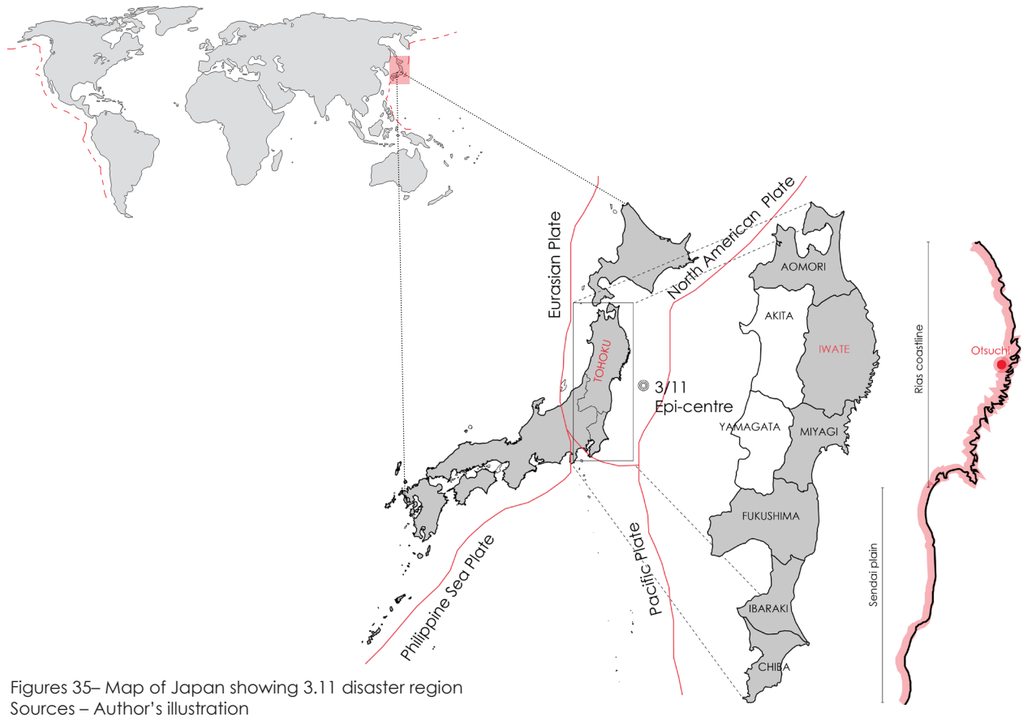
Figures 33– Hazard map of Japan.
Sources – JSHIS



Figures 34– Seismic intensity map of Japan.
Sources – JSHIS



The great eastern Japan earthquake and tsunami, 3.11



Figures 35– Map of Japan showing 3.11 disaster region
Sources – Author's illustration

On march 11, 2011, an earthquake of magnitude 9.0 struck the Pacific Sanriku coast of Japan's Tohoku region. This earthquake generated shaking the ground as far away as western Japan and lasted for several minutes. The followed up tsunami after half an hour that broke over 50 km of the coastline as seen in the image above, toppled the sea walls and other defence systems flooding more than 500 sq km of land and washing away entire town and villages.
The devastation so left 20,000 people dead or missing with most of the deaths caused de to drowning. The tsunami disrupted and dismantled, 130,000 houses and damaged 270,000 more. About 270 railway lines stopped functioning following the disaster and 15 expressways, 69 national highways and 638 prefectural and municipal roads were closed. Around 24,000 hectares of agricultural land was flooded. The areas of Miyagi, Iwate and fukushima prefectures were worst hit by the tsunami. This great east japan earthuake tsunami (henceforth mentioned as GEJE) was the first ever recorded disaster that cascaded from a natural hazard of earthquake and tsunami into a megadisaster on contact with the coastal communities asit was followed by a nuclear power plant accident, a power supply failure and a large scale disruption of supply chains.
Since then learning from this megadisaster has been in the disaster discourse to share Japan's knowledge about disaster risk management (DRM) and post disaster reconstruction which is addressed in the next sections.

The Telegraph

Waiting for disaster is a way of life in Japan

Published by : Leslie Downer
11, March 2011

The Guardian

Japan earthquake: 'The tsunami just swept my parents away'

Published by : Jonathan Watts
13, March 2011

The new york times

Seawalls offered Little Protection Against Tsunami Crushing Waves

Published by : Norimitsu Onishi
13, March 2011

TEMBLOR

Fate and denial: The Fukushima reactor 3, and the L'Aquila earthquake 7
Opinion by : John C. Mutter, Ph.D4
23, March 2011

Figures 36– Japan after 3.11
Sources – google images

4.3 japan and disaster reconstruction

Japanese way of coping with earthquake tsunami's

Figures 37– Reconstruction in Japan after 3.11
Sources – author

What did the disaster teach Japan?

In its tsunami history, Japan had not foreseen an event of this magnitude and complexity;

1. It was a high- impact event with a low probability of occurrence. Because of enormous damage from the tsunami and moderate but widespread geo-technical damage, the GEJE event was the costliest earthquake in world history.

2. It was a highly complex phenomenon, the effects of which cascaded to sensitive facilities. The earthquake and ensuing tsunami provoked fires at damaged oil refineries and a potentially catastrophic nuclear accident. The effects of the accident at the Fukushima Daiichi nuclear power station have compromised Japan's energy supply, imperilled its environment, and threatened public health.

3. Direct damage to major Japanese industries rocketed through supply chains around the world. In the second quarter of 2011, Japan's gross domestic product (GDP) dipped 2.1 percent from the previous year, while industrial production and exports dropped even more sharply— by 7.0 percent and 8.0 percent, respectively. Japan experienced a trade deficit for the first time in 31 years.

To cope to GEJE, Japan's advanced DRM system and years of coping with natural risks and hazards led to;

1. Investments in structural measures (such as reinforced buildings and seawalls), cutting- edge risk assessments, early-warning systems, and hazard mapping— all supported by sophisticated technology for data collection, simulation, information, and communication, and by scenario building to assess risks and to plan responses (such as evacuations) to hazards.

2. A culture of preparedness, where training and evacuation drills are systematically practiced at the local and community levels and in schools and workplaces.

3. Stakeholder involvement, where the national and local government, communities, NGOs, and the private sector all know their role.

4. Effective legislation, regulation, and enforcement— for example, of building codes that have been kept current.

5. The use of sophisticated instrumentation to underpin planning and assessment operations.

These responses though carried out in policy and decision making were not fully effective and lacked efforts in the direction of a complete recovery leading to dissatisfaction and chronic illness within the populations. Therefore being unidirectional and less effective.

1. Spreading a better understanding of the nature and limitations of risk assessment among local authorities and the population at large would improve collective and individual decision making, especially in emergencies.

2. Communication about the unfolding disaster could and should have been more interactive among local communities, governments, and experts.
3. Distributing hazard maps and issuing early warnings were not enough.

4. The magnitude of the tsunami was underestimated, which may have led people to delay their evacuation, if only for a fatal few minutes. If local governments and community members had been more aware of DRM technologies and their margins of error, fewer lives might have been lost.

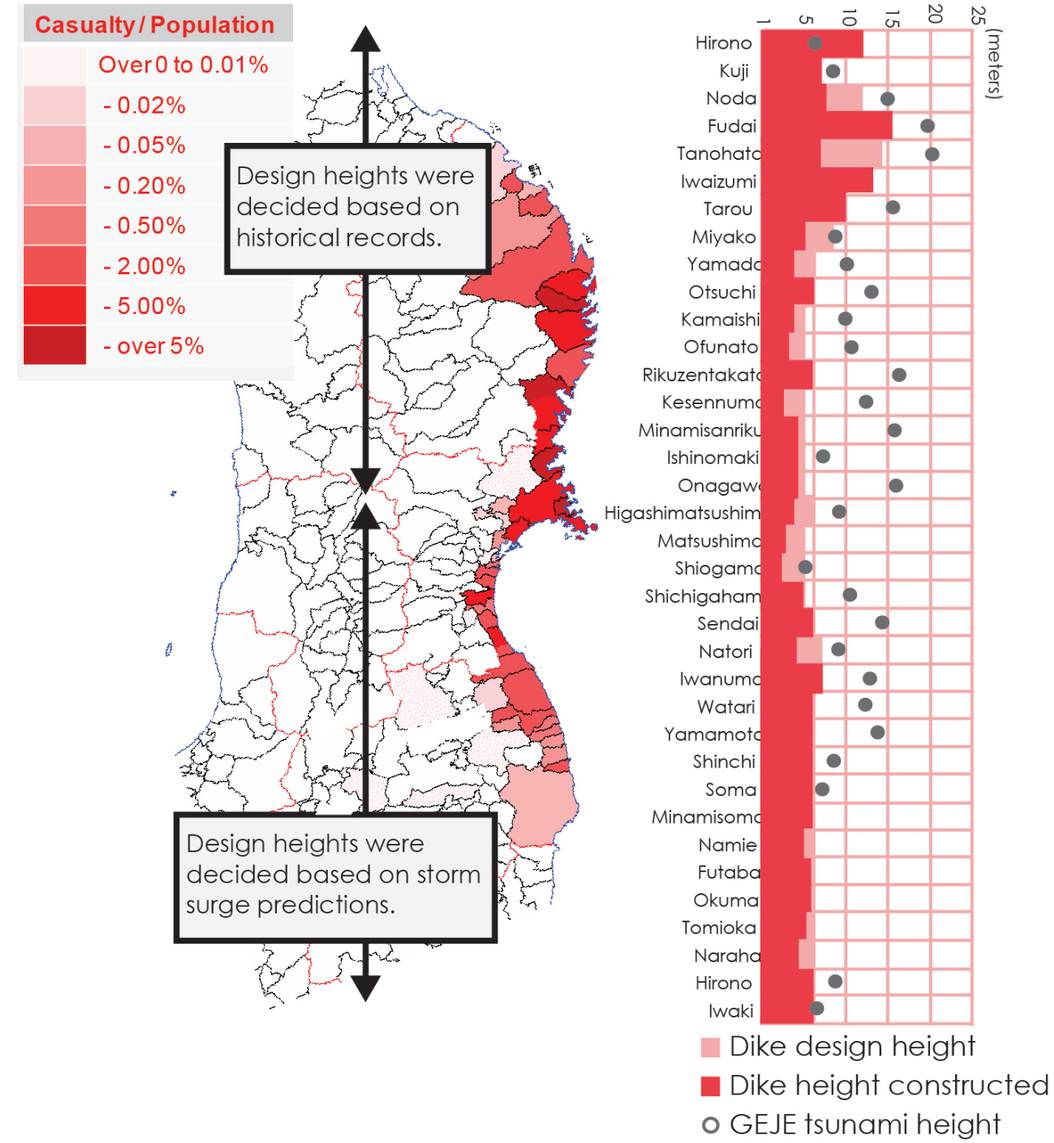
5. Coordination mechanisms on the ground should be agreed on before the fact. During the GEJE, coordination among various groups, such as governments (national, prefectural, and local), civil society organizations (CSOs), and private entities was often poor— or at least not optimal.

6. Local governments, whose facilities in some cases were wiped out by the disaster, had little experience working with other organizations on a large scale, and they received insufficient support from the central government in managing the new forms of cooperation.

7. Vulnerable groups must be not only protected but also engaged. Understanding and meeting the challenges of the elderly, children, and women, both during the emergency and in its aftermath, are priorities for effective post-disaster response.

8. Culturally sound solutions that take account of special needs among segments of the population should have been planned in advance to enhance resilience and facilitate recovery and reconstruction.

This empirical analysis of the existing ground condition during the fieldwork at Otsuchi of the reconstruction activities becomes the foundation that forms the problem field for research. Idea of recovery and reconstruction needs to be holistic and to do so, what parameters are essential, what is resilience and can recovery be non-structural in nature? These questions are contested, researched and analysed in the further sections for the renewal of Otsuchi during the field visit as well as in the project.



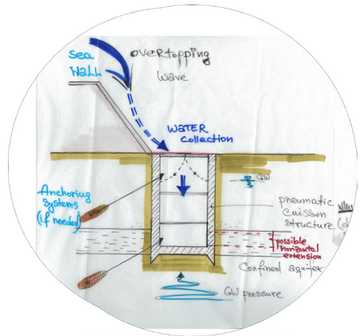
Figures 38– Countermeasures along the tohoku coast, Japan after 3.11
Sources – (Ranghieri & Ishiwatari, 2014)

4.4 field research

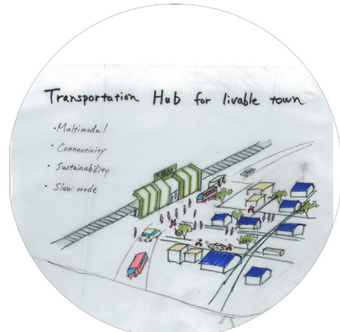
Figures 39– At the community hall Otsuchi in Japan
Sources – author

Figures 40– Proposal for Otsuchi
Sources – author

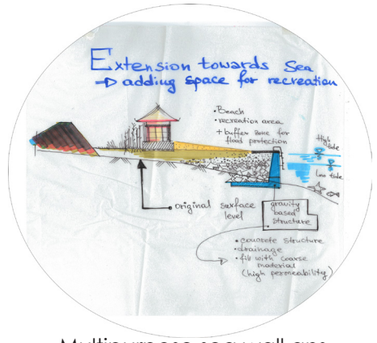
Turning Bridge



Over-topping water collection

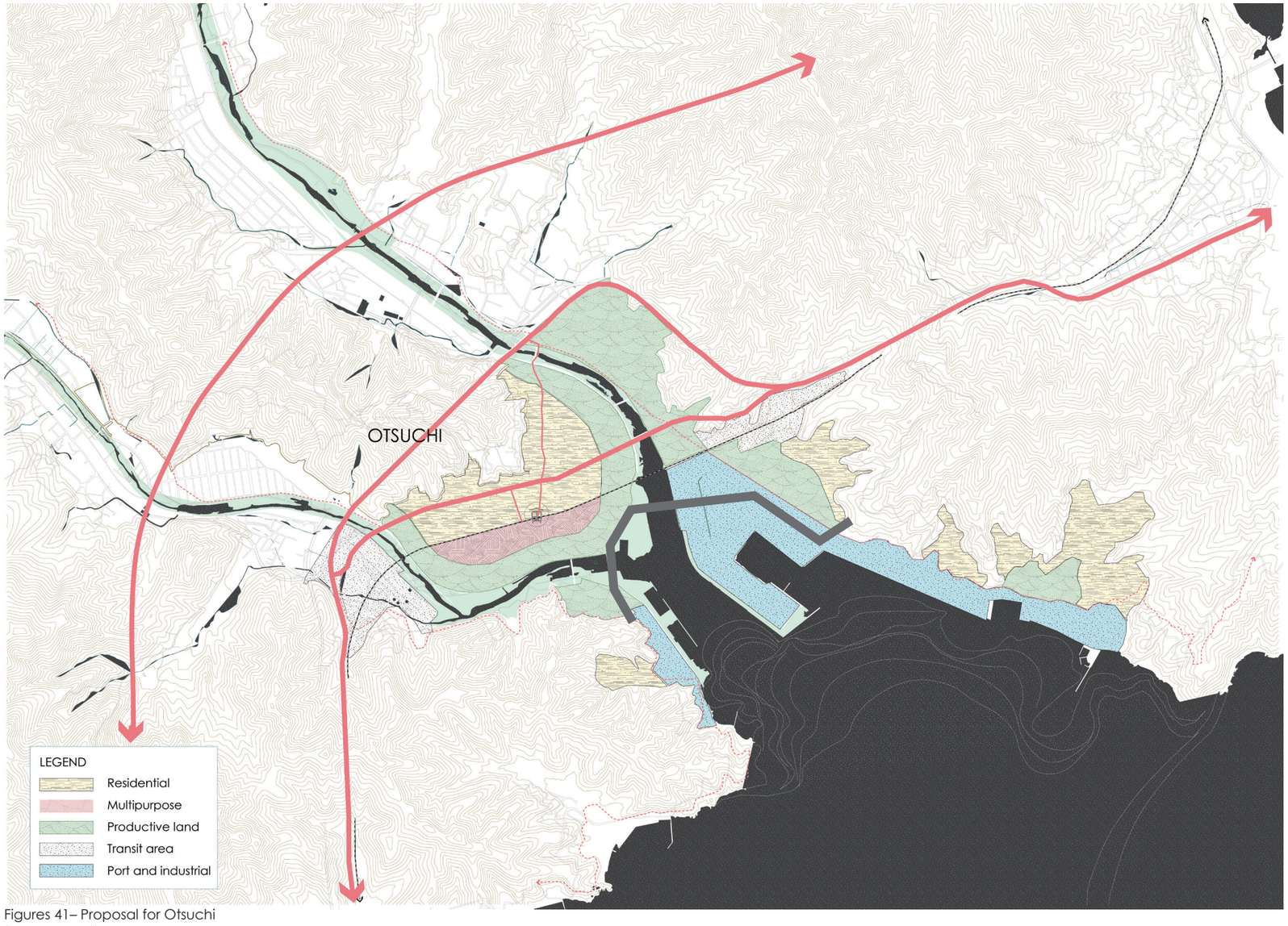


Transport network hub

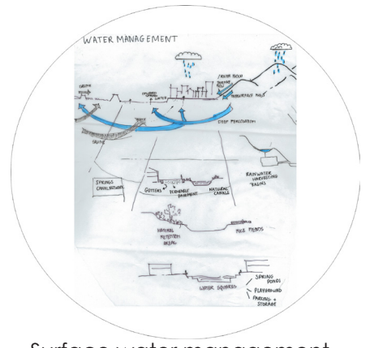


Multipurpose sea wall ans space beyond

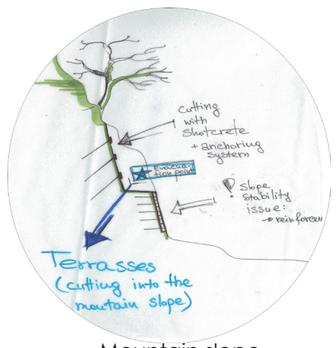
Based on the empirical research carried out during the site visit and the scoping exercises at Delft and Otsuchi, understanding for an integrated reconstruction of Otsuchi was desired within the thesis group. This realisation was based on the charette methodology and balance of 4Ps or the fourth bottom line principles of sustainability- People, Planet, Prosperity and project/ process. The exercised carried out within individual disciplines and later with the multi-disciplines lay the foundation for a design proposal for Otsuchi at site. The adjacent map of Otsuchi is based on this understanding derived from fields of transport, urbanism, landscape, hydro and geological engineering and water management disciplines.



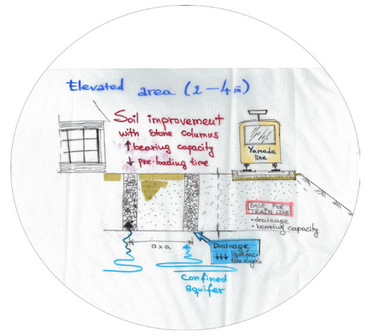
Figures 41– Proposal for Otsuchi
Sources – author



Surface water management



Mountain slope reinforcement



Land raising

Tsunami specific spatial morphology

The desired proposal takes a balanced state between the nature based and engineering reconstruction activities and deals with the revival of the lost heritage of Otsuchi as felt and observed from the reconstruction plans and activities at Otsuchi.

The proposal promotes a layered approach that is multi sectoral and observes understanding of the potential of Otsuchi in recovering effectively from the impact of the disaster.

Based on the layered approach safety, sustainability, coping capacity and making recovery holistic in all aspects is considered. The sections further explains the research based on the theories developed and adapted for this understanding and the take towards dealing with the nature of the problem field.

05 | *theoretical study*

The evidence and precognition

This chapter deals with the theories that correspond to the development of the research methodology. While the research done does not follow the normative approach and derives itself from the requirements of the micro scale and depending on it further of the larger scales. This gives a new perspective about the studies that actually trickle down till the bottom level and get implemented. The study is inventive of the process that is followed in the multidisciplinary studio for Japan. For the readers benefit, order of the chapters in the report follow a normative 'global to local' approach.

Figures 42– Otsuchi,dockyard Iwate prefecture, Japan
Source – author

05 | theoretical study

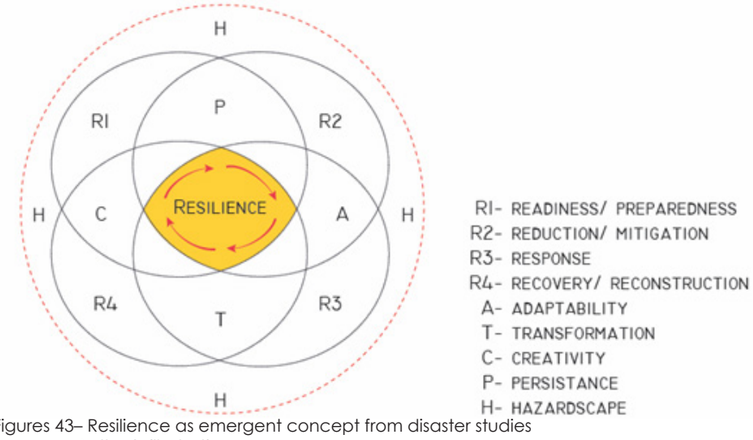
5.0 Sections

5.1 resilience capacities

Research areas

Hazard-scape fosters community response, which either reduces the intensity of the hazard or intensifies the hazard to become a disaster and further a catastrophe depending on the characteristics of the hazard-scape. All disaster management studies until the early 21st century focused onto the 4R's i.e. reduction, readiness, response and recovery (Ministry of Civil Defence & Emergency Management, 2009) while classifying responses for both the natural and technological disasters. But since the early 21st century, as the intensity and frequency of these disasters increased, in addition to sea level rise by climate change resulting in a large scale economic, environmental and societal disruptions. Moreover, the unsustainable consumption of resources and the growing demand of public interest within the society led to the conceptualization of sustainable development and its relation to disaster management and emergency planning (Ministry of Civil Defence & Emergency Management, 2009) shown in figure below.

While demand for a more holistic and integrative planning was observed, resilience as an attribute of sustainability was realized. "It is recognized that while a top-down policy is needed, it is really the local-level bottom-up policy that provides the impetus for the implementation of mitigation strategies and a successful disaster management process"(Pearce, 2003). While this concept of resilience is extensively used by scholars and academicians in the disaster studies, there is still no clear definition for resilience. Universally, it is understood that the resilience is the ability of a community to adapt and cope to the disaster. But accepting "Sudmeier's international discourse and that resilience has taken a firm hold in development, humanitarian, disaster risk reduction and climate change adaptations. A pragmatic approach for resilience should be realized which is: the ability of a system, organization, community, household or individual to change (cope, adapt, persist, transform) in a positive manner, when faced with adversity"(Sudmeier-Rieux, 2014). While resilience developed as an essential criterion for recovery and reconstruction planning, for its operationalization the desired

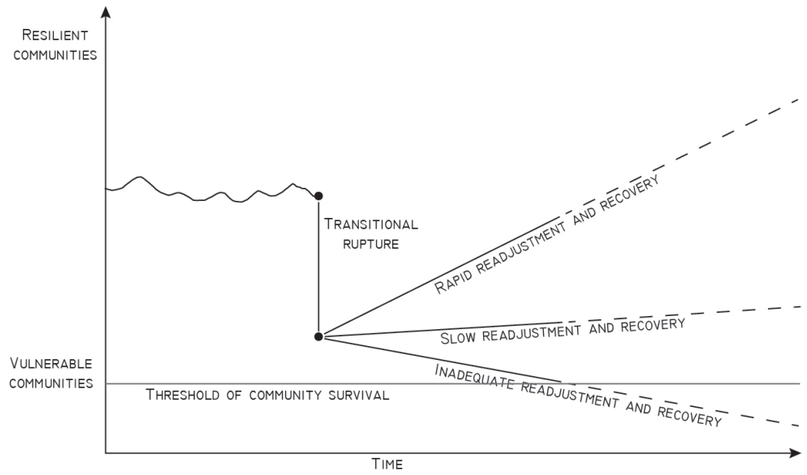


Figures 43– Resilience as emergent concept from disaster studies
Sources – Author's illustration

scales change from global to local and mostly at the level of community. As, seen in practice for such complex problems require adaptivity, persistence, transformation and creativity because the solutions are mostly context based, local and innovative while the methods and tools used to assess varies.

Approach to resilience in practice requires understanding of the coping and adaptive capacities of the communities in the hazard-scape. "Most people are inherently resilient or have the capacity to be resilient" (Abramson et al., 2014). These capacities can also change from traditional to contemporary communities of the hazard-scape. "Several factors influence the capacity of resilience of societies when facing brutal and recurring natural hazards. It is evident that the nature of the hazard, the intrinsic social condition of the particular group exposed to a given hazard, the geographic setting and the rehabilitation policy set up by the authorities greatly vary in time and space, from one disaster to another"(Gaillard, 2007). And so, communities that are constantly exposed to the nature of such hazards have inherent resilience capacities.

This resilient capacity enables the community to overcome the disruption caused by the natural hazard either through maintaining their pre-disaster fabric or by accepting marginal or greater change in order to survive. While the intensity and the periodicity of these events has increased in the last decade and so has the structure of the cities in terms of demographics which has resulted in a lot of diversity and sometimes redundancy in the resilience capacities of these traditional hazard-scapes. "Individuals and organizations build their everyday activities around complex modern systems over which they have little control, such as electricity, computerized systems, and communication networks supported by distant satellites. Each of these modern conveniences allows communities to function more efficiently. The ability of these systems to bounce back after a disaster will have a direct impact on the ability of a community to respond and recover"(Longstaff et al., 2010). And so, the response and reconstruction in these affected areas needs to be dealt, by knowing the history, their hazard-scape, inherent resilience capacities and resource availability and complex governance models which will help in assessing how much diverse are the coping and adaptive capacities of the communities.



Figures 44– Resilience capacities and strategies post disaster
Sources – (Wilson, 2012)

5.2 Community resilience

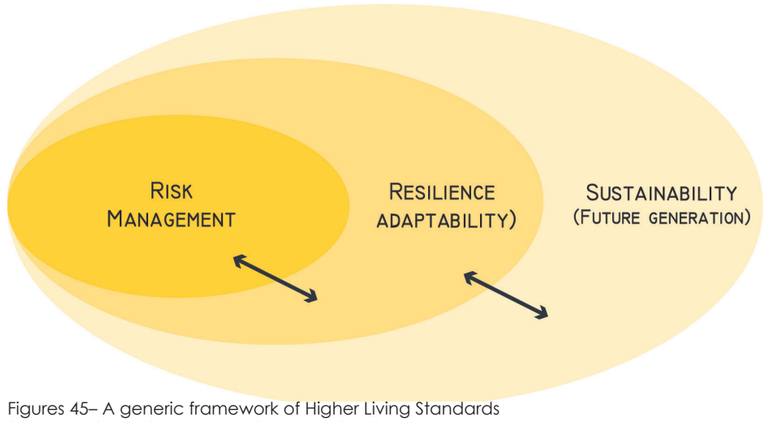
Community resilience- A scale for intervention

For the purpose of this paper and to understand the coping and adaptive capacities, a 'community' is, "defined in three ways: those who live in a similar region; those who have similar characteristics and relate to each other as a community; and those who come together in response to an issue"(Maguire & Cartwright, 2008) which also constitutes the P3 attribute of the hazard-scape, refer fig-23.

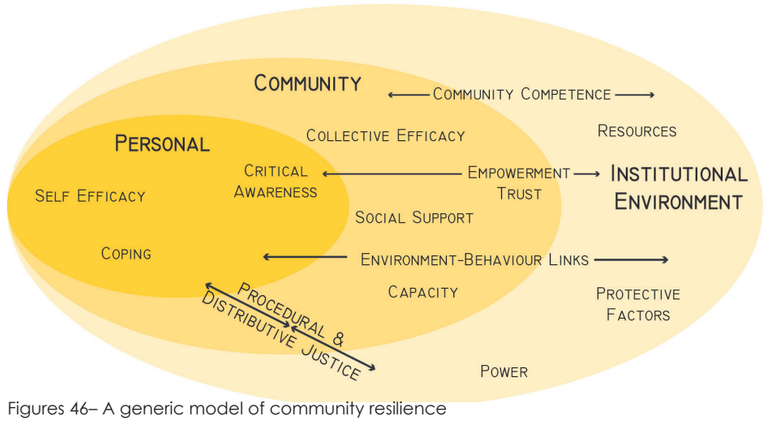
Such capacity is catered by, (1) reducing its vulnerability elements, (2) mobilizing socio-economic resources, and (3) utilizing the existing biophysical infrastructures" (Shim & Kim, 2015). To be precise, cooperative capacity, social skills, and knowledge should be fostered within the process of resilience building. In this case a centralized planning structure for development or any intervention is not useful.
Nevertheless, a generic frame work for identifying the factors that can influence the resilience building strategies in the communities will be very beneficial as shown in the fig-24 which shows selected attributes at each level (personal, community and institutional) and relationships between them adapted after Paton (2006). It provides an outline for local initiatives to develop their own organizational and developmental model to deal with disasters.

But, before dealing and understanding of these capacities it is very important to understand resilience of what-to-what? For purpose of this paper, it can be aptly said resilience to natural disasters and their repercussions. Our societies are made of complex bio-physical, socio-economic and socio-cultural systems, which cannot be dealt with analysis of resilience to a single kind of event as some might be resilient, but others might not be. Natural disruptions cannot be considered to be uncertain in its entirety, they can also be natural and triggered due to global processes. In the capacity of the paper, the scope has been limited to understand and evaluate the parameters influencing disruptions due to natural hazard such as earthquake and for a context of Japan.

From above generic resilience model it is well understood that, community resilience forms an operational scale for resilience, many conceptual and empirical studies have shown that, "resilience at community level can enhance both the individual/ household and wider population level outcomes" as mentioned by (Berkes (1998), Cote and Nightingale (2010), Nelson (2007), Ross and Berkes (2014) and cited in Kruse et al., 2017). But many times, in practice, "community is looked at as sub-systems represented by groups of stakeholders such as town management, town residents, local businesses, schools, etc. However, this type of analysis can build artificial barriers between stakeholders by emphasizing differences over common concerns" as mentioned by (Ramsay (1996) and as cited in Callaghan & Colton, 2008). The concept can be refined furthermore specifically to communities in regard to the spatial context where demographic, historical, socio-economic, physical, and environmental capitals are understood attributes of community resilience, addressed through the lens of "critical capital'. Basically, community resilience is a multi-dimensional concept that is applied in many fields and different situations having multiple attributes. And, by looking through the social lens it allows for an integrated short-term and long-term recognition of the attributes and also propagates collective action towards community resilience, and therefore the institutions can anticipate and adjust to change in a more holistic way.



Figures 45– A generic framework of Higher Living Standards
Sources – Central government New Zealand Treasury



Figures 46– A generic model of community resilience
Sources – (adapted after Paton, 2006) and cited in (Daly Becker, J., Parkes, B., Johnston, D., and Paton, D., 2009)

5.3 theoretical framework

Conceptual model of community resilience as theoretical framework

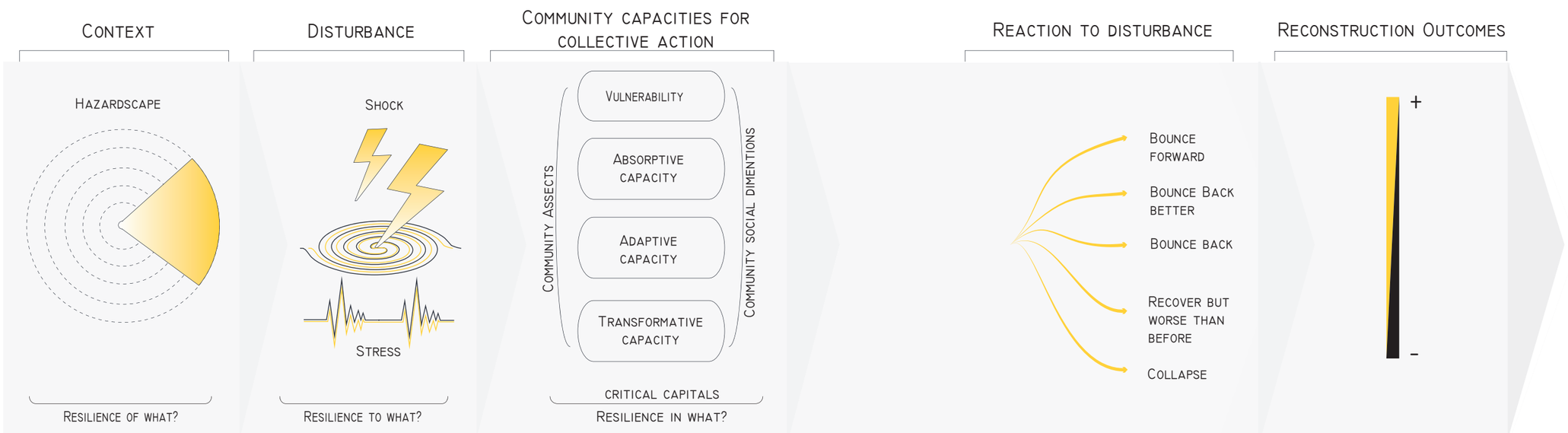
The generic model of the community resilience can be universally accepted model due to its scope for replicability in any hazard-scape and for any period of the event and its process. The nature of the model is such that it can be used by all kinds of governing bodies and can be used as a guiding principle for formation of a framework that is specific to that context. Explained below is one such conceptual model for community resilience that is extracted from the generic model for the earthquake hazard-scape. It identifies the context of the hazard-scape, its intensity of disruptions over different community functions and the kinds of reactions that are possible by the community to deal with them. Further it also categorizes these reactions into positive and negative criteria depending on the responses of the community. The framework analyses the attributes of the resilience is a way that helps in answering the critical questions about resilience, like how, to whom and in what ways it can be addressed. Since it's just a conceptual framework, there is possibility for change and reformation based on the context and the community requirements. It takes into factor different critical capitals as is put in the framework which addresses different areas of the disaster that needs to be catered by the resilience strategies.

Graphically explained below in fig-25, DIFD's conceptual frame work for community resilience and the generic model of resilience by Paton, (2006) were the main understanding models that influenced the structure of the theoretical framework. The framework identifies the context of the hazard-scape, its intensity of disruptions over different community functions and the kinds of reactions that are possible by the community to deal with them. Further it also categorizes these reactions into positive and negative criterion's depending on the responses of the community.

The framework analyses the attributes of the resilience that, it helps in answering the critical questions about resilience, like how, to whom and in what ways it can be addressed. Since its just a generic framework, there is possibility for change and reformation based on the context and the community requirements. It takes into factor different critical capitals as seen in the framework and addresses different project scopes that needs to be catered by the resilience strategies. The theoretical framework not just gives insight into the different study domains but is also a progressive analysis of the ways in which the nature of disaster has been addressed till now. It gives a quantum depth to the analysis carried out and the direction the future studies should take to bridge the links and fill any gaps due to limitations of the earlier studies.

These community capitals such as natural, human, financial, physical, social and political are critical assets for the community that are called as the "critical capital". This critical capital is the most important aspect of the resilience framework as it not only factors the different capacities for resilience to be possible but also helps in deciding if the community can be resilient on its own or not and weather in cases of being resilient for a particular hazard-scape, is it robust enough to deal with a hazard of a different kind.

As it is understood that, the community resilience undertakes an integrated approach which helps in building community capital that "can enhance the capacity of communities for collective action in the areas of disaster



Figures 47– Conceptual model of community resilience as theoretical framework
Sources – Adapted from Frankenberger et al. (2012), DFID (2011a), TANGO (2008), and CARE (2002) and authors illustration

risk reduction, conflict mitigation, social protection, natural resource management, and the management of public goods and services"(Mueller, Spangler, & Alexander, 2013). These capacities are influenced by both endogenous and exogenous factors and therefore adoption of the framework should be dealt with the awareness of different system connections that can enable (or disable) the proper functioning of the community.

As said before the critical capitals are the essential aspect of the resilience framework as they take into factor the different community assets, capacities and the social dimensions that collectively influences community resilience. This necessitates the understanding of the different innovative measurement indicators that can further help in the collective actions to enhance community resilience. The next section will put light on these different components that are a part of the community collective actions of the conceptual framework. Further sections will contain comparative of the different measurement tools that are used to asses community resilience and how these indicators can help in formation of a strategy for planning for collective action which will enhance the community's capacity for resilience.

For coherent and complete understanding of community resilience, "it is critical to remember that each of its individual components entails dynamic attributes, as well as transactional linkages and relationships that must complement and work in conjunction with one another to achieve a resilient community"(Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

Community based approach as defined by (Longstaff et.al., 2010) describes attributes of resilience as resource robustness (performance, redundancy, diversity) and adaptive capacities(institutional memory, innovative learning, connectedness). This is further elaborated in work of Bene et. al (2012) as mentioned by (Mueller, Spangler, & Alexander, 2013) that undertakes all forms of resilience capacities- absorptive, adaptive and transformative, these operate at multiple levels but mutually enhance the condition of coping capacities in the hazardscape.

Critical capitals

Community assets considered under critical capital i.e. social, human, economic, natural, physical, and political capital are the tangible and intangible resources that help communities to meet their basic requirements. "Greater diversity of these assets reduces vulnerability to shocks, and higher levels of absorptive and adaptive capacity result from the ability of communities to access and utilize these assets in a way that allows them to respond to changing and unforeseen circumstances" (Frankenberger et al., 2007).

Therefore, the most vulnerable communities are those that are deficit of one of such resources or assets and are therefore unlikely to be able to absorb the stresses/ shocks and engage in community enhancement activity. It is very essential to measure the level of the community assets as it helps to assess and identify such deficits pre-event. While measuring of these critical capitals, it is also important to answer some key questions;

a) What is the current state, quality and extent of each of the capital?
b) Which populations have access to these capitals?
c) Which organizations, institutions and government bodies control access to these capitals?
d) How does the current state of the capital provide for the community's resilience and safety?

It is quite well understood that these critical capitals are basis for the sustenance of the community. As "without healthy environmental capital, humans will be unable to sustain themselves for very long; without humans and human capital, there is no society and hence no culture. Without social structures and networks it is impossible to foster culture; public structural capital builds up around the needs of societies and is influenced by cultural norms; finally, commercial capital depends upon public infrastructure, culture, and society in order to do its business"(Callaghan & Colton, 2008). It is very necessary to understand these capitals in more detail in terms of how they interact with each other and in itself for the benefit of the community which is explained in the next section of the report.

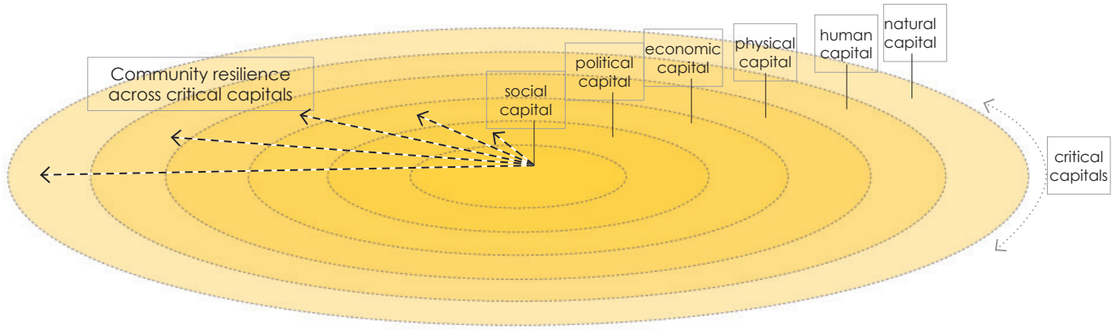
Critical capital is defined as community assets i.e. social, human, financial, natural, physical, and political capital are the tangible and intangible resources that help communities to meet their basic requirements in the aftermath of a disaster. "Greater diversity of these assets reduces vulnerability to shocks, and higher levels of absorptive and adaptive capacity result from the ability of communities to access and utilize these assets in a way that allows them to respond to changing and unforeseen circumstances" (Frankenberger et al., 2007).

Influencing these capitals effectively and efficiently guides stability and recovery in a sustainable manner(King et al., 2013), therefore the identified indicators- called as 'critical capitals' undertake human, physical, political, economic, social and natural capitals. These capitals offer dimensions that can continually improve the ability of response to meet the real needs of the affected communities and are described as;

Economic capital – It denotes the financial resources, industrial setups, market economies of the community to achieve their civic and social standards. It addresses community's accessibility, reliability and inclusiveness of formal saving and credit systems that can cope, absorb and speed up recovery processes. Economic capital at community level is identified within the patterns and trends that contribute in generation of income at both macro as well as micro levels. Investments in this sector throughout the disaster cycle provides stability for sustenance for the community.

Physical capital – This form the basic spatial structure that undertakes the built fabric, infrastructure accessibility, forms of service and utilities that enable sustenance of the communities by providing protection, security, safety and enhances wellbeing. It includes transportation, communication, power, shelter, water systems, health facilities, markets and productive assets. While many of the physical capital is beyond the control of the individual and households, redundancies that allow alternative systems to function can be incorporated. Within the hazardscape, these can be critical infrastructures and public goods that need immediate recovery and functioning to bring functional normalcy back in the community.

Social capital – Community resilience is steered greatly by the capacity dependence of the social capital through the collective actions, collaborations, self-organisation and its association with the governance as well as the informal sectors outside the community.



Figures 48– Community assets to measure resilience called as critical capitals
Sources – Authors illustration

It undertakes individual or organization empowered by social connections that have strong perceptions of local embeddedness, self-regulating moral codes and norms, reciprocity and trust. Research by (Aldrich & Meyer, 2015) highlight the importance of this capital in disaster survival and recovery that has been the main goal of the research undertaken towards holistic recovery.

Political capital – It undertakes the responsibility of decision making that is based on power relationships at the different governance levels. Political capital influences nature of community participation through the process of policy formulation and implementation. Decision making bodies include both formal as well as traditional authorities that involve mayor, municipality officials, community leader, religious heads, and other sector officials that have influence over the community's participations. This capital undertakes the responsibility and accountability for recovery during the pre and post disaster stages and that can change the course of recovery by linking with the outside.

Human capital – It forms the community's skills, knowledge, health and abilities that individuals, households, institutions and municipalities use to cope, adapt and transform to changing social, economic and environmental conditions. This capital is key to innovation and determining the resilience shift that can effectively and efficiently change the resilience capacity building for collective responses in the wake of disaster. The demographic, socio-economic and quality of social services contribute in gaining insight into the level of human capital. Influence from this capital changes the dynamics of interdependence between capitals.

Natural capital – It is the availability of natural resources within the community's environment that forms the essential stock through which the supplies for livelihood are derived. These are the biodiversity elements and the ecosystems services that provide condition for a community to localize and settle. Possessing natural resources and maintaining a sustainable livelihood is essential to community resilience.

Social capital as driver for community resilience

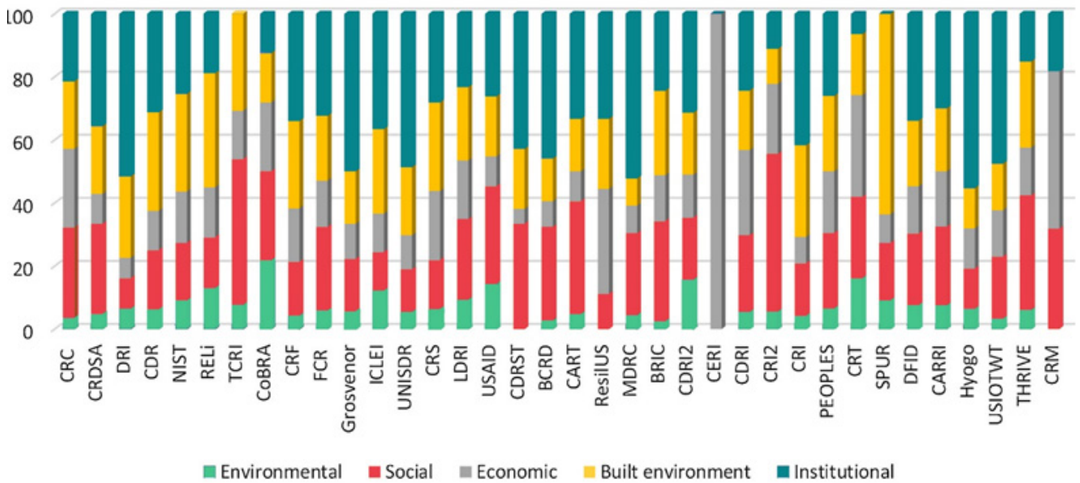
Social capital can be described as the quantity and quality of social resources (e.g., networks, membership in groups, social relations, and access to wider institutions in society) upon which people draw in pursuit of livelihoods (Frankenberger & Garrett, 1998). "Investing in social capital fosters community resilience that transcends natural hazards and positively affects collective governance and community health" (Aldrich, Meyer, & Page-Tan, 2018). Aldrich (2012) cited in (Gotham, 2018) explains "The resilience of a community is dependent on social bonds and collective action based on networks of relationships, reciprocity, trust, and community norms.

Social capital can contribute to community resilience by providing an informal buffer to those affected by disaster, overcoming challenges to adaptation through coordinated local processes, and enabling transformative change by strengthening the community's collective voice". (Aldrich et al., 2018) provides a useful analytical approach for assessing the influence of social capital on community resilience by identifying three distinct but interrelated forms of social capital: bonding social capital, bridging social capital, and linking social capital. "To ensure community resilience to shocks and stresses over the long term, each of the different types of social capital must be promoted and sustained together, and communities can take actions that enhance their absorptive, adaptive, and transformative capacities simultaneously" (Mueller et al., 2013).

It is also necessary to find which intra-inter community relations foster collective action so that in case of inherent inequitable relations within the community like power and wealth can be managed efficiently. This can help in planning and strategizing for the community led early response systems.

Tool	Scale	Formative, Summative	Format	Data source	Quan or qual	Baseline	Thresholds	Principles of good resilience	Benchmarking	Recovery speed	Equal weighting	Ongoing communi-cation	Strengths/ weaknesses	Changes over time	Illustration techniques
CRC	Community	S	Index	NA	Both	×√	×	×	√	×	√	×	√	×	√
CRDSA	Community	S	Index	NA	Both	√	×	×√	×√	×	×√	×	×	×√	√
DRI	City	S	Index	Prim	Qualitative	×√	×	√	√	×	√	×	×√	√	√
CDR	City (local municipalities)	S	Index	Seco	Quantitative	√	×	×	√	×	√	×	√	×	√
NIST	Community	F	Toolkit	Both	Both	√	√	√	×	√	√	×	√	√	×
RELI	Community, building, infrastructure	S	Index	NA	Both	√	√	√	×	×	√	×	√	×	×
TCRI	Community	S	Model	Seco	Quantitative	√	×√	×√	√	×	×√	×√	√	×√	√
CoBRA	Community, household	F	Toolkit	Both	Both	√	√	√	×	×	√	√	√	√	√
CRF	City	F	Toolkit	NA	Qualitative	√	×√	×	×	√	√	×	√	×√	×
FCR	Community	F	Toolkit	NA	Quantitative	×	×	×√	×	×	×√	×	√	×√	×√
Grosvenor	City	S	Index	Seco	Qualitative	×√	×	×√	√	×	×	×√	×√	×	√
ICLEI	City	F	Toolkit	Both	Qualitative	√	×	√	×	×	×√	√	√	×	√
UNISDR	City	S	Scorecard	Both	Both	×	×	√	×	×	×	√	×√	×	×√
CRS	Neighborhood	F	Toolkit	Both	Qualitative	×	×	×√	×	×	×	√	√	×	√
LDRI	Community	F	Index	NA	Both	×√	×	×	×	×	×√	×	×	×	×
USAID	Community	S	Toolkit	Both	Both	√	×	×√	×	×√	×	×	×√	×	×
CDRST	Community	S	Toolkit	Both	Both	×	×	×	×	×	×√	×	×	×	×
BCRD	Community	F	Toolkit	Both	Both	×√	×	×	×	×	√	√	√×	×	×
CART	City, neighborhood	F	Toolkit	Both	Qualitative	√	×	×	×√	√×	√	×	√	×	×√
ResilUS	Household, neighborhood, Community	S	Model	Seco	Qualitative	√	×	√	√	√	×	√	√	×	√
ICBRR	Community	F	Index	NA	Both	√	×	×√	×	×	×√	×	×√	×	×√
BRIC	County	S	Index	Seco	Quantitative	√	×√	×	√	×	×	×√	√	×√	√
CDRI2	City	S	Toolkit	Both	Both	√	×	√	×	×	√	√	√	√	√
CERI	Local Authority District	S	Index	Seco	Quantitative	×	×	×	√	×	×	×	√	×	√
CDRI	County	S	Index	Seco	Both	√	×	×	√	×	×√	×	√	×	√
CRI2	County	S	Index	Seco	Both	√	×	×	√	×√	×	×	√	×	√
CRI	Coastal Community	S	Index	Seco	Qualitative	√	×	×	×	√	√	×	√	×√	×√
PEOPLES	Community	S	Toolkit	Both	Both	√	×	×	×	×	×√	×√	×√	√	×√
CRT	Neighborhood, city, or county	F	Toolkit	Both	Qualitative	×	×	×	×	×	√	√	√	×	×
SPUR	Community, city	F	Scorecard	Prim	Quantitative	√	×	×√	×	√	√	×√	×√	×	×
DFID	Community	F	Toolkit	Both	Qualitative	√	×	√	×	√	×√	√	√	×	×√
CARRI	Community to regional	S	Index	Seco	Both	×	×	×	×√	×	√	×	×	×	√
Hyogo	City and state levels	F	Toolkit	Both	Both	√	×	√	×	√	√	×	×	√	×
USIOTWSP	Community	F	Toolkit	Both	Qualitative	√	×	√	×	√	√	×	√	√	√
THRIVE	Neighborhood	F	Toolkit	Both	Qualitative	×√	×	√	×	×	×	×	√	×	×
CRM	Community	F	Toolkit	NA	Both		×	×	×	×	×	×		×	×

√ : addressed.
× : not addressed or not enough information provided.
Prim: primary data source.
Sec: secondary data source.
Both: both primary and secondary data source.
NA: not enough information provided.



Figures 49– Percentage distribution of the frequency of criteria falling under each main theme
Sources – (Sharifi 2016)

Collective capacity of organizations

As mentioned by, (Frankenberger et al., 2013c; Dercon, 2002; Morduch& Sharma, 2002) and cited in (Mueller et al., 2013) "Traditional systems tend to function best in the event of idiosyncratic shocks and stresses, while formal systems are more effective in the context of covariate shocks". It is important to understand the trends relating to customary or traditional institutions where social capital is exercised in an organized way to promote community resilience. These structures are central to collective action at the local level in areas such as risk sharing, social protection, natural resource management, and conflict prevention/mitigation.

Community social dimensions

As the capacity of the social organizations help in creating collective action. The network of these organizations helps in achieving and decision-making during stress/shocks thereby enhancing resilience during the event. Such social dimensions are listed below that also part take in the conceptual framework for community resilience. These include;

a) Preparedness
b) Response systems
c) Learning and innovation
d) Social memory
e) Self-organization
f) Diversity
g) Inclusion
h) Aspiration

These dimensions play a vital role in the field of planning and strategy for the emergency responses during, and after the disaster. The emergency plans are desired to be optimal in the scope of planning in the event of disaster, they need not be conditioned plans that are restrictive and without scope for improvisation. Military strategists from Napoleon Bonaparte to Dwight D. Eisenhower have noted that, when preparing for war, plans have little value, but planning is essential. This underlines the importance of planning as a process, and above all a process of discovery. "In this sense, whether or not the plan works during an emergency is of secondary importance: more vital is what the plan tells us about the needs of preparedness and organization"(Alexander, 2013).

Exogenous collective action capacities

"Conceptions and measurement of community resilience must be founded on a thorough understanding of the collective actions a community carries out in support of the security and well-being of its members"(Mueller et al., 2013). This conceptual framework emphasizes five main areas of collective action where communities play a significant role: DRR, conflict mitigation, social protection, natural resource management, and management of public goods and services.

Comparative analysis of the different frameworks developed for community resilience assessment Tools have mainly been developed in developed countries, raising concerns about their generalizability and applicability to communities in the developing world. Local authorities and community organizations are the main target audiences. There are also tools designed to inform other sectors such as academia, aid agencies, and insurance companies. In the comparative of the resilience tools selected below in table-1, (Sharifi, 2016) uses five major assessment and scoring methods that are, in order of their frequency of use, assessment against baselines, assessment against principles of good resilience, bench-marking, assessment based on recovery speed, and assessment against thresholds reflecting program objectives. It is recommended that a combination of all these approaches should be used to gain outputs that would be conducive to more-informed decision making. Different types of assessment criteria's have been used to evaluate the community resilience either in combination of the above-mentioned methods and assessed based on the frequencies, indices, toolkit, and scorecards.

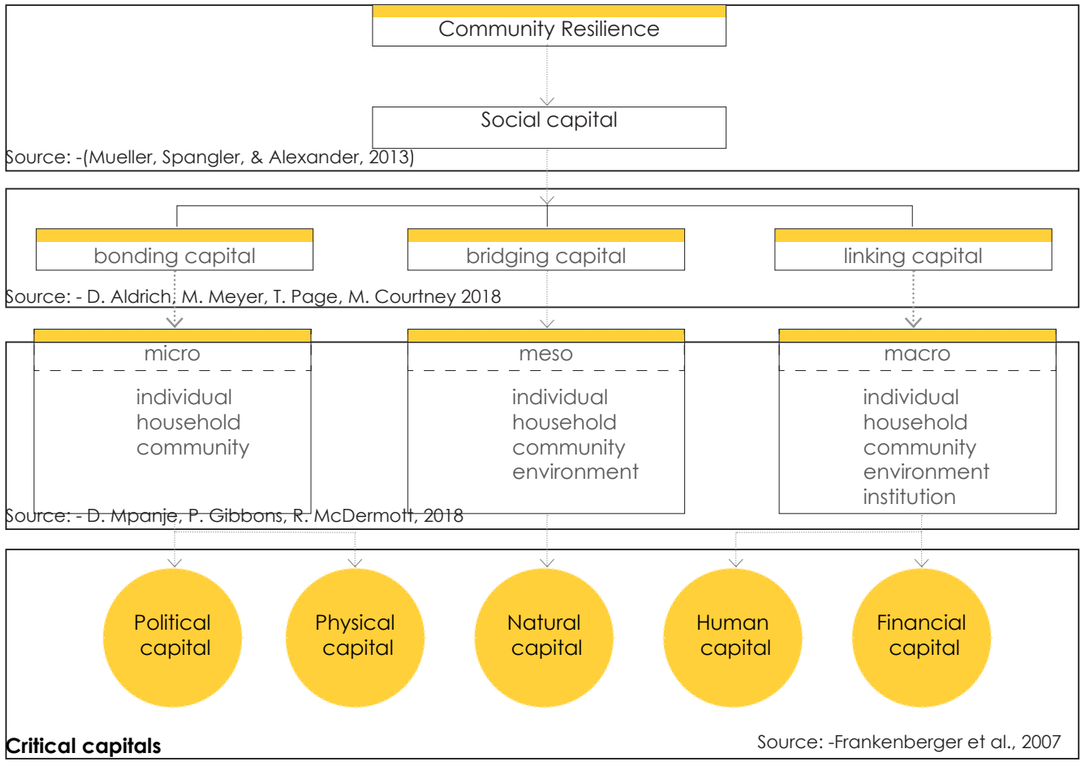
Top-down tools are often intended for use by an oversight body or require external expertise a government office or an academic entity, for example; to help a community measure different aspects of their resilience to inform decision making. In (Dominic A. Brose, 2015) Dr. Cutter noted that the purpose, scale, and target of these top-down approaches vary, and outlined several examples. Four overarching target categories for developing community-based resilience measures are identified in the 2012 Disaster Resilience report: critical infrastructure, social factors, buildings and structures, and vulnerable populations. These criteria through each of the tool highlight openness, transparency, align with the community goals and vision and include measures that are inclusive and well documented.

Assessment indicators and measuring community resilience

As mentioned earlier and also cited in (Andrew, 2012), "social capital is a driver for community resilience". Measurement of the indicators of social capital will also be indicators of community resilience. Many councils survey their communities on indicators of social capital, such as trust of institutions and connectedness. "Ultimately the success of building a sustainable and resilient community depends on strong leadership, vision, and clear and open communication. Conviction and the willingness to make tough decisions is critical",(Callaghan & Colton, 2008). Evaluating the community's ability to recover from past disasters is the main method used by the tools for taking the past conditions into account. In particular, they have focused on time needed for recovery and lessons learned from the event (Frankenberger and Nelson, 2013) as cited in (Sharifi, 2016). Adjacent figure-33 shows the percentage distribution of the frequency of criteria falling under each main theme used to assess the transcending of the amount of resilience achieved by each of the tools for assessment. The sections further explain the dynamics of these dependence factors that make the performance domain and measurement of the community resilience.

Performance domain

It is the field based on which interception, calculation, intervention of the project performance is classified constituting all plausible levels and hierarchies of the project. By classifying into this scale, it helps in understanding the scope and limitations of the project. It also helps overcome for futuristic research the areas that are not factored in the project scope. The performance scale also acts both pre-disaster as well as post-disaster. Pre-disaster this scale helps in quantifying the threshold capacities of the critical capital within the area, while post disaster it helps in quantifying the residual critical capital. This analysis helps in understanding the dynamics involved within each critical capital and that which is needed to be improved.



Figures 50– Attributes of the community resilience in performance domain
Sources – Authors illustration

5.4 Preparedness

In the hazardscape due to frequent nature of disasters it is essential to be prepared. When we are prepared, responses are timelier and more effective, resulting in reduced human, economic and environmental consequences. The process of preparedness is a continuous process that requires action, investment, participation, collaboration and political commitment at all levels and times for it to sustain (World Health Organisation, 2017). The focus of preparedness in this paper has been towards tsunami (of extreme scenario). By understanding the scope of the measures required to be prepared for a tsunami, the tsunami's that are not catastrophic can also be mitigated.
To understand preparedness, it is important to consider spatio-temporal domain in which it is implemented and the methods for its intervention. To execute this, it is necessary to assess the current or the pre state of the hazardscape. The action-decision flow chart takes into consideration this requirement for preparedness through decisions and designs for principles mentioned below to achieve a holistic recovery.

1. To safeguard, maintain and restore the health and wellbeing of the communities which is in unison with the hypothesis considered for the project.

2. Decisions and activities governing the critical capitals should be participatory, inclusive and collaborative with multi sectors and comprise of measures that are all short-term and long-term specific.

3. To achieve preparedness, the commitment required from the political, social and economic sectors should be enduring and persistent.

4. To invest in preparing it costs time and money, but investment in health, safety, security and development makes it sustainable.

5. By preparing, it helps in building the resilience of the systems which is utmost important to achieve a better future of the hazardscape.

6. The measures undertaken for preparedness should be integrative with the approaches of recovery, reduction and mitigation that are observed throughout the disaster cycle.

Preparedness for emergencies depend upon a complex, multidimensional process that are difficult to operationalize if even a single element is missed which is also in the case of non-emergency or post disaster reconstruction stage(King et al., 2013). In order to be prepared enough, relevant, accurate and timely knowledge and awareness of the communities in the hazardscape is essential. Social capital plays a vital role in sharing, transmitting and networking across all the critical capitals (Mueller et al., 2013). This helps in circulating and generating capacities for collective action that prepares and mitigates the impact of tsunami and parallelly develops relative perception of risk. This perception of risk helps in mobilizing the resources and changing attitudes of the inhabitants of the hazardscape to become sufficiently prepared while strengthening resilience capacities.

5.5 Socio-technical study

While critical capitals are essential for the sustenance of the community. It was also realised that taking critical decisions in the event of the disaster considering pre-disaster stage, warning stage and post disaster stage is also crucial. Otherwise, it holds no value to be prepared. To understand this aspect associated with the critical capitals the capital model for disaster resilience by (Sakurai et al., 2016) was referred. Their capital model deals with the relationship between organization and the pathway of returning to business as usual as speedily as possible.

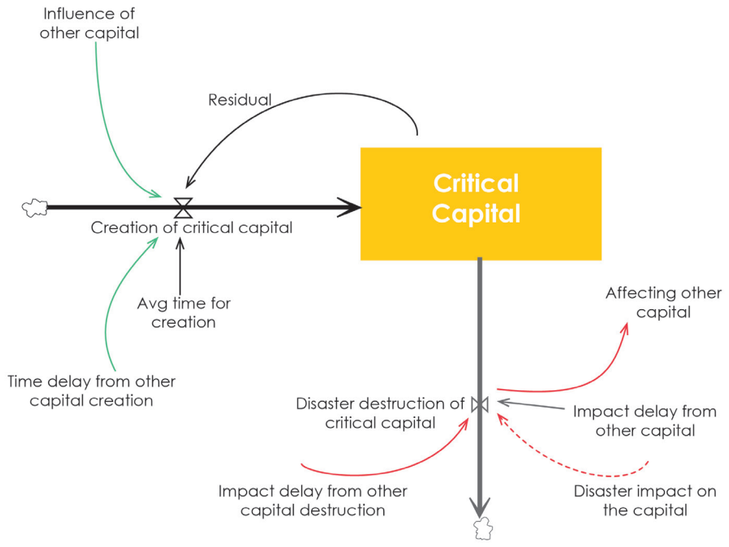
Extracted from that model the conceptual capital model developed is a manifestation of the preparedness phase, when plans are drawn intending to mitigate damage from a disaster situation by making people, facilities and organisations robust. But plans are effective only in the cases of anticipated situations. Unexpected calamities require an adaptable capability that recognizes new opportunities in any given situation (Dynes et al. 1976; Mintzberg et al. 1985) as mentioned in the paper. The disaster 3.11 and the delayed reconstruction process clearly points planning for recovery should be effective as well as efficient. Their capital model uses the empirical data of 3.11 in a system dynamics model and visualises the model results as a simulation.

Taking evidence from this and asserting that resilience is the ability to recover capital effectively and efficiently, relative to the magnitude of the disaster. The capital model developed is based on the performance domain and community resilience indicators mentioned above- the critical capitals. One form of capital causes changes in another form through a capital conversion and creation system. The capital model demonstrated the critical role of enhancing the resilience capacities of systems. Once a form of capital is destroyed, factors within the community trigger changes in other form of capitals to take actions necessary for the capital creation.

In the above concept critical capitals model the bold arrows directed towards and away from the critical capital indicate the creation and destruction of the capital. The green arrows show the time parameter and the influence of decision taken on other capital that impact the creation of this capital. Similarly, the red arrows show the impact of other capitals on the destruction of this capital while indicating the other capital that gets triggered due to this change. The black arrows are delays and self-formation time arrows that impact the critical capital.

This concept critical capital model served as basis for developing the causal structure and simulation behaviour of the dependencies within the six critical capitals. Another key aspect of this model is the spatio-temporal outlook. Planning activities that need to be strategic yet emergent for the hazardscape are understood. This helps in taking necessary planning decisions within the critical capital network during emergencies. The model explores the existing recovery and reconstruction activities at Otsuchi inclusive of all the delays and impacts of certain decision making during the 3/11 stage. The impact is explored further to assess the reconstruction plan and therefore to propose a new urban renewal plan for Otsuchi. The simulations are processed over a span of 5 years based on the planning principles. The model so developed is conceptual in form but can be further explored through the Vensim software for realistic results.

The causal structure of the system dynamics that indicate the dependencies between the different critical capitals is the key to understanding the importance of time and as criteria that influences the dependencies and changes the recovery of a community. This model helps further in actualizing the decisions under the design for preparedness to factor in contingencies from the other capitals. The spatio-temporal vision that it guides is critical in planning for the hazardscape. Integration of emergent and strategic decisions indicate a specific typology of planning that supports such time-dependent decision making.



Figures 51– capital model for disaster resilience by (Sakurai, Gonzalez, Watson, & Kokuryo, 2016)
Sources – Authors illustration

Capital being influenced in creation stage

Capital being influenced /destroyed in the destruction stage

5.6 emergency planning

Disaster resilience and planning for recovery and reconstruction

Hazard-scape fosters community response, which either reduces the intensity of the hazard or intensifies the hazard to become a disaster and further a catastrophe depending on the characteristics of the hazard-scape. All disaster management studies until the early 21st century focused onto the 4R's i.e. reduction, readiness, response and recovery (Ministry of Civil Defence & Emergency Management, 2009) while classifying responses for both the natural and technological disasters. But since the early 21st century, as the intensity and frequency of these disasters increased, in addition to sea level rise by climate change resulting in a large scale economic, environmental and societal disruptions. Moreover, the unsustainable consumption of resources and the growing demand of public interest within the society led to the conceptualization of sustainable development and its relation to disaster management and emergency planning (Ministry of Civil Defence & Emergency Management, 2009) shown in figure below.

While demand for a more holistic and integrative planning was observed, resilience as an attribute of sustainability was realized. "It is recognized that while a top-down policy is needed, it is really the local-level bottom-up policy that provides the impetus for the implementation of mitigation strategies and a successful disaster management process"(Pearce, 2003). While this concept of resilience is extensively used by scholars and academicians in the disaster studies, there is still no clear definition for resilience. Universally, it is understood that the resilience is the ability of a community to adapt and cope to the disaster. But accepting "Sudmeier's international discourse and that resilience has taken a firm hold in development, humanitarian, disaster risk reduction and climate change adaptations. A pragmatic approach for resilience should be realized which is: the ability of a system, organization, community, household or individual to change (cope, adapt, persist, transform) in a positive manner, when faced with adversity"(Sudmeier-Rieux, 2014). While resilience developed as an essential criterion for recovery and reconstruction planning, for its operationalization the desired scales change from global to local and mostly at the level of community. As, seen in practice for such complex problems require adaptivity, persistence, transformation and creativity because the solutions are mostly context based, local and innovative while the methods and tools used to assess varies.

Figures 52– Development of the approach to resilience within disaster studies
Sources – Author's illustration

Developing a planning typology for the hazardscape

As understood from the earlier sections within the recovery and reconstruction in the hazardscape there is a lack of perception of what kind of decisions should be made and when? Dealing with the uncertain environments of the hazardscape the decisions need to be immediate and effective. This requires the knowledge of the hazard, the resilience capacities of the exposed and vulnerable capitals in the hazardscape while also necessitating the effective, emergent and strategic planning within the recovery process. By emergent it means the strategies that are specific to the hazardscape and which further in the planning stage can be strategically improvised(Wiechmann, 2007). In this way planning for the short term as well as long term can be made possible. These could be influenced through polices and design considerations that are sensitive and vital for the sustenance of the hazardscape.
For effectuating preparedness to a satisfactory level in the hazardscape, planning guidelines should be specific and emergent to the nature of the hazardscape and strategic in its process to mitigate and transform to become prepared for the next tsunami. This emergent and strategic nature of planning and the realization of emergency in crisis as well as long-term planning post disaster leads to the formulation of this planning typology that is symbiotic of the hazardscape and evolutionary in approach that integrates within the other forms of planning within its near future. The graphic below extracted from (Alexander, 2013) explains the different stages within the emergency planning that can be modified and integrated with other forms of planning therefore realizing an 'integrated emergency planning' typology in the hazardscape.

By introducing integrated emergency planning typology in the hazardscape;

1. It attends to the need of long-term aspect of planning in the recovery and reconstruction processes.

2. It caters to immediate and yet continual recovery process and strategy that evolves and improvises based on the necessities of the hazardscape post disaster.

3. It provides decision synergy between the scales in the operational domain that effectuates planning ahead and planning post disaster by arranging necessary assessment of the various critical capitals that form the performance domains.

4. The core principle of emergency planning is to reduce the likelihood of the lives being lost which is also the considered hypothesis for the project. While this aspect is essential to improve the resilience capacities in the hazardscape, it is also crucial reduce damage to the environment (built and unbuilt) that caters to an efficient recovery. Since emergency planning is the foundation for this motivation, proposing this planning in a long-term way creates decision clarity, resource maximization, risk analysis, contingency planning, and faster in reaching normalcy(Alexander, 2013).

5. Planning is a continuous process and for a hazardscape more so due to its frequent changing nature. By making integrated emergency planning specific it supports community resilience.

6. While emergency planning takes care of the crisis situation, by adopting its principles of leadership role, participation and collaboration, engagement strategy, preparation that are also the requisite aspects to achieve community resilience, exercising it for the hazardscape implicates for a better recovery.

7. The main aspect of emergency planning is getting results which are based on certain improvisations based on the outlook of the disaster, which characteristically changes many dependencies within the risk impacts.

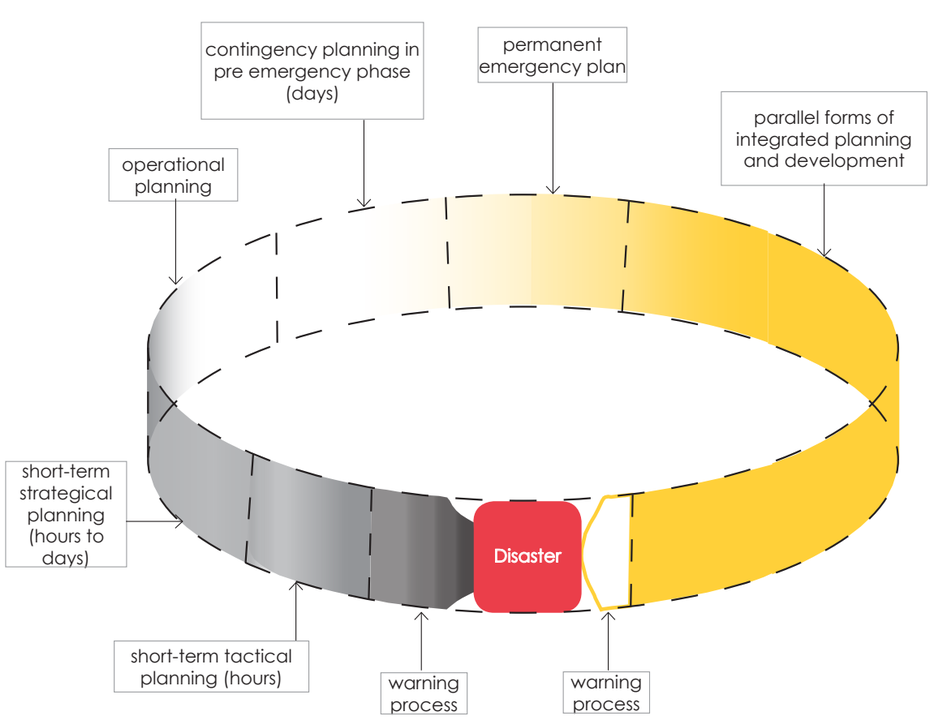
8. Within a disaster situation, through many literatures it was also understood that to take

decisions it was essential to be flexible, trust worthy yet also be accountable for the decisions taken to meet extraordinary circumstances with limited resources which can be adopted as a positive attribute of this planning typology.

9. Finally, as emergency planning is inclusive and accessible to all, consideration has been specifically given to the tsunami hazardscape, but its principles can be transferable for other hazardscapes which can be explored further.

Spatio-temporal domain

This is the catalytic field which recognizes the time and spatial dimensions of the disaster cycle the pre-event stage, during the event and post-event stages and triggers intervention in the form of policies, planning and implementation strategies, data computation and simulation, design and capacity building for initiating resilience in a continuous developmental form reaching the desired equilibrium state. This scale functions differently at different time intervals of the disaster cycle depending on the level of the interaction, impact ranges, planning urgency and integration of parallel forms of planning. Through the planning cycle seen below in the graphic it can be understood that this scale takes into consideration the planning attributes of the emergency planning which has been used as a guiding tool for reconstruction planning.



Figures 53– Attributes of the spatio-temporal scale
Sources – (Alexander, 2013) and Authors illustration

06 | *research methodology*

The gathering of storm clouds

This chapter of methodology gives the framework for the whole graduation thesis project. It explains the in brief the scenario of the problem, what is the scope for the project, the theoretical backing that is used to understand the problem, the conceptual framework that is derived from the analysis and the developmental studies that are done in response to reach towards an analytical structure for the project. It further clarifies the different methods and frameworks and studies done to answer the research questions. Finally, the chapter gives a glimpse into the project time-line and the different relevance criterion's it deals with for the realization of the project.

"By failing to prepare, you are preparing to fail."
— Benjamin Franklin

Figures 54– Otsuchi, Iwate prefecture, Japan
Source – author

06 | *research methodology*

6.0 Sections

6.1 introduction

Overview

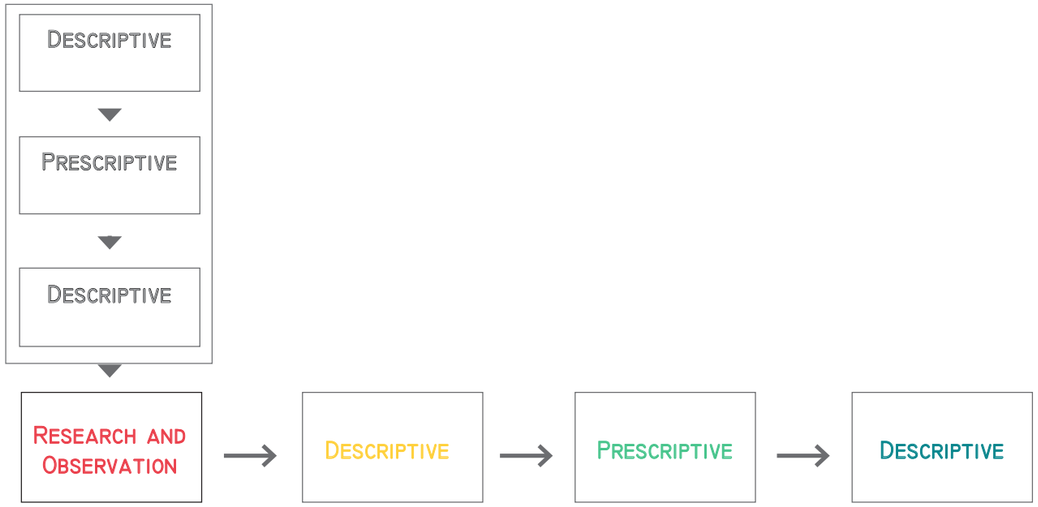
This graduation project follows the current discussion within the disaster community regarding the preparedness strategies and protection measures that should part take in the spatial planning domain for the sustenance of humanity. As the intensity of disasters is becoming severe and recurring, the vulnerability of human population is also increasing leading to urbanisation crisis as seen in Japan.

The project as a part of the multidisciplinary group consisting of design, planning, management and engineering faculties tries to understand the concurrent problems faced in the coastal regions of Japan after the 3/11 tsunami event, that impacted Japan resulting in a crisis situation for its economy and further to its coastal populations.

It is noted that measures taken for renewal address immediate and short term risk reduction strategies involving physical infrastructure constructions. Often such measures leave the community dissatisfied and helpless to survive. The focus of this project is to address this gap in governance and renewal measures that can equip the community better for future such events.

The research methodology follows the sequence of inquiry and analysis on site during the field investigations that takes place while understanding the problem. It takes into factor the overlap of different disciplines and their scopes and addresses the problem by inquiry and analysis and strategic design integrating the existing and the past measures with the new ideologies of preparedness.

Theoretically, the research methodology can be classified as reverse research methodology, with the design proposed during the workshop to understand the context and the kind of research required to be carried out which resulted in the formulation of the problem field and research question. This method of research was beneficial to understand the context, its problems and their limitations in administering them which necessitated a "bottoms-up" research methodology, where in the research and analysis carried out shifted from micro to macro and vice versa. This has resulted in making the project more realistic and site specific.



Research outline

The research for the project is based on the book DRM – a design research methodology (Blessing & Chakrabarti, 2009). In this research methodology the four main stages are:
1. Research and observation
2. Descriptive study I
3. Prescriptive study
4. Descriptive study II

Each stages are sub-divided into sections that are based on the sequence of the analysis carried out for the project elucidated under each section. Focus of the research being integrated (all domains involved of planning) carried out 'the scientific way' makes the methodology also very real.

Research / Observation (clarification)

This stage deals with observation of the problem at site and investigates based on the evidence of what aspects of the problem were left unaddressed. Because of the multidisciplinary interactions during the fieldwork the problem field is realised and a hypothesis is considered that delineates the goal and scope for the research.
The section is subdivided into types of inquiry carried out to understand the problem field which further helped in forming the problem statement, research question and the sub research questions.
The aim of research is to understand the gaps in the socio-technical domain of the reconstructions strategies used in context of Japan and find spatial gaps within that could be addressed by changes to the policy and strategies for implementation.

Descriptive Study I

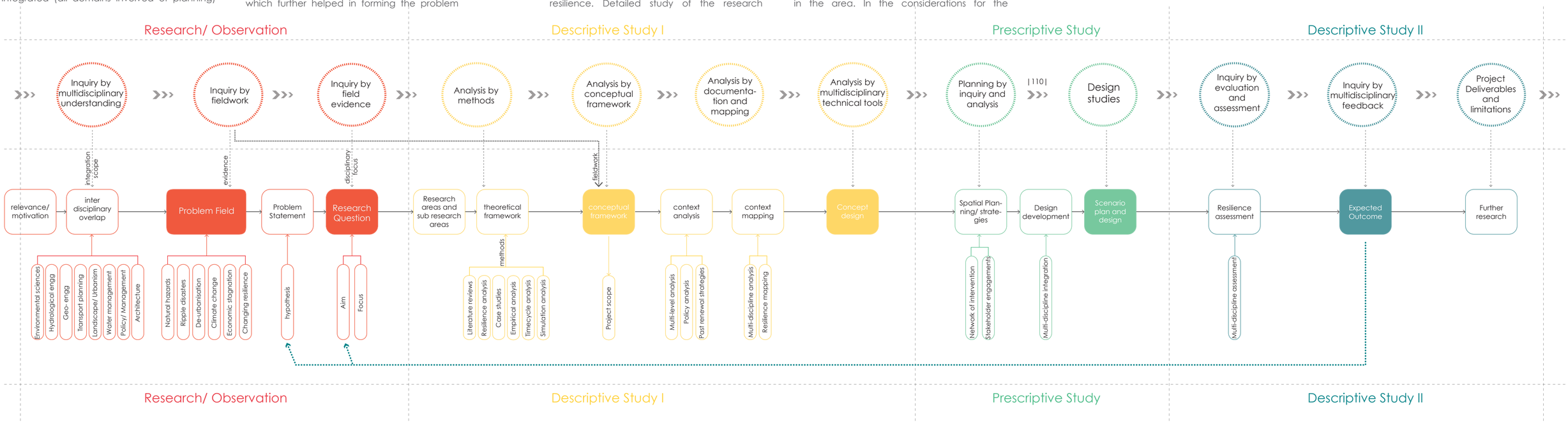
This section follows the research stage with the methods used to carry out analysis of resilience within the context of Japan and understand the different dimensions relative to achieving resilience. Detailed study of the research areas helps in forming and concluding to many theories that further form the theoretical framework for the project. Analysis and synthesis of these theories and relevant concepts are used to make the conceptual framework for the project. Empirical data collected at site supports the context to be held in focus of the study throughout the process.

Prescriptive Study

Following the detailed research and descriptive study, this section deals with the measures and strategies that need to be addressed and introduced to improve resilience capacities in the area. In the considerations for the proposal the section also explains the overlay of different disciplinary aspects to reach towards a comprehensive developmental strategy. Simulation studies and empirical data retrieved form the field-visit support and guide the design research in this stage.

Descriptive Study II

It forms the final stage of the design research methodology that forms the final output of the research in the form of spatial strategies for increasing the resilience capacities and also encompasses design solutions that can be introduced at the macro level. In addition to this it also evaluates the project on the depth it reaches in addressing the research question in all its aims in the form of multidisciplinary evaluations and a detailed reflection of the project.



6.2 Problematization

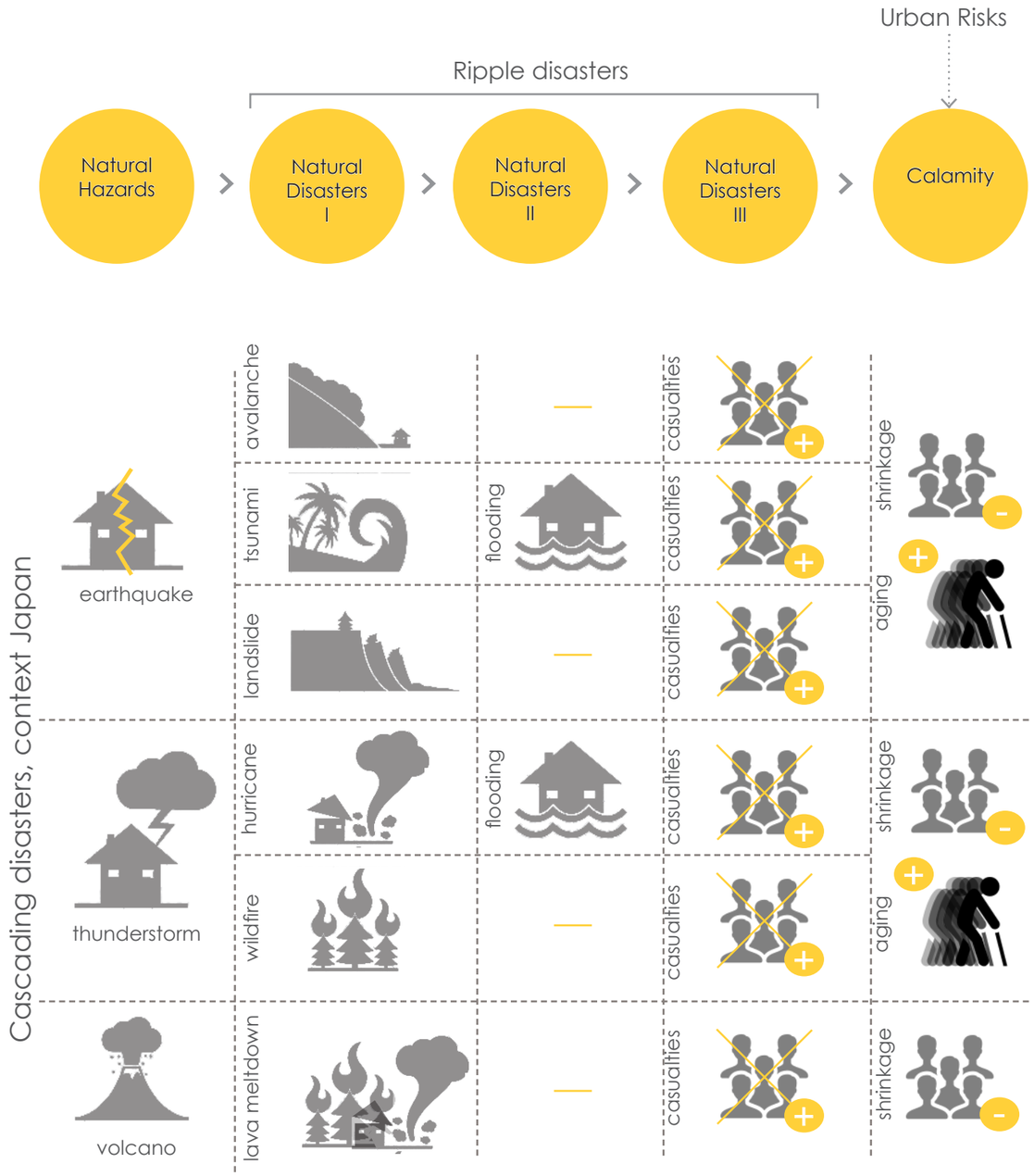
Problem field

Natural Disasters result into disruptions and destruction on every level. Although human intervention cannot change the incidence or intensity of most natural phenomena, but they have an important role to play in ensuring that natural hazards are not converted into disasters by their own actions. Human interventions can increase the frequency and severity of natural hazards but if acted right also reduces the intensity of the hazard calamities.

The impact of the disasters in the 21st century combined with infrastructure failures have become recurring, multi-scalar and multidimensional phenomenon in addition to anthropogenic climate change, which have demonstrated vulnerability of the urbanized regions. The geographic orientation, scale of the metropolises and interdependent infrastructure networks further enhances the disaster intensity causing secondary disasters like earthquake, causing tsunami which triggers power cuts and fires, resulting in complete disruption of all network systems. The territory of Japan lies on such vulnerable location. The whole landforms is in the zone of extreme crystal instability on the "ring of fire" and facing recurring natural disasters every 40 -100 years and this has become a cause of concern amongst the whole academic and professional community as these disasters not only have problems related to rebuilding of physical infrastructure but also towards societal health, socio-economic setbacks, environmental concerns and social cohesion. Such disasters many a times lead to shrinkage of the city since many inhabitants leave and the once that return, they have lost their financial source. The topography of Japan dictates to a large extent where and how its people earn their livings, and its climate influences its agriculture and styles of living (contemporary Japan, Columbia university) and therefore cities continue to grow at the edge of risk while being vulnerable to future natural hazards.

Current reconstruction plans focus on protective built infrastructure like dikes, leaves, sea walls, breakwaters to protect the local communities against the threat of tsunami, despite little evidence that they have saved lives(Aldrich & Sawada, 2015). With the increase in intensity of natural disasters aggravated by climate change there is a need to shift from a contemporary urban planning (Alexander, 2013) to emergency urban planning (anticipating the unexpected) that not only responds to the impacts of disaster, but also maintains business continuity while managing the crisis. In addition, it also guides recovery and reconstruction effectively while simultaneously copes with complex and sophisticated transfers of human and material resources.

Dealing with disaster is a social process that requires public support for planning initiatives and in-addition participation by a wide variety of responders, technical experts and citizens. It needs to be sustainable in the light of challenges posed by non-renewable resource utilization, climate change, population growth, and imbalances of wealth (David Alexander 2015). In this globalization world, where accelerating physical, social, and economic change is impertinent, the challenge of managing emergencies well, depends on effective planning and foresight, and the ability to connect disparate elements of the emergency response into coherent strategies which is what my graduation thesis is focussed on. It attempts to understand the local hazards, coastal vulnerabilities and be compatible with local perceptions, traditions, activities, and expectations while improving resilience within the communities to combat the disaster.

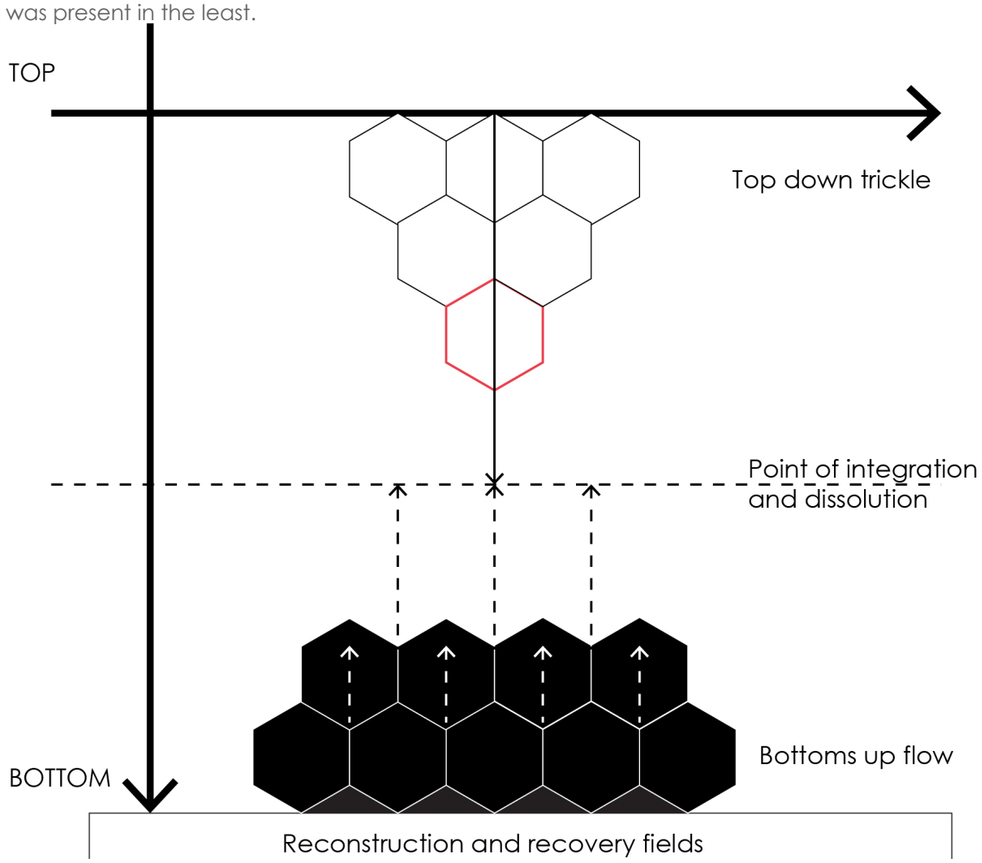


Figures 55– Cascading disasters, context Japan
Sources – author's illustration

Problem statement

The research and field visit highlighted the ineffectiveness of emergency planning measures that could mitigate the impact of the disaster. While the reconstruction plans focused extensively on implementation of just short term protective built infrastructure and building back rather than investing in long term risk evolving resilient strategies. The social memory of the earlier disasters did nothing to reduce the impact and was present in the least.

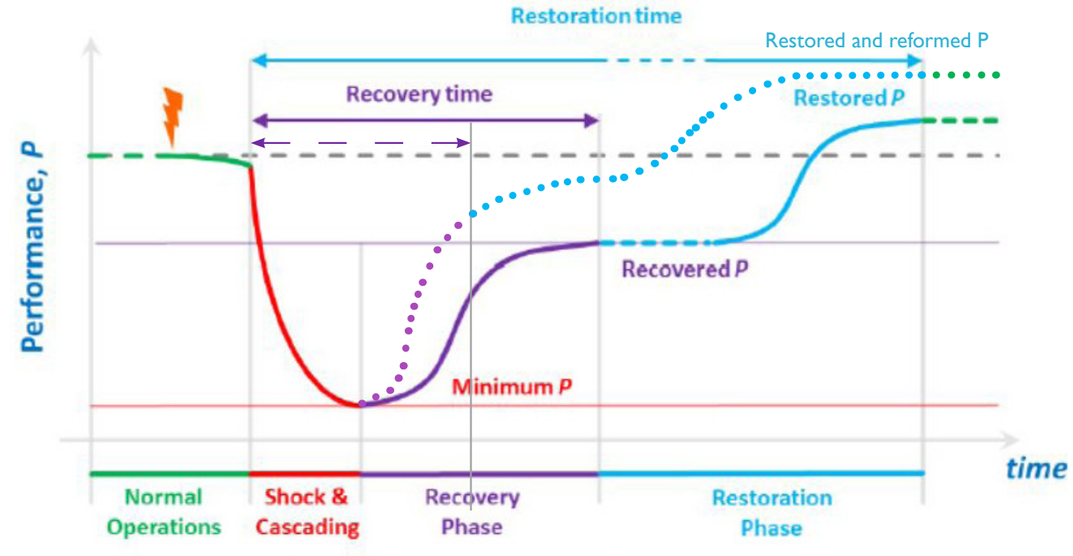
The project aims to address a **typology of spatial planning** for the disaster prone regions that focuses on building a **framework for the emergency response** which is **multilevel, multi sectoral** and caters to **long term risk reduction strategies** that are relative of the **hazard-scape**.



Figures 56– Problem statement
Sources – author's illustrations

Hypothesis

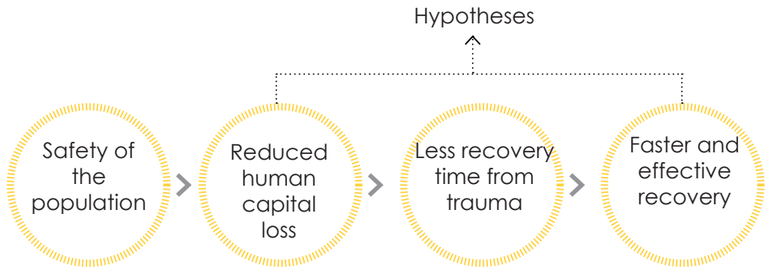
The investigations on the field-visit and the collaborative approach towards a resilient outcomes posed a plausible hypothesis that subjects to the understanding of resilience in its entirety. According to it, if the population in the hazard-scape is prepared enough, such that the scale or the severity of the event amounts to very less human loss subsequently resulting in a better coping of the disaster and its impact psychologically, can then result in a faster and resilient recovery of the community and the environment. This theory also holds true for different systems under stress and forming the essential components of the hazard-scape wherein during the restoration stage the aspects change for social, environmental and physical domains as seen from the resilience curve diagram shown below. According to the curve, the x-axis denotes time and on y-axis the performance of the system. The system while in a normal state when affected by a disruption the performance curve drops showing very low resilience. The rise of the curve shows increase in the resilience over time in the recovery phase till it reaches the full potential in the restoration phase. This supports the hypothesis if the system dynamics are considered. To test its function through the social domain is the scope of this thesis.



Figures 57– Resilience curve in support of the hypothesis
Sources – Engineering resilience in critical infrastructure and edited by author

6.3 research focus

Aim and objectives



Workshop guidelines that form the problem statement for urban renewal at Otsuchi

The project aims to find a much more holistic strategy in mitigating disaster within all dimensions of the disruption study fields in cases of earthquake tsunami.

It focuses on the most extremes of the disaster disruptions and on both short as well as long-term strategies.

The goal of the research is to recognize the overlaying complexities involved in the reconstruction and recovery strategies of disaster risk reduction.

While it is necessary to look into all aspects of the mitigation strategies of disaster risk reduction and development, however to limit the scope for the masters thesis, the research focuses on the objective of preparedness in the whole disaster cycle i.e. pre-disaster, in disaster and post disaster.

With recognising the fields of complexities it also researches into different methods and tools that can be used to understand the different aspects of the event and the process.

Research question

Sub-research questions

Community resilience

1. How is it possible to reduce disaster impact while creating awareness and preparedness and consequently contribute to improvement of community resilience in the hazard-scape?

2. What role does context play in the domain of community resilience? How significant is it ?

3. How can the study of community resilience contribute to disaster risk reduction governance elsewhere?

Governance

1. How is the approach to mobilization of land-use made enough in a disaster vulnerable region?

2. In what ways can the study of governance measures for urban renewal improve resilience in the reconstruction of the disaster-scape?

3. Can resilience of critical capital and critical infrastructures be undertaken by community-based disaster risk reduction systems and to what extent?

Planning and design

1. How can spatial design and planning strategies generate preparedness within the community in a disaster-scape ?

2. In what ways spatial strategies influencing mobilization of critical capital and infrastructures protect, mitigate and cause recovery in the event of disaster?

3. How does long-term crisis management of resources affect the reconstruction process?

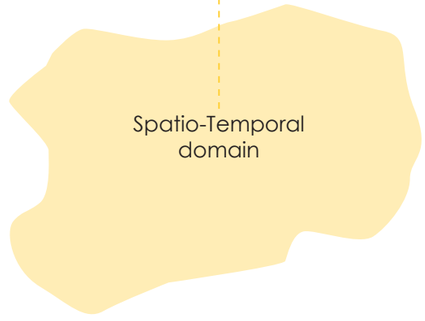
4. How can design and planning after the disaster event support the governance of spatial decision making?

5.How is emergency spatial planning different from the contemporary spatial planning? And in what ways it influences the reconstruction process?

Performance domain

Operational domain

Spatio-Temporal domain

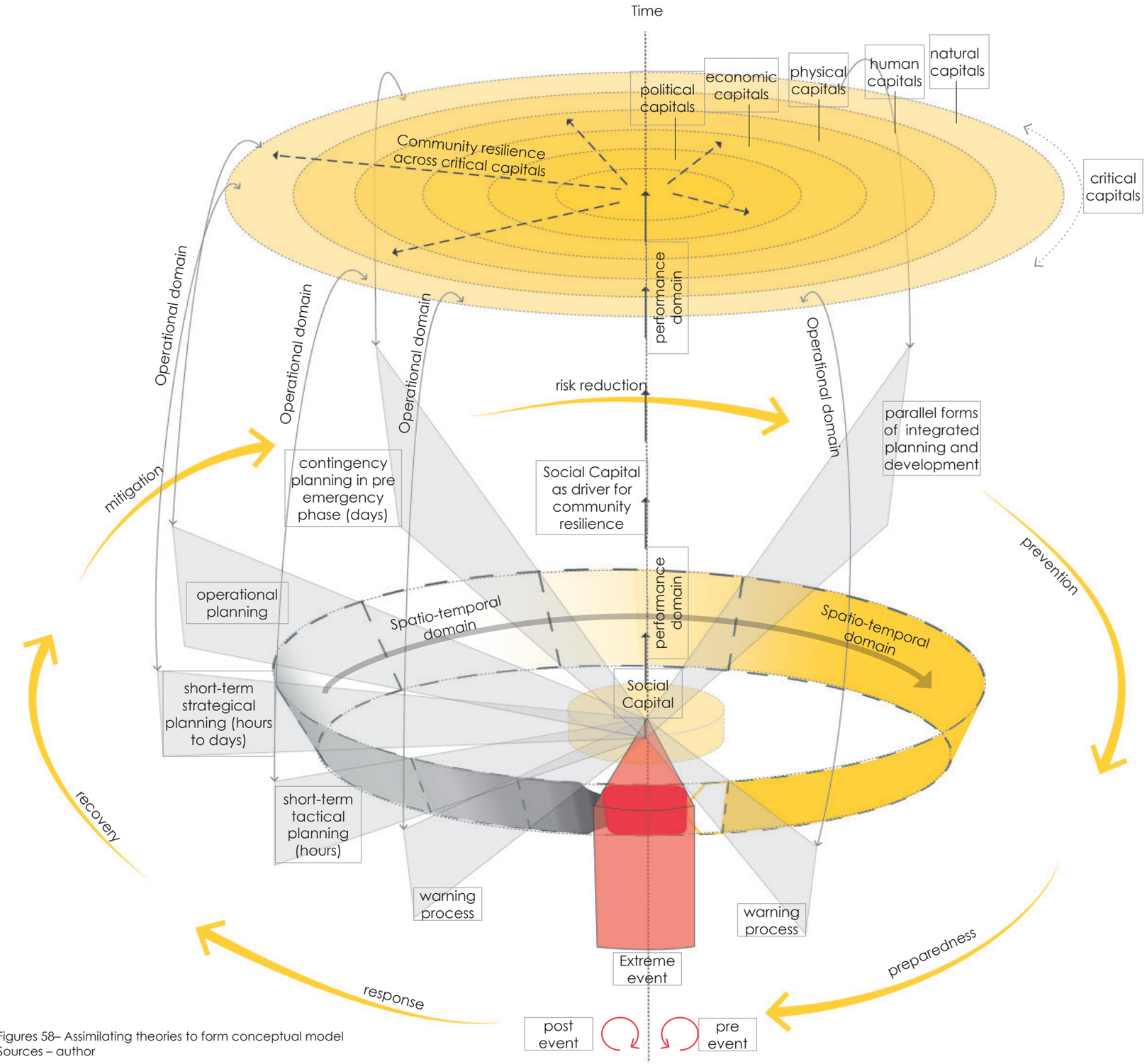


6.4 Conceptual framework

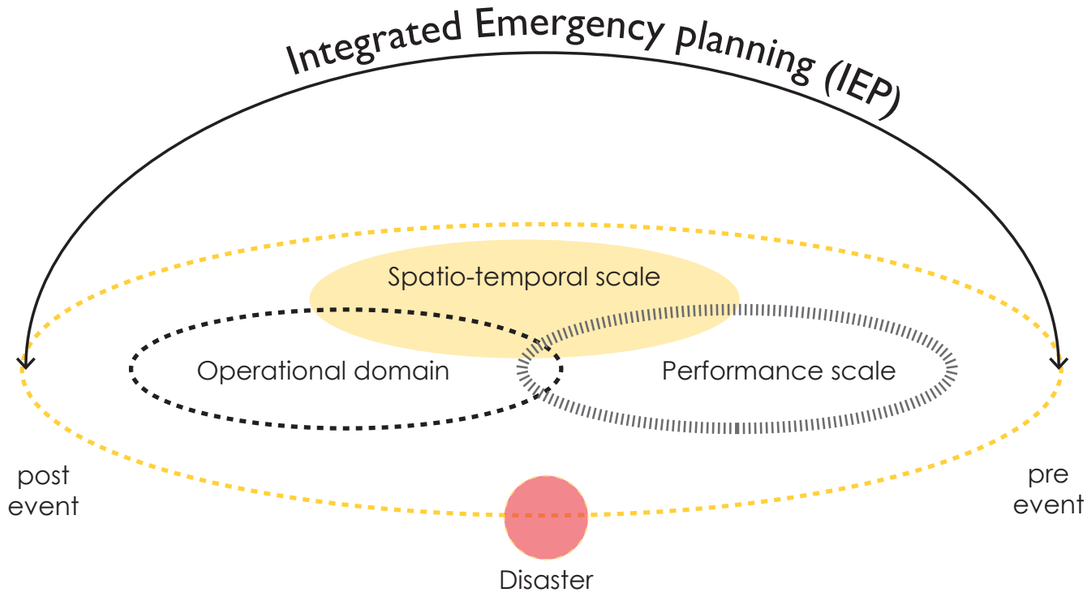
The project is supported by the conceptual framework. At the centre is the event cycle which is guided by the methodology of the emergency spatial planning. Community resilience acts as a response strategy to minimize the impact of the disaster event throughout the event cycle. The framework cuts across all three scales of operation, performance and socio-temporal dimensions while addressing the attributes of the community resilience.

At the centre of the framework is the social capital which acts as a driver for the performance of other critical capitals in the formation of long term risk reduction techniques for resilience building. Through the performance scales.

A simplified version of the conceptual framework is shown on the next page for better understanding



Figures 58– Assimilating theories to form conceptual model
Sources – author

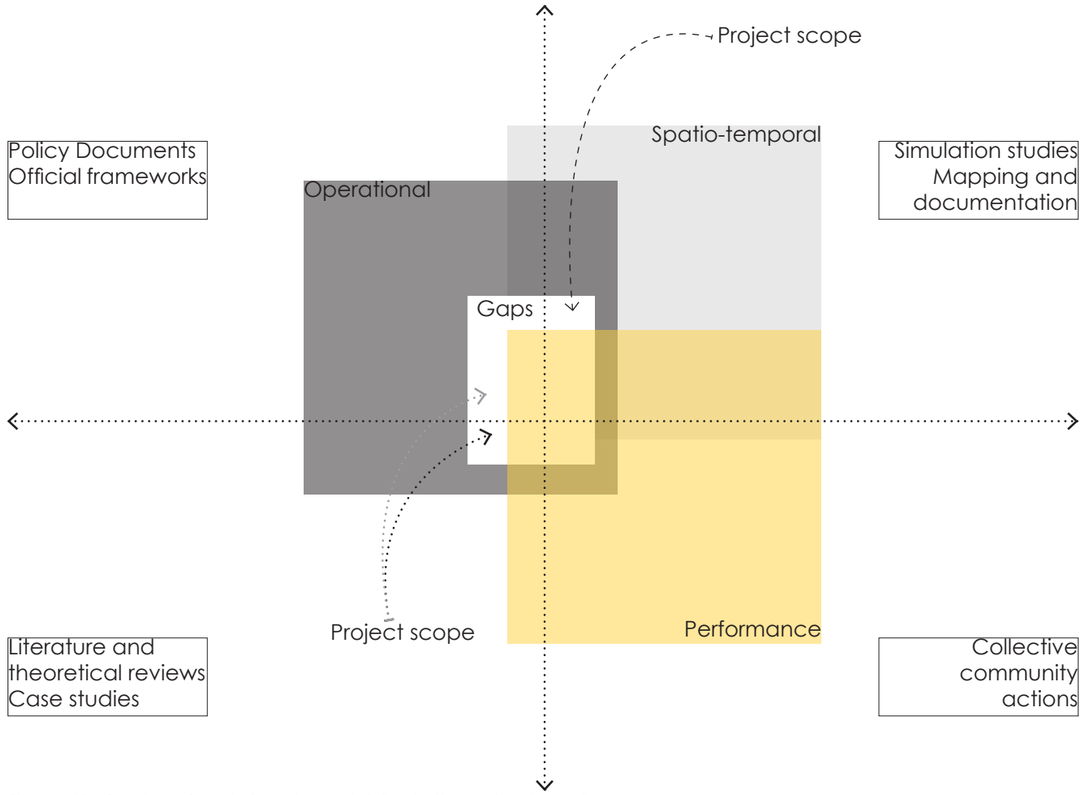


Figures 59– Conceptual framework
Sources – Authors illustration

6.5 Analytical framework

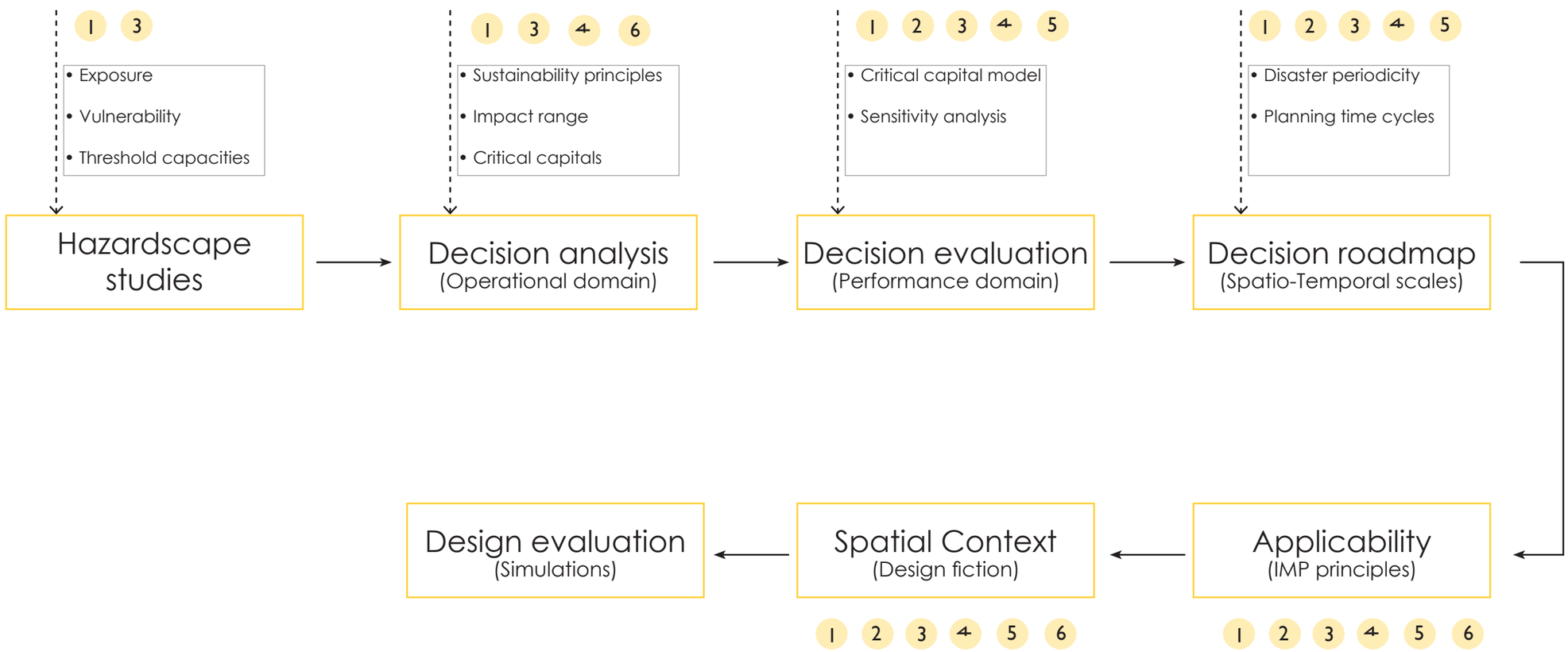
To understand the complexities of the project it is important to understand the different decision making domain and scales for research, intervention and implementation. These scales clarify not just address the different levels and dimensions for the project but it also highlights the missing inter-linkages which needs to be addressed.

This section shows the different methods and tools used to address the aspects of the research question and reach to supportive conclusions. The methods include empirical studies, computational, qualitative and quantitative data which makes the research more integrated and coherent. The graphic below shows the current state of overlap for the analytical methods that are used in the disaster studies to understand and comprehend ways for reconstruction strategies. It is realised that there factors a lot of interdependent variables that create missing links and gaps within the research methods used and therefore result in inadequate resilience building. This project with the above-mentioned scales tries to understand these gaps and comprehends a conceptual framework that targets these gaps and methodologically proposes actions, tools, strategies and design development ways to achieve a more complete reconstruction pathway.



Figures 60– Overlap of analysis scales pertaining to the methods used
Sources – Authors illustration

Analytical framework



1 Literature reviews

2 Mapping and documentation

3 Empirical studies and field studies

4 Policy and planning documents

5 Ethnographic review studies

6 System dynamics simulation studies

6.6 Conclusion of methodology

The main purpose of this chapter has been to explain in brief the development of the graduation project from its conception, dealing with the brief idea about the intricacies of the research topic to the relevance of the project in all dimensions of the studies.
Starting with the brief overview and introduction to the research outline, it reflects on the choice of research principles used for guidance of the research project. Aligning to the structure of the research it progresses with explanation of the problem fields and the problem statements to reach towards a research question.
Further through field visit studies, empirical understandings and literature studies of policy documents, articles, journals and reviews a comprehensive framework is developed that supports the research claim while giving insight into the complexities and gaps in the researches till now. The research progresses with understanding of the multiple layers and scales involved which need to addressed. This is lined out with requirement of other studies for understanding the temporal dimensions. Analysing the methods, scales, concepts, frameworks and necessities for interventions allows composition required for the conceptual framework. Further, it is showcased through graphically as well as analytically for better understanding of the progress of the study that will be carried out further.
Finally the project time-line gives clear view of the research that is carried out along the duration of the graduation thesis.

07| analytical study

DNA of the region

This chapter focuses on the Iwate prefecture and specifically on the town of Otsuchi. Initially it links the disaster topography of Iwate and Japan within the Tohoku region by different analysis methods. It showcases the built up of the region through the history of disasters while still retaining the identity, wisdom and resilience intact. The sections focus on the state of otsuchi before 3.11 and the reconstructed today by assessing the change in resilience capacities and the nature of dependencies within tsunami risk.

Figures 61– Ando Otsuchi , Iwate prefecture, Japan
Source – author

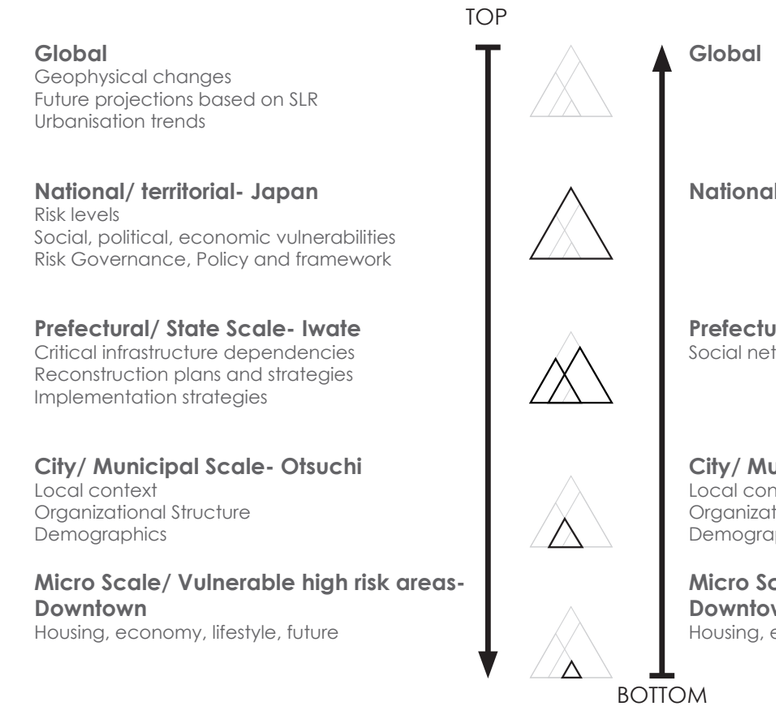
07 | analytical study

7.0 Sections

7.1 domains of assessment

Operational domain

These are the areas where in a project can be classified in the current governing structure for implementation. It is categorised mainly based on the analytical dimensions of decision making followed all over the world and specifically in the Japanese context. The operational scale influences the working of the socio-temporal scale. It is influenced by the global processes as well as the territorial and local changes subjugating it to be very rigid and inflexible making it ineffective for resilience building.



Figures 62– Governance levels considered
Sources – Authors illustration

Assessment of operational domain

Community resilience has been researched and addressed in the contexts of diverse disaster scenarios ranging from certain to uncertain, periodic to irregular and seismic to climatic disasters while being focused at multiple levels of city, urban and community. A deliberate choice has been made for the case of Otsuchi, Japan to examine the, actions, decisions and the scope of planning based on the nature of the hazardscape and exiting levels of operation and implementation. This allows resilience thinking and supports long-term planning for all critical capitals while taking into consideration global as well as local processes.

Within the domain of governance, decisions, actions and condition of critical capitals need to be assessed within space and time. Scales of processes, occurrence of the phenomena and change in sustainability parameters that contribute in influencing and improving the resilience capacities as mentioned in (Weichselgartner & Kelman, 2015) guides the operational domain. This operationalization of resilience is based on the mentioned factors that are described below;

Impact range – The uncertain and irregular behavior of tsunami sets the context for community resilience in the hazardscape. As the regions around the pacific ring of fire are seismic activity prone tsunami in the region have occurred of varied magnitude, intensities causing risks at multiple levels and sectors. These impacts of the tsunami have been categories into different categories depending on the level of disruption created.

Threshold capacity – This capacity is relative to the resilience capacities that deals with the response to the tsunami under the different operational domain. To achieve community resilience the threshold capacity acts at multiple levels of the operational domain but for effective and efficient implementation threshold capacities need to become emergent as well as strategic for a complete recovery.

Community resilience (CR) framework – Literature reviews of CR focused on its measurement and operationalization. The study concluded with the understanding that CR cannot be measured and compared but can be enhanced based on certain changes in the operationalization of the critical capitals. This understanding guided towards making CR frameworks that operate at multilevel and guides socio-temporal factors of critical capitals.

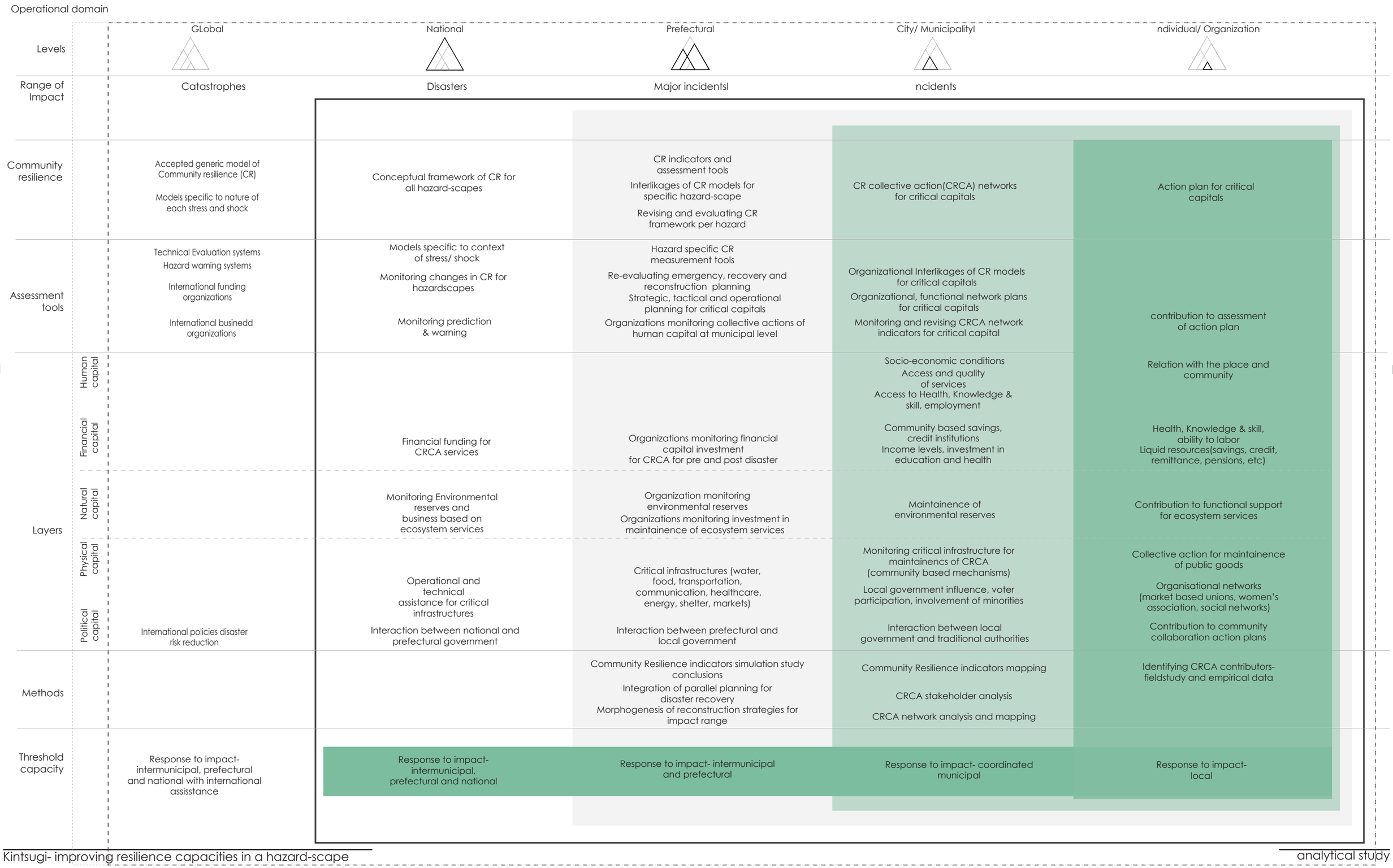
CR enhancement tools – To enhance and improve CR in the operational domain, toolkits that are based on computational models such as GIS mapping, risk simulators, vulnerability models, casual-loop models can be developed which monitors changes in the hazardscape. Further, these toolkits can create awareness and enhance social networks that supplements preparedness activities throughout the disaster cycle and across all age groups.

Critical capitals – These selected CR indicators that are influenced by decisions and actions of the lower levels in the operational domain have the capacity to stimulate and enhance community resilience. They operate at multiple level in the spatial scales and show temporal factors that change the resilience capacities of the hazardscape.

Methods –For the operationalization of CR, it was realized that a complete transformation within the planning of recovery and reconstruction(Alexander, 2013) is required that is emergent of the hazardscape and strategically influences the critical capitals. This understanding guided research into the planning activities, actions and decisions of recovery that was investigated through capital dependencies, sensitivity analysis and design fiction of the tsunami scape of Otsuchi. The analysis leads to reformation within the planning methodologies specifically for the hazardscape and the design of principles that when implemented enhances community resilience.

Figures 63– Action planning
Sources – Authors illustration

7.2 Action decision planning

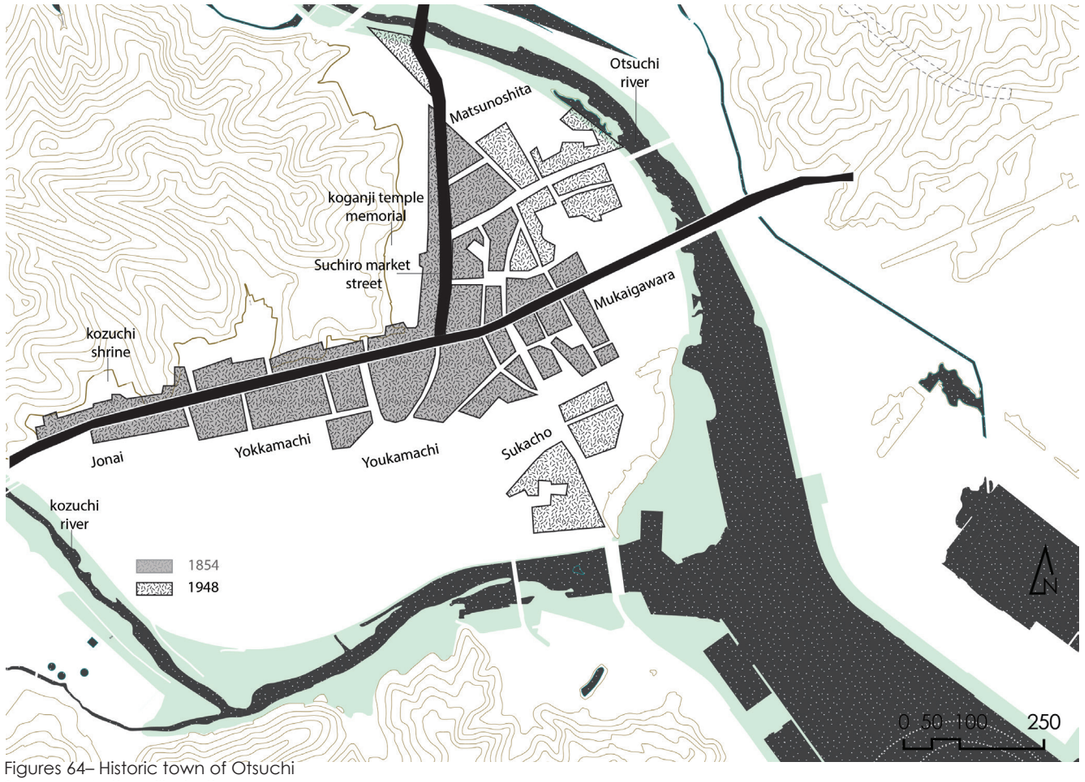


7.3 Sensitivity analysis

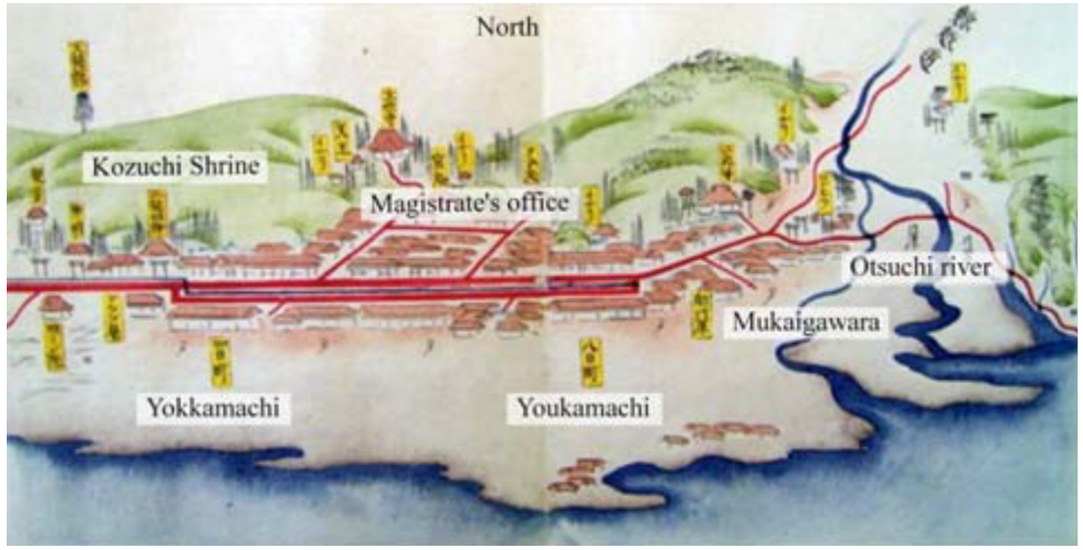
Otsuchi in the Ansei Era 1854-1860

The fishing village of Otsuchi located 50km north of Rikuzen-Takata on the Sanriku coastline in the Iwate prefecture and has had a history of being susceptible to the onslaught of the tsunami as seen from the historic old city map shown in figure-12 below. The orientation of Otsuchi village is typical of the ria coast i.e. steep and narrow bays. It is nestled between the mountains and faces two bays: Funakoshi bay and Otsuchi bay. The urban area of this town is located on an alluvial plain between the Otsuchi River (approximately 27.6 km long) and the Kozuchi River(Kume, Mori, Kitano, Sumi, & Nishida, 2018). Otsuchi prior to 3.11 was home to 16,000 people. The local economy of the town catered to the service sector with a significant contribution from the fishing industries that farmed sticklebacks, salmon, scallops, seaweeds and other fish processing industries (Esteban, Akiyama, Chen, Ikeda, & Mino, 2016).

Post 3.11, 52% of the residential area was submerged under water and 1,284 lives were lost. Furthermore, the fire that was propelled by the tsunami aggravated the conditions for three days. All emergency facilities from the fire department, police station, medical or healthcare facilities, administrative buildings of the town hall and district office buildings were all devastated as all were located in the downtown area of Otsuchi. To make situation worse the government was paralysed as many municipal officials including mayor, directors lost their lives. The sensitivity analysis with respect to the historic



Figures 64– Historic town of Otsuchi
Sources – Authors illustration



contexts, that provides insights in to the evolution of these dynamic social vulnerabilities and their socio-spatial and temporal relations. The results of the analysis conclude that;

1. Historically the coastal communities of Japan were resilient to the nature of tsunami and adapted themselves to the changing nature of the hazardscape by reflecting on the damage in their own traditional ways, that also resulted in stronger social connectivity. But with the development of tsunami science and the investments done in protective infrastructures, the change in frequency of disasters due to mitigation of the smaller disasters through the physical infrastructures created blind faith of the communities about the infrastructures in place.

2. The social memory of the disasters does not last more than 10years as seen from the past

Sensitivity Analysis

Behaviour	Response	Prepared ?	Measures
Morphogenesis	Morphogenesis	Socio-historical memory analysis	Tsunami Wave heights
Socio-historical memory analysis	Socio-historical memory analysis	Countermeasure	Countermeasure
	Critical capital analysis	Critical capital analysis	

Figures 65– Basis for sensitivity analysis
Sources – Authors illustration

events. The community symbols for actions during tsunami does not hold importance in today's times.

3. Intense tsunami events of 9M (repeat period of 500 years) that causes greater impact on the living conditions acts as turnkey and lasts longer in recovery as well as social memory.

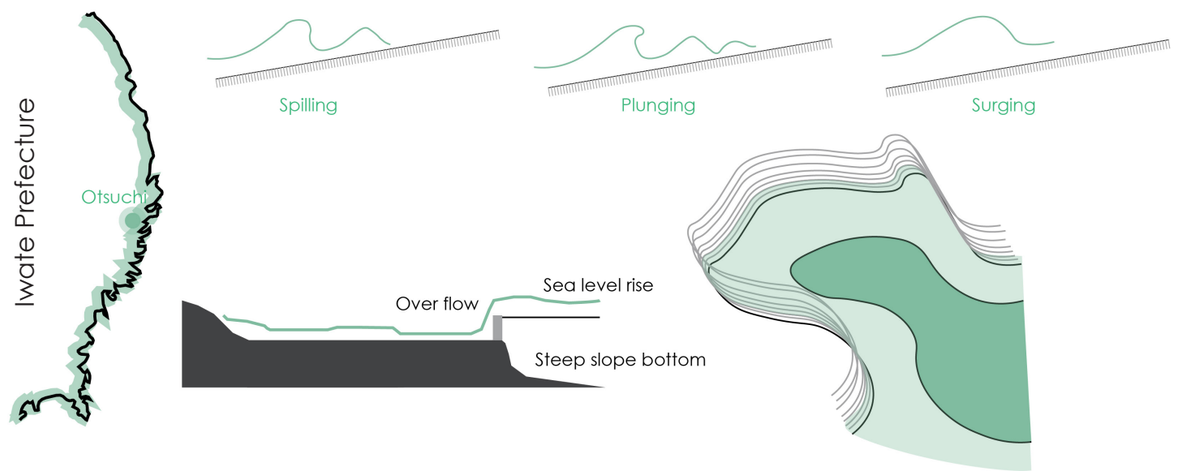
4. Political system, top-down governance methodology changes the course of disaster impact. Both preparedness as well as the recovery stages are crucial for mitigation of the impact.

5. For a total recovery(if it's possible), all stages of the disaster cycle (mitigation, preparedness, response, and recovery) should contribute in improving the resilience of the communities in the Sanriku coast.

6. All the activities and decisions directed towards a complete recovery should be symbiotic of its environments.

It is critical to understand here that by losing the decision-making officials in the event of tsunami the scope of reconstruction and recovery was affected drastically. By losing the pragmatic and rational decision maker in the crisis it affects the response required for the emergency relief aid that further delayed the process of achieving normalcy. The analysis of decision making in the pre and post disaster stage has been the focus for the sensitivity analysis in addition to mapping change in resilience within the critical capitals. The design fiction (GM atlas, Ch-10)examines this further in the spatio-temporal scale and proposes for a new recovery model in case of a 50-100-year tsunami event.

Otsuchi hazardscape



Expert Advice- Jochem Roubos (Multidisciplinary group)

Figures 66– Seismicity at Otsuchi

Sources – Authors illustration

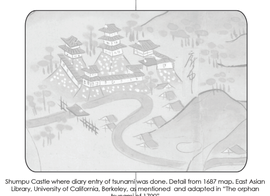
The Tohoku coast has unique geography and topography with the coastline in the shape of a necklace along the Sanriku coast, with cities of Kesennuma, Ofunato, Kamaishi and Miyako as the base for many smaller fishing villages and industries see figure-4. The Japanese fishery law gives these villages exclusive rights to function autonomously with its own fishing ground and port for landing, processing and distribution. While the communities in these fishing villages have enjoyed exclusive rights to the rich resources of the sea, social services and amenities are not evenly distributed (Miyake, 2014). Therefore the 3.11 disaster and its impact were differently felt and in particularly at the villages of Iwate and Miyagi, where the density of ports is far higher than the national average.

The Great eastern Japan earthquake tsunami that struck the Sanriku coast on 11th March 2011 was the most destructive of all times for these Tohoku coastal communities. The loss estimates to be 22,626 persons killed or missing nationwide (of which 15,534 are confirmed deaths), 107,000 buildings collapsed, and another 111,000 partially collapsed (National Police Agency, 2011). The economic damage itself cost up to 16.9trillion Japanese yen.

The regional areas of Japan which includes Tohoku and the non-metropolitan areas has been shrinking since the post war period due to national consensus on economic expansion for regional development which was prompted by the top-down political, bureaucratic and corporate elites cited by (Machimura, 2002) and cited by (Cho, 2014). Consequently, the socio-economic vitality of Japan has decreased and weakened. While the national population is on the decline(Jung Soon-dol, Park Hyun-joo, 2011) the disaster of 3.11 has exposed the vulnerability of Japan's the socio-political systems(Cho, 2014) too. The paper has understood this critical aspect in its fundamental stages. This has contributed and enhanced the research methodology by driving bottoms up research and evaluating several contemporary practises, service dependencies, transportations, emergency measures, economic proliferations with respect to the local to national governance decision exchanges.

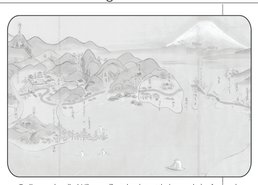
Morphogenesis and sensitivity analysis of Japan- focus on Tohoku coast

Keicho Sanriku Earthquake Tsunami
8.1M, 21 meters wave height



Shumpu Castle where diary entry of tsunami was done. Detail from 1687 map, East Asian Library, University of California, Berkeley, as mentioned and adapted in "The orphan tsunami of 1700"

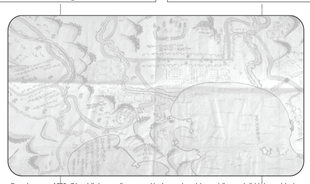
The orphan tsunami, Japan
9M Earthquake at Cascadia, North America
4 meters wave height



On the scenic spit at Miho, a village leader puzzled over a train of waves in january 1700, as mentioned and adapted in "The orphan tsunami of 1700"

Chilean Tsunami
8.5M earthquake at chilean coast,
5-6 meters wave height

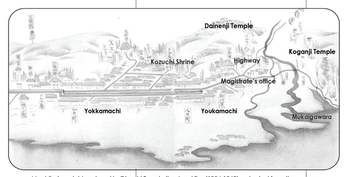
Kansei Earthquake Tsunami
8-8.4M, 4-6 meters wave height



On a tax map 1730, Otsuchi's houses line a road between bayside paddies and district magistrates office . To the southwest, smoke rises from the kiln, as mentioned and adapted from in "The orphan tsunami of 1700"

Hachinohe Earthquake Tsunami
7.5-8M, 4-6 meters wave height

Meiji Great Sanriku Tsunami,
8.5M, 38.2 meters wave height

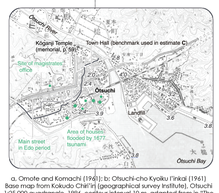


Machikata neighbourhood in Otsuchi Townin the Ansei Era (1854-1860), adapted from the reconstruction plan of Otsuchi town.

Showa Great Sanriku Tsunami,
8.1M, 28.7 meters wave height

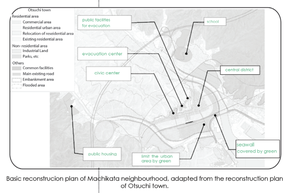
Topographic maps of Machikata neighbourhood in 1913, adapted from the reconstruction plan of Otsuchi town.

Chilean Tsunami,
8.6M earthquake at chilean coast,
5-6 meters wave height



a, Omote and Komachi (1961); b: Otsuchi-cho Kyoiku Iinkai (1961) Base map from Kokudo Chiri'in (geographical survey institute), Otsuchi 1:25,000 quadrangle, 1996, contour interval 10 m, adapted from in "The orphan tsunami of 1700"

The Great Eastern Japan Earthquake Tsunami
9M, 38 meters wave height



Basic reconstruction plan of Machikata neighbourhood, adapted from the reconstruction plan of Otsuchi town.

Tsunami Wave heights

50
40
30
20
10
0M

Socio-historical memory

Ansei-Tokai Earthquake, East coast
Ansei-Nankai Earthquake, West coast

Kanto Earthquake

Japan Sea Earthquake Tsunami

Hokkaido Nansei-Oki Earthquake Tsunami

weakest	moderate	moderate	moderate	moderate	moderate	strong	strong			weakest	
89 years	51 years	42 years	63 years	40 years	37 years	27 years	51 years				

1600s 1611 1700 1751 1793 1800s 1854-55 -56 1896 1900s 1923 1933 1960 1983 1993 2000s 2011 2019 2100s

Age of samurai | Age of samurai | Modernization | Post war | Post disaster

Edo Period (1603 - 1868) | Edo Period (1603 - 1868) | Meiji Period (1868 - 1912) | Taisho Period (1912 - 1926) | Early Showa Period (1926 - 1945) | Late Showa Period (1945 - 1989) | Heisei Period (1989 - 2019)

Critical capital analysis

Political capital
Environmental capital
Economic capital
Human capital
Social capital
Physical capital
Countermeasure

Closed door policy
Open door policy and westernisation
Militarisation WWI WWII
Democracy & open door policy

Active trade with Southeast Asia
Strong economy and industrialisation
recession and banking crisis
Strong economy and industrialisation
Bubble burst and economic stagnation
Environmental destruction
Economic developemnt (per million)

Agrarian society
Rural to urban migration
Evacuation and dispersion of population
urbanising society
Social innovation and urbanised (aging)society
Population developemnt (per million)

Rapid urbanisation, multi-polar urbanization and mass transit systems
Sustainaible growth and high quality of living standards, social transformation

Green field development
Slowdown and maturity

Historical evacuation measures

Historical evacuation measures

Tsunami science started

* Official undertaking of Tsunami countermersures
* Relocation of dwelling houses to high ground and tsunami forecasting

* Tsunami engineering by elaborating coastal structures for tsunami defense.
* Practical comprehensive tsunami disaster prevention 3 measures, defense structures, tsunami-resistant town development and evacuation based on warning
* Tsunami breakwaters, coastal dikes, tsunami resistant forests, memorial ceremonies
* Tsunami and earthquake resistant building standards

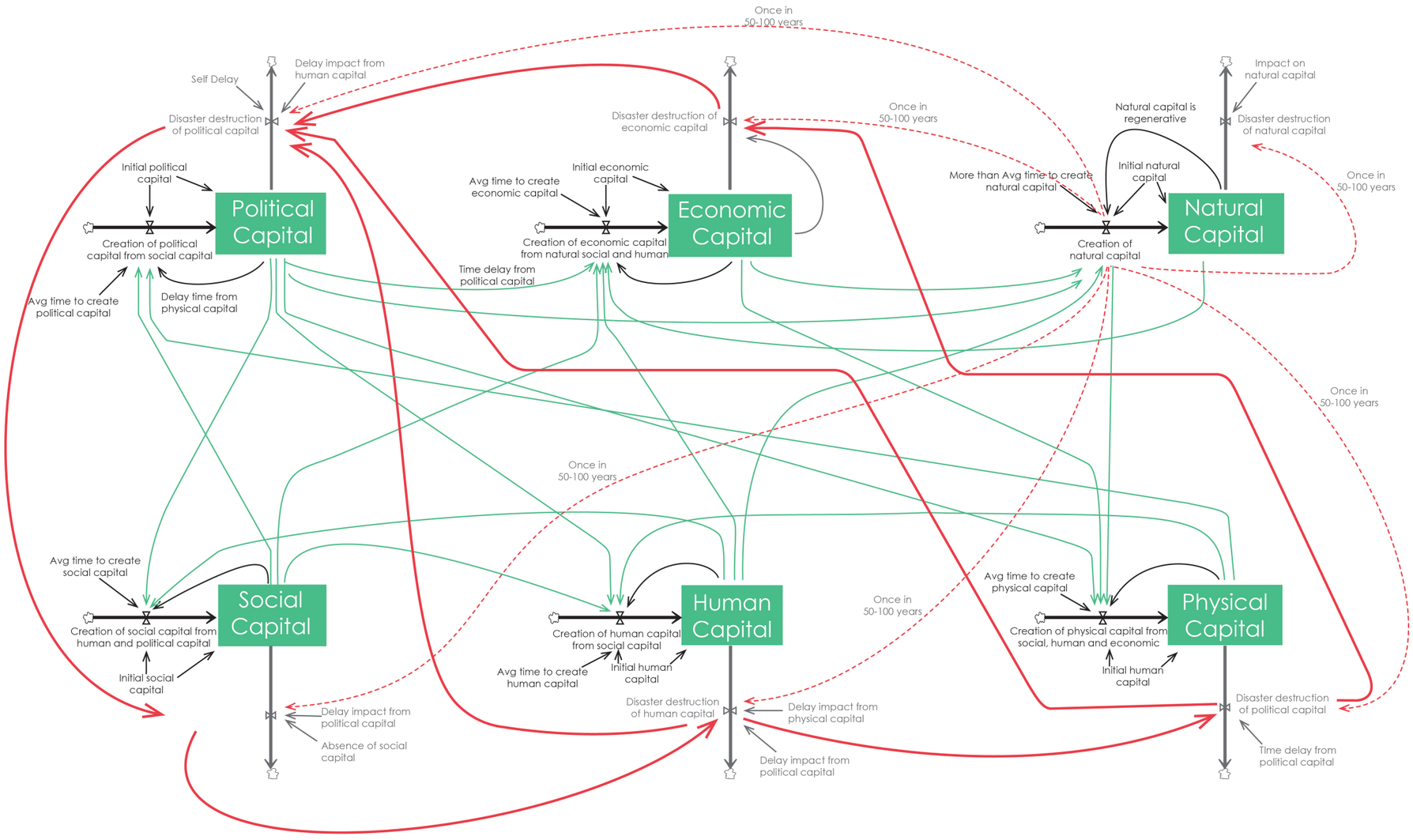
* Combiantion of non-structural and structural measures
* Amendment in tsunami countermeasures act
* Changes in zoning laws

7.4 Conceptual capital model

Evaluating decisions of 3.11

Reconstruction decisions of 2011 tsunami evaluated based on system dynamics

- Tsunami occurred, a natural phenomenon of the natural capital
- Town mayor died in tsunami and deputy nearing his term end
- Many governmental official lost their lives
- Town concentrated on election of new mayor
- For elections efforts put on restoring ICT
- Damaged ICT due to wrongly located
- Delay due to demographic information lost
- Transport external input from prefecture government (social capital)
- Emergency services provided
- Transport external input from prefecture government (social capital)
- Emergency services provided
- Healthcare volunteers catered to evacuees (human capital) and took electoral information
- Communication restored
- New mayor took charge
- Funding and aid was used for recovery
- New mayor through collaboration and participating with other leaders started relief and reconstruction work
- Human efforts to restore the
- 1st recovery plan made in Dec 2011
- Actual reconstruction started in 2014



Capital being influenced in creation stage

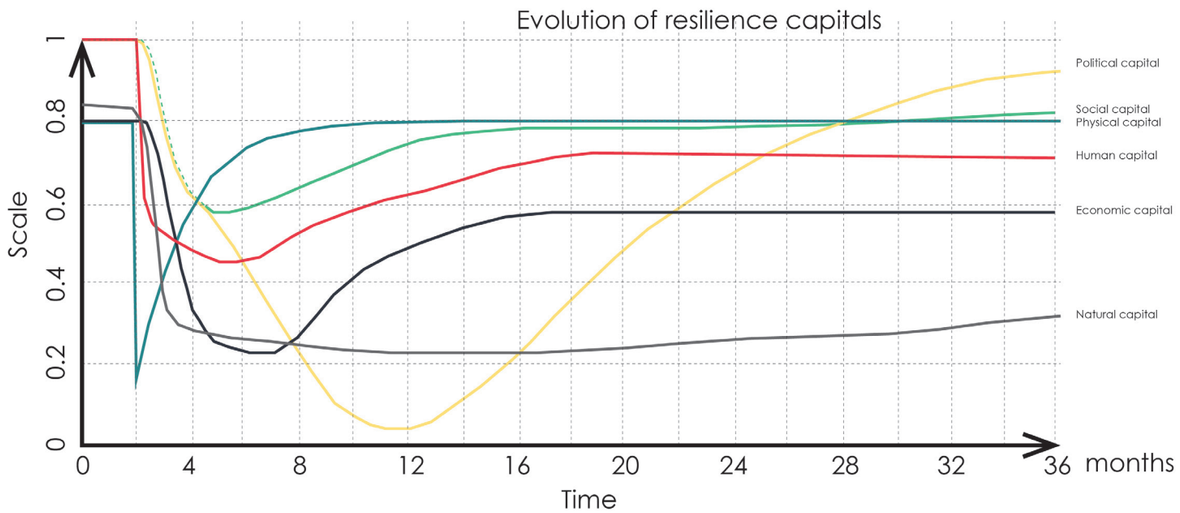
Capital being influenced /destroyed in the destruction stage

7.5 Simulations

Decision analysis based on the simulations of 3.11

The simulated decisions of reconstruction are based on the 3 year model for the critical capitals

- 9 month delayed response for recovery caused, displacement, psychological trauma, reduced resilience, uncertainty and mistrust in the government
- Power to take decisions should be decentralised
- Emergency decisions should be exercised within decentralised government
- Alternatives should be present for emergency relief
- Social connections should be enhanced
- Critical services should be located in non-hazard area
- Business contingency plans should be well researched
- Awareness of tsunami should be activated
- Hazards maps and coastal regulations need to be incorporated



Figures 67– simulation of decisions for reconstruction at Otsuchi
Sources – Authors illustration

08 | assessment stages

Inter-linkages and associations

This chapter focuses on the Iwate prefecture and specifically on the town of Otsuchi. Initially it links the disaster topography of Iwate and Japan within the Tohoku region by different analysis methods. It showcases the built up of the region through the history of disasters while still retaining the identity, wisdom and resilience intact. The sections focus on the state of otsuchi before 3.11 and the reconstructed today by assessing the change in resilience capacities and the nature of dependencies within tsunami risk.

08 | assessment stages

8.0 Sections

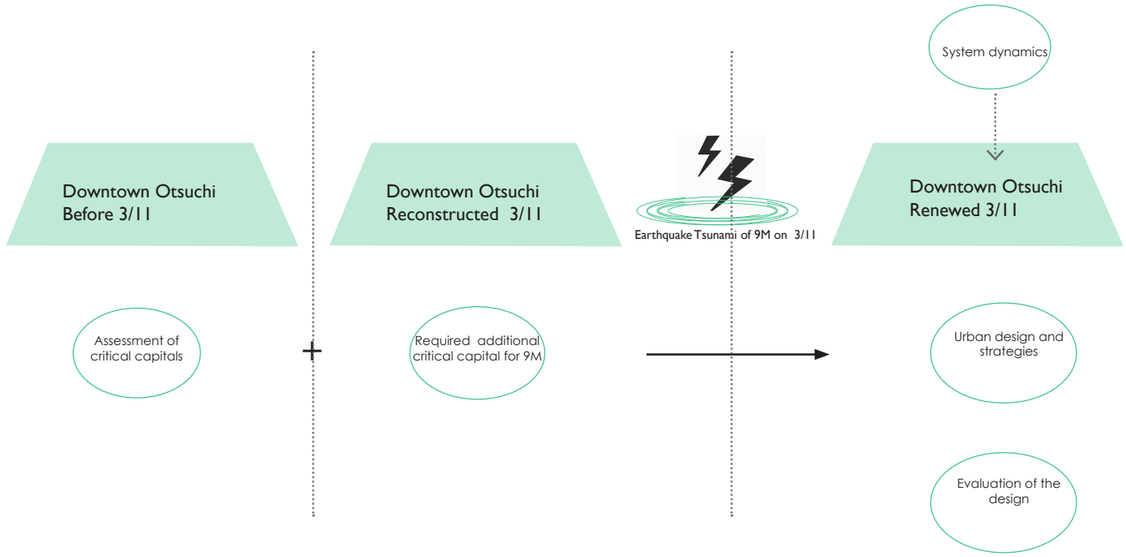
8.1 Design fiction
Pre 3.11 and post reconstructed 3.11

8.1 decision analysis

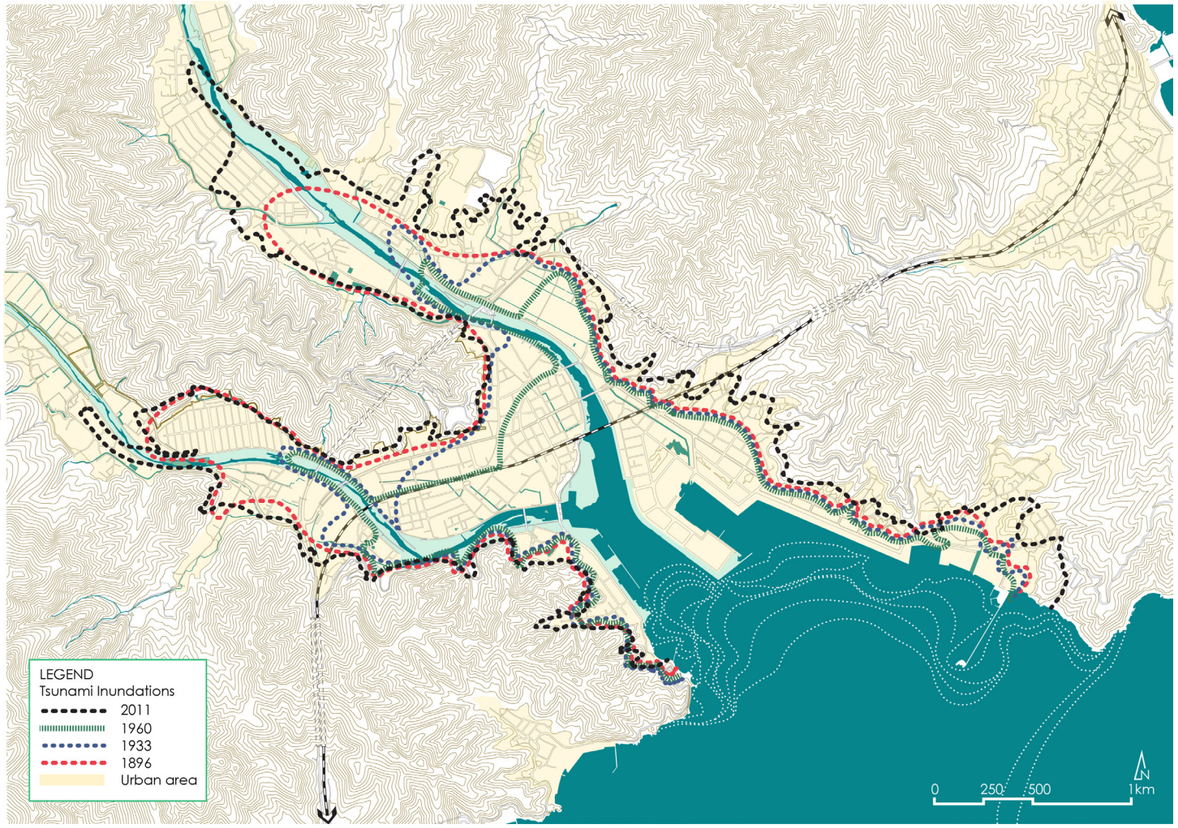
Design Fiction

In the context of Otsuchi, based on the sensitivity analysis and the enhancement of critical capitals on site (GM atlas, Ch-10) the new development/ renewal plan for Otsuchi was desired that is different from the current reconstruction plans. The 'design fiction' forms a strategy to understand and effectively prepare, mitigate and reduce the impact while planning for the post disaster recovery measures. As it was realized through theories, preparedness is a continuous process, so the design strategy mapped the resilience conditions of Otsuchi prior to 3.11 and the reconstructed resilience conditions post 3.11. In doing so changes based on the developed planning methodology of IEP and the support tool of the conceptual critical capital model were integrated, and relative interventions were planned.

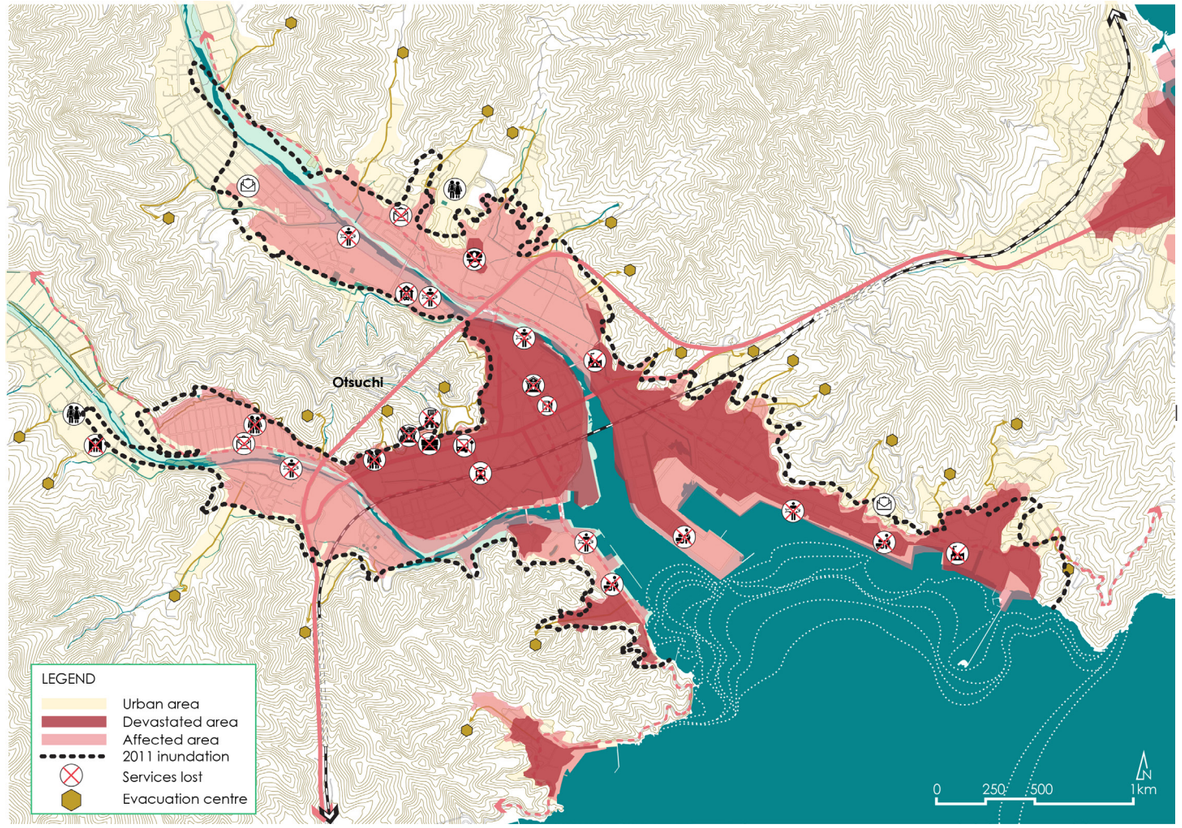
It is critical to understand here that by losing the decision-making officials in the event of tsunami the scope of reconstruction and recovery was affected drastically. By losing the pragmatic and rational decision maker in the crisis it affects the response required for the emergency relief aid that further delayed the process of achieving normalcy. The analysis of decision making in the pre and post disaster stage has been the focus for the sensitivity analysis in addition to mapping change in resilience within the critical capitals. The design fiction (GM atlas, Ch-10)examines this further in the spatio-temporal scale and proposes for a new recovery model in case of a 50-100-year tsunami event.



Inundations levels in Otsuchi



Damage due to 2011 Otsuchi

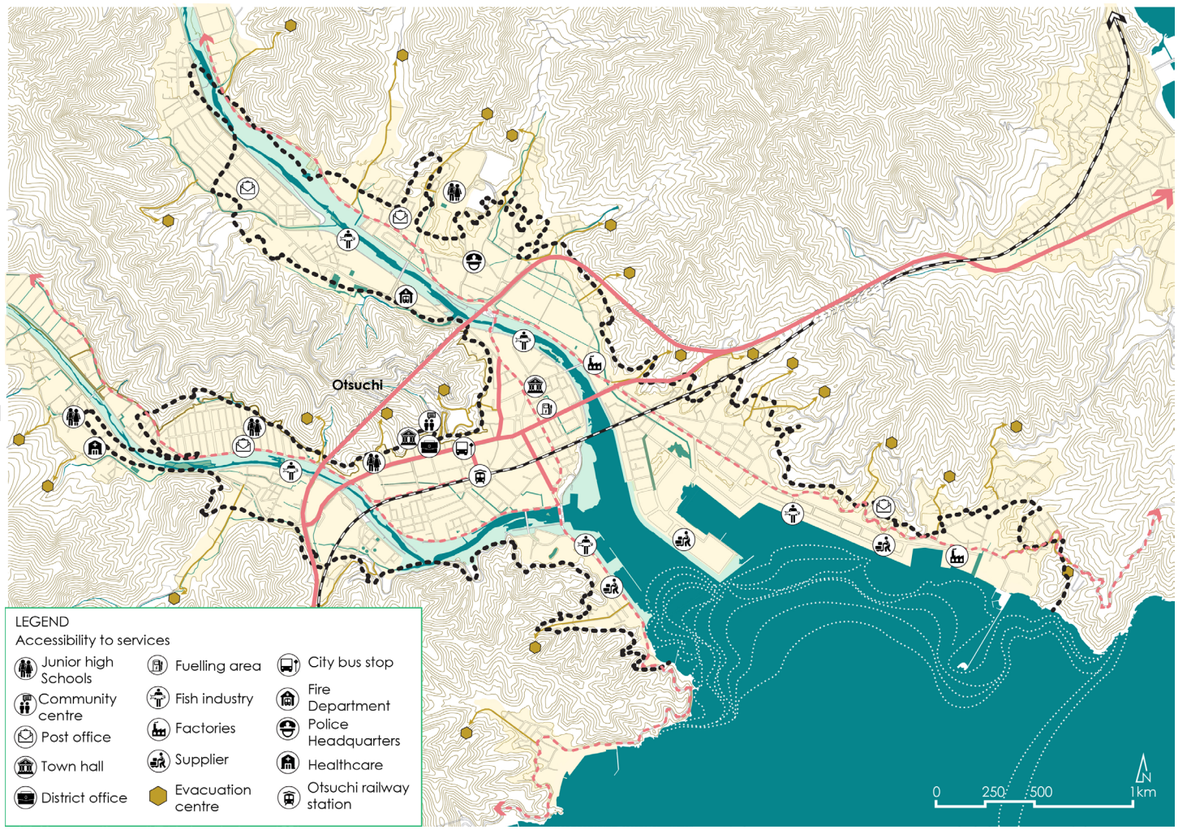


Otsuchi Before 3/11

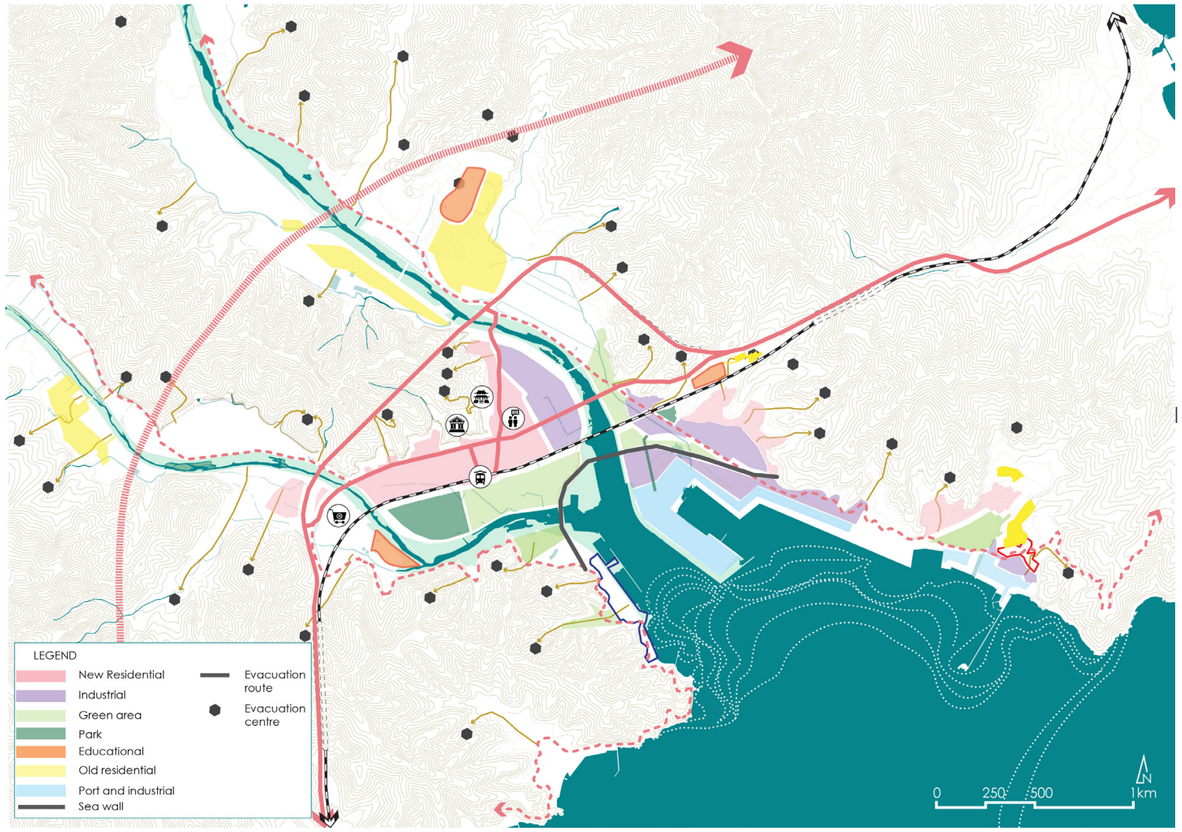
Otsuchi After 3/11

Figures 68– Otsuchi, Machikata district
Sources – Extracted from presentation

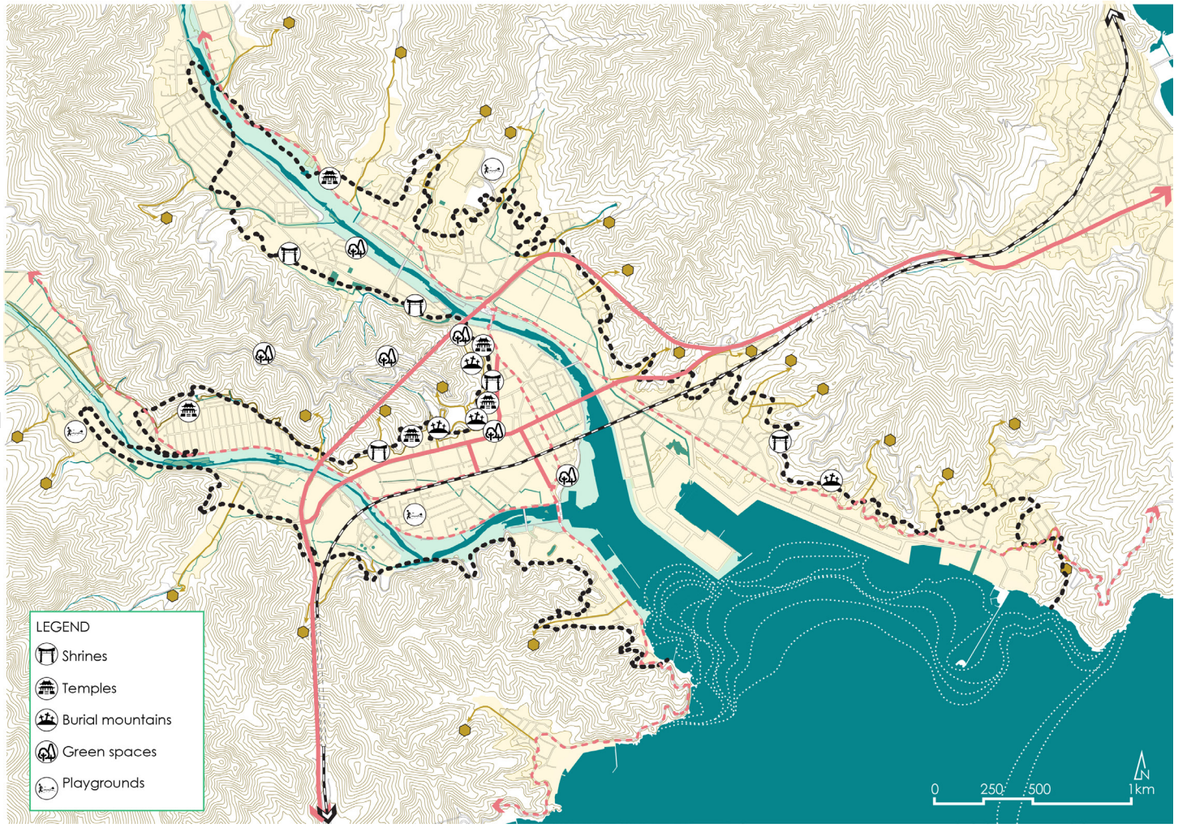
Otsuchi Before 3/11



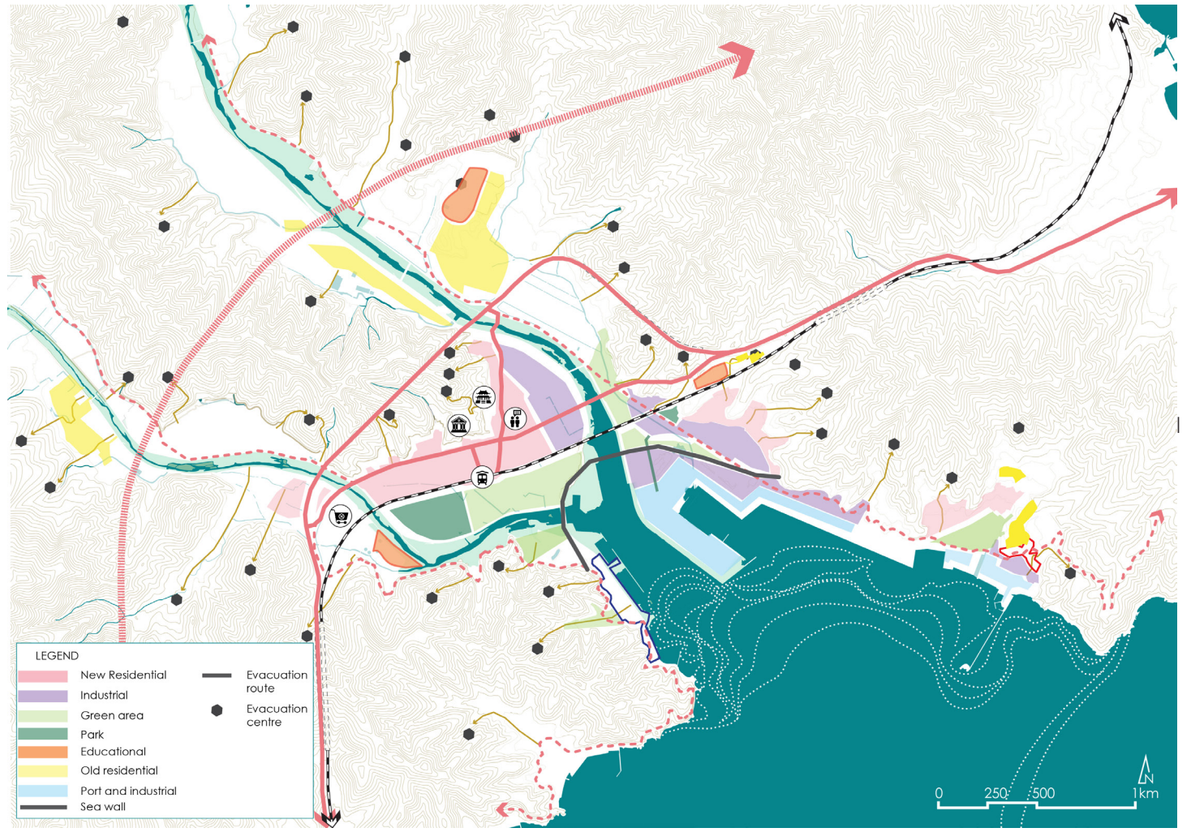
Otsuchi After 3/11



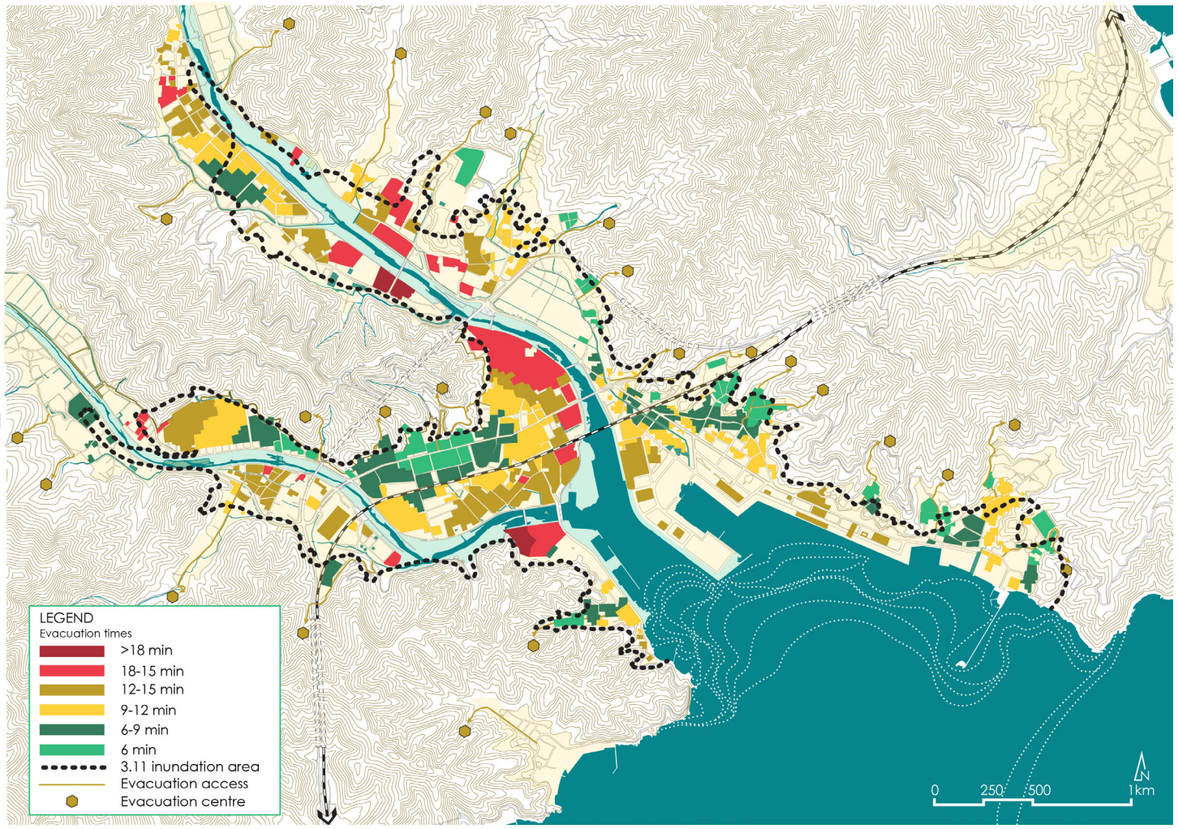
Otsuchi Before 3/11



Otsuchi After 3/11



Otsuchi Before 3/11



Source- MAS SimTread Software, Tomonori Sano

Design fiction conclusions

- Clustering (residential and amenities) near the mountain
- No coastal regulation but hazard zone present as green space
- Evacuation not enhanced
- Elements for cascading disasters still present, like use of gas cylinder
- Landuse and demographics disproportionate
- Down town area looked ghost town (field visit)
- Use of expensive infrastructure like tsunami wall but
- Identity and local connection of land and sea lost

09| design and strategies

Blueprint- adapting to the disruptive

This chapter focuses on the Iwate prefecture and specifically on the town of Otsuchi. Initially it links the disaster topography of Iwate and Japan within the Tohoku region by different analysis methods. It showcases the built up of the region through the history of disasters while still retaining the identity, wisdom and resilience intact. The sections focus on the state of otsuchi before 3.11 and the reconstructed today by assessing the change in resilience capacities and the nature of dependencies within tsunami risk.

Imaging resilience capacities and shaping future landscape

09 | design and strategies

9.0 Sections

9.1 disruptive normal strategies

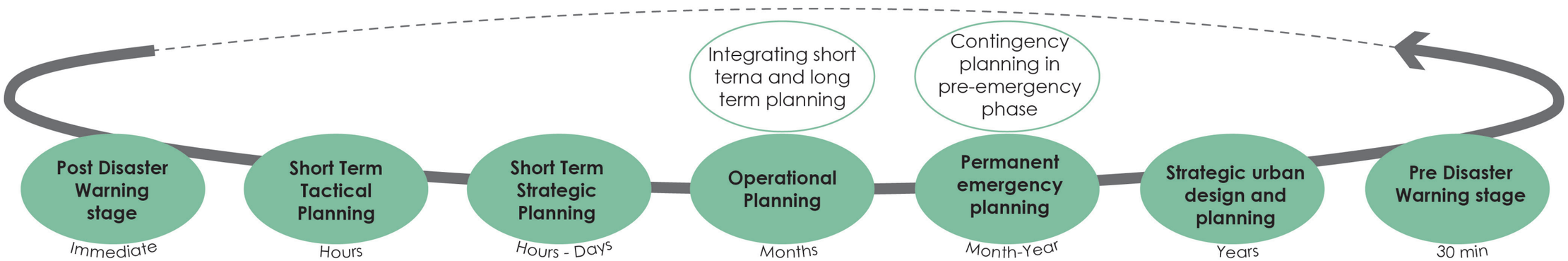
Integrated emergency planning methodology

The integrated emergency planning cycle elaborates on the different stages of action and decision making that are integral for planning within the recovery and reconstruction process. These stages are critical for they change the course of recovery. Formulation and integration of the planning domains has been done based on the simulation results of the conceptual capital model and resilience enhancement of the critical capitals on site. The stages involved in the planning cycle commence with the emergency response that is spread over few hours and days within which health of the affected population is significant for long-term resilience building. Stages following assess the damage and the scope of reconstruction required to be carried out.

The actions listed against each of the planning stages are based on the collective capacities of the community as well as the influence of the political capital. The literature reviews pointed out the dependency of decision making limited to the political capital which has been altered in these approaches. The current political system in Japan shows transition from top down to being integrative of bottoms up approaches. This has been factored within the planning approaches by means of highlighting the decentralized state of the political capital. This results in reducing the complexity of risk during the crisis. The scope of work within each phase is spatio-temporal in dimension and therefore result in contributing towards spatial design of the approaches into strategies depending on the relative capacities of the hazardscape.

The integration of long-term planning aspects does put pressures on the forms of planning towards timely action, but time is the critical element. The approach to planning therefore also takes into factor exercising these decision-making capacities of the political capital by proposing a directive for collaboration and exercising decision making that transcends across the operational domains. The principles of these planning approaches are integrated by running through the capital model to know if all the dependencies are met and if not which critical capitals need to be influenced.

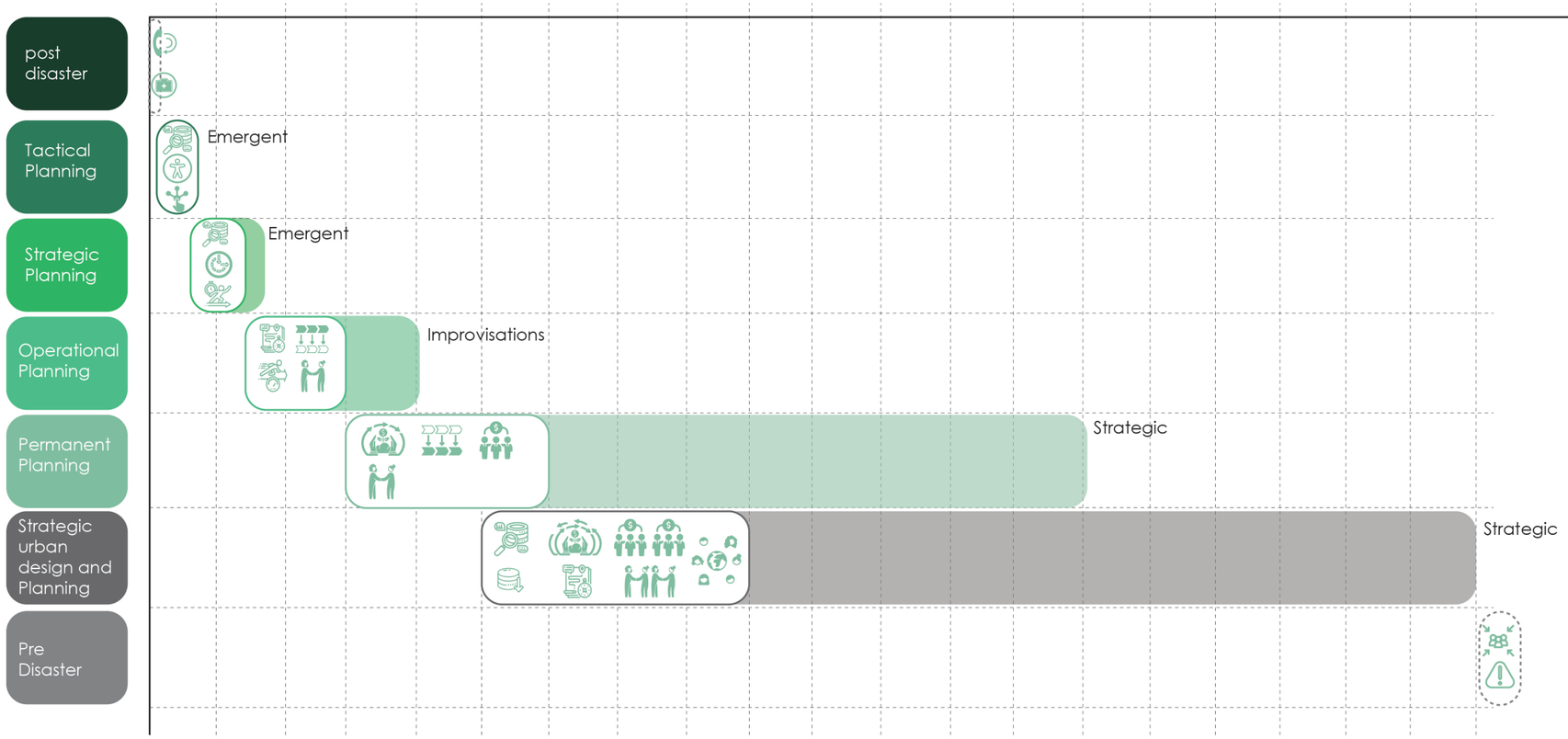
Integrated emergency planning strategy



NOTES

1. **Dispersing the power of political capital to manage decisions**
2. **Exercising emergency decision making across operational domains**

9.2 Strategy roadmap



To implement these planning approaches in a formal way a roadmap for implementation was made based on the 3.11 impact that guides about the time investments within the planning fields. A 5-year timeline for planning and implementation is considered based on the contingencies. While this helps to know the effectiveness of the plan, the flexibility aspect within encourages to improvise if the need arises. Based on the time line certain attributes for the critical capital model and urban design of Otsuchi were derived;

1. Alternate accessibility to critical services after the disaster

2. IEP planning results in less likelihood of loss to human and social capital

3. Decentralized political capital and exercise of IMP supports efficient decision making

4. Decisions in the event of disaster will be based on empirical and rational possibilities of the available data backups.

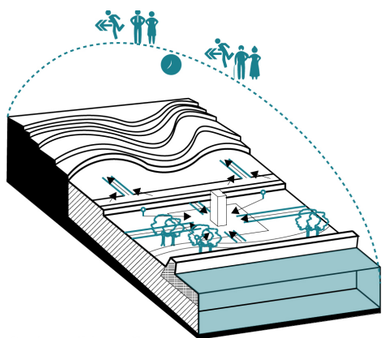
5. Recovery and reconstruction activities will be based on assessment of the hazardscape for its futuristic potentials.

6. The design for Otsuchi should be vital, sensitive, site specific and futuristically sustained.

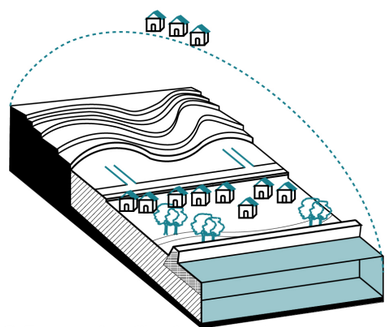
9.3 Principles of integrated emergency planning

Spatial Principles

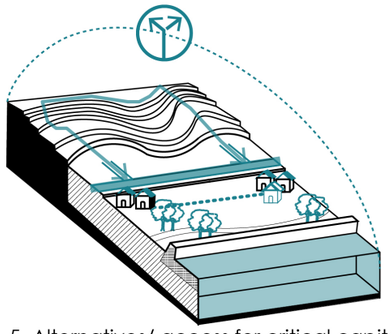
Integrating strategies and processes within the framework of the integrated emergency planning requires to define principles that are specific to the hazardscape and particularly to the fishing communities of the Ria's coastline of Tohoku. These principles support the decision-making and the time dependent actions required during the recovery and reconstruction processes. The principles mentioned are categorized based on the balance of 4Ps model which are people (resilience), planet (wellbeing), prosperity(feasibility) and project (damage/impact). These principles are explained in detail in.



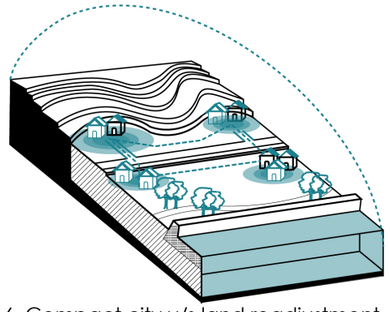
1. Age friendly evacuation



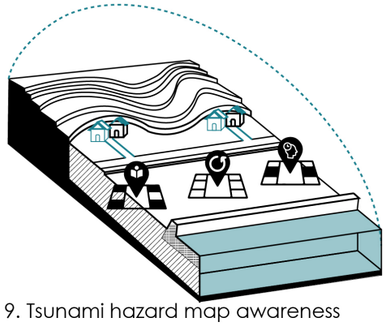
2. Tsunami resilient morphology



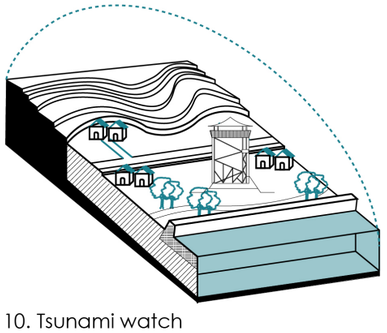
5. Alternatives/ access for critical capitals



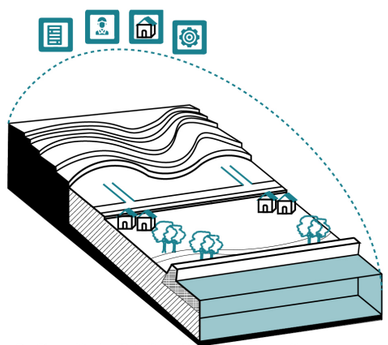
6. Compact city v/s land readjustment



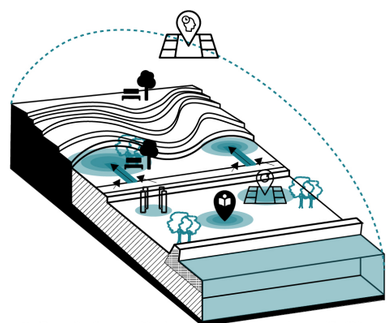
9. Tsunami hazard map awareness



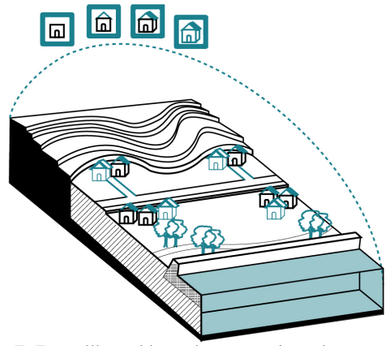
10. Tsunami watch



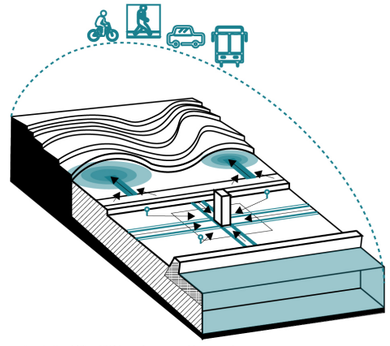
3. Spatial distribution of functions



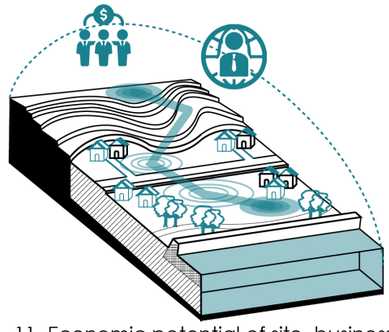
4. Social spatial and cultural activities stimulating resilience



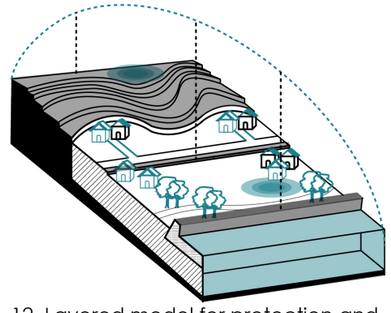
7. Transitional housing as a typology



6. Multiutility transit systems



11. Economic potential of site, business as usual



12. Layered model for protection and mitigation

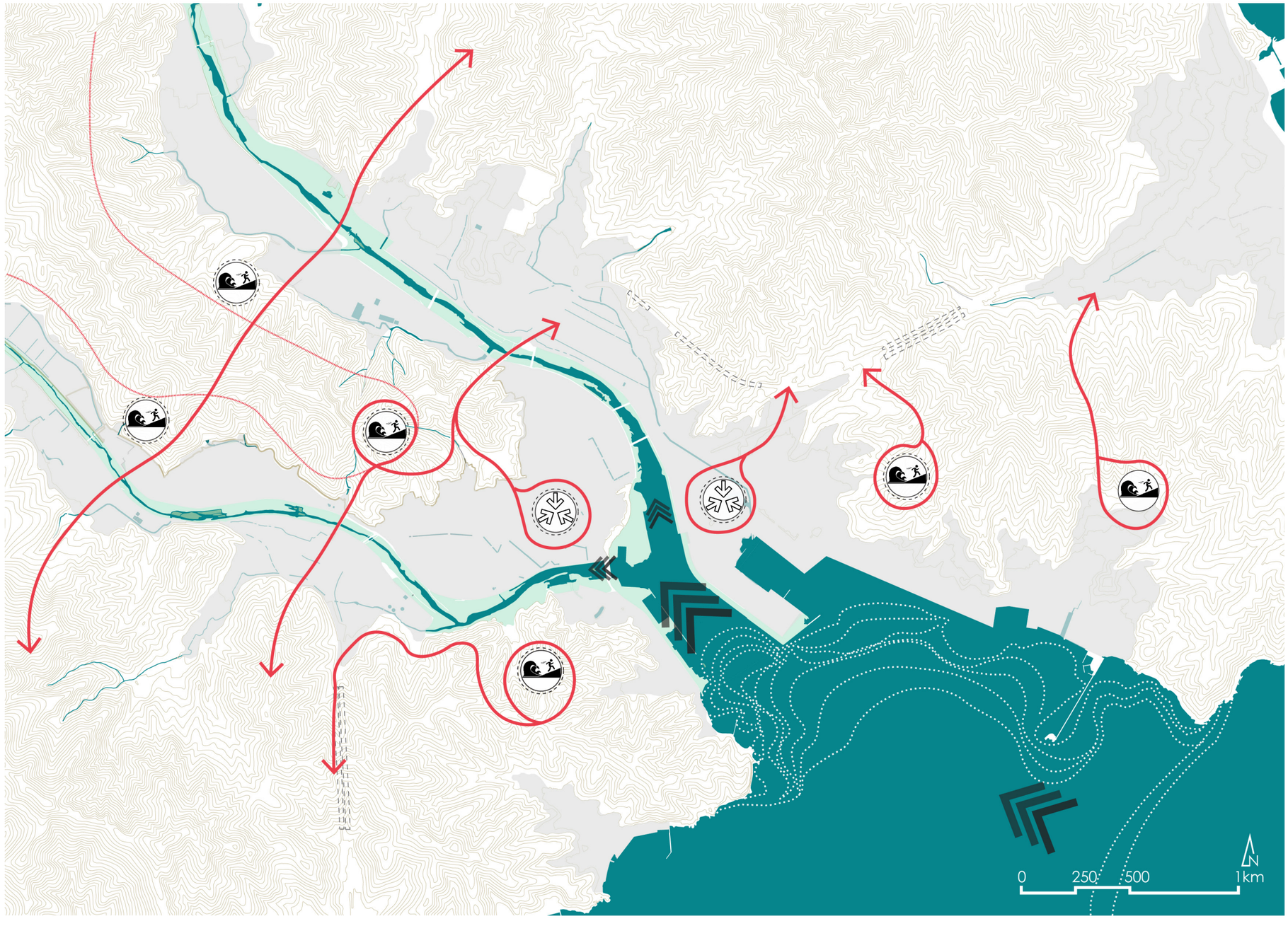
9.4 Vision for Otsuchi

The analysis from the strategy and the dependency model of the critical capital through the principles of integrated emergency planning support the new vision for Otsuchi which is 'Kaizen Otsuchi'.

Kaizen means continuous improvement. The vision for Otsuchi realises the potential of Otsuchi for its inhabitants within the Tohoku region. This drives the vision for the revival of Otsuchi town, its identity with the place and the lost heritage due to 3.11 to form a safe and sustained community that is prepared enough.

Vision Goals

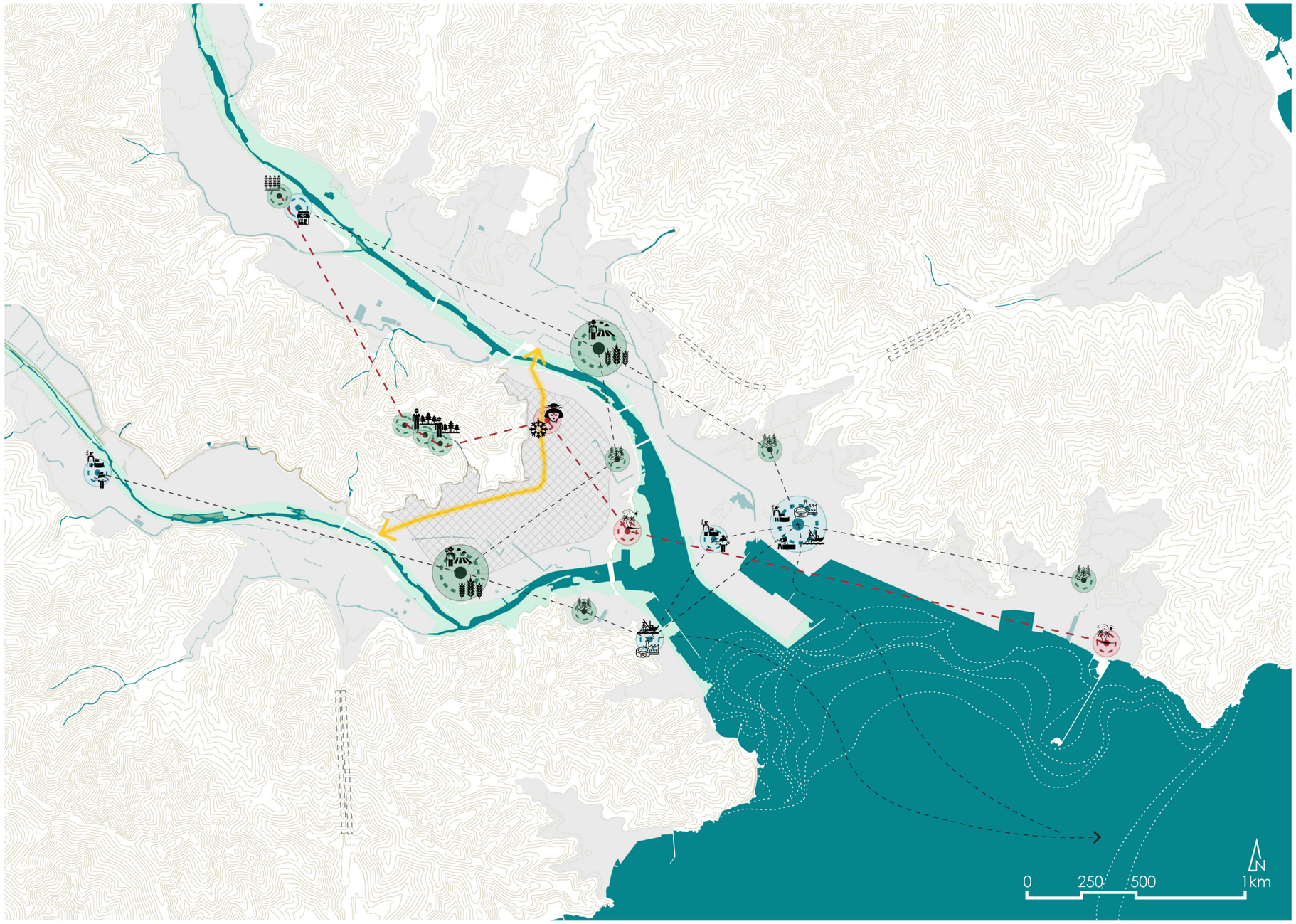
- **Safety** and **connectivity** during and after disaster
- **Evacuation** and **relief** catered faster



9.3 Vision for Otsuchi

Vision Goals

- **Compact** and **livelihood** neighbourhoods
- **Sustained** living
- **Identity** and **connection** with the sea and land retained
- Society's lost treasures **revived**



10| design development

Revive, reinforce and reinvent

This chapter focuses on the Iwate prefecture and specifically on the town of Otsuchi. Initially it links the disaster topography of Iwate and Japan within the Tohoku region by different analysis methods. It showcases the built up of the region through the history of disasters while still retaining the identity, wisdom and resilience intact. The sections focus on the state of otsuchi before 3.11 and the reconstructed today by assessing the change in resilience capacities and the nature of dependencies within tsunami risk.

10| design development

10.1 design features

Kaizen means continuous improvement. The vision for Otsuchi realises the potential of Otsuchi for its inhabitants within the Tohoku region. This drives the vision for the revival of Otsuchi town, its identity with the place and the lost heritage due to 3.11 to form a safe and sustained community that is prepared enough.

The map above highlights the vision goals identified for Otsuchi's renewal which are

1. Accessibility to critical services even during disaster

2. Retained connection with the land and sea, hence no sea wall till 15 years

3. Regulate coastal zoning measures

4. Stimulate collaborative business as usual projects

5. Revitalise the downtown

6. Revive Otsuchi's natural heritage

The urban renewal design of Otsuchi relies on its potential as a site for historic and natural treasures while embracing the nature of frequent disaster like conditions. With this ideology for the communities living in Otsuchi, important design considerations were made for its holistic recovery.

1. The downtown area of Otsuchi shall adhere to the coastal regulations for zoning. The area near the bay moth will not be habituated and will be used for multifunctional use of economic production, recreation and biodiversity.

2. The physical protective barriers such as dikes, flood gates at the bay mouth and break water will be rebuilt in harmony with the prevailing ecosystems of the area.

3. Railway connectivity shall be restored at the same place with due consideration given to feasibility of rerouting. While additional highway connectivity shall be built behind the inundated areas for alternative access during disasters.

4. The downtown areas considered unhabitable shall be relocated in the new city's fabric with due consideration to sentimentality of the people and rational of the place. In addition, compact and concentric planning of functions and activities shall be managed for town's proliferation.

5. Evacuation routes and centres (horizontal and vertical) will be accessible in the event of the disaster through the urban morphology and tsunami resilient designs.

6. Evacuation designs for steps and ramps to reach the evacuation centres shall respect all age groups and post disaster map the demographics for spaces contributing to sharing typology .

7. The natural and social elements like fresh water springs, tsunami stones etc will be used in the city fabric as evacuation directions and will be made aware to people through hazards maps and medias.

8. Old heritage structure sites damaged in 3.11 shall be co-designed based on concepts of social memory and cultural remembrance.

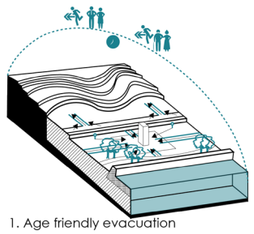
9. The economic potentials of the land shall be dealt with business as usual model and a holistic research in the sector of contingency planning.
10. The old historic town road shall be revived with distributed amenities and residential spaces around.

11. After the disaster, land will be redesigned for readjustment based on priority without delays. This shall be done in addition with the assessment for compact city planning and relocation.

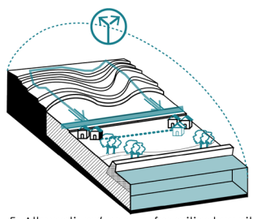
Safety

Principles

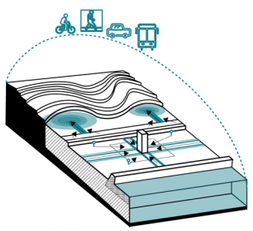
- 15 more evacuation areas added to the earlier 23 existing
- Out of 38 evacuation centres 4 centres are for vertical evacuation in the downtown area



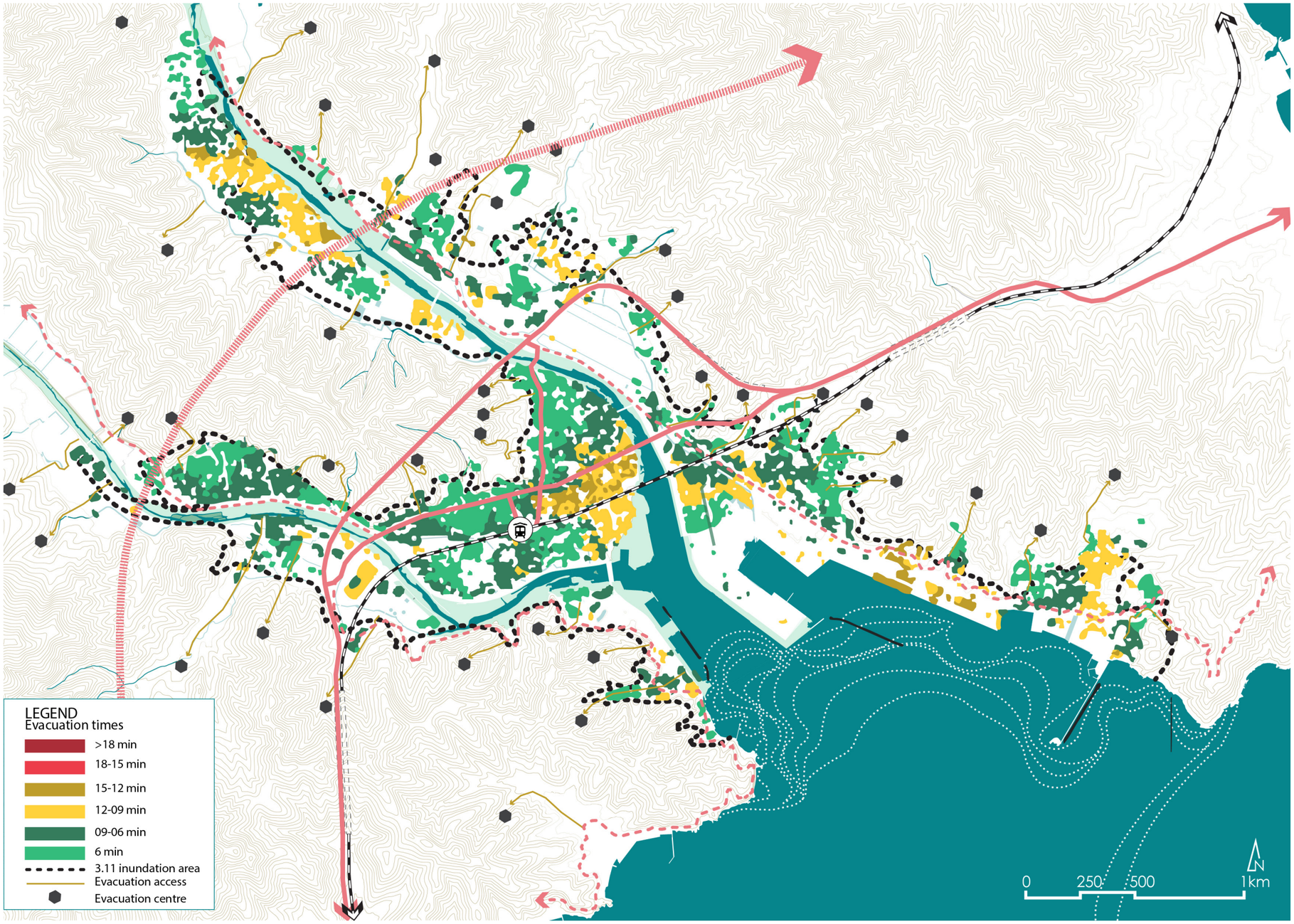
1. Age friendly evacuation



5. Alternatives/ access for critical capital



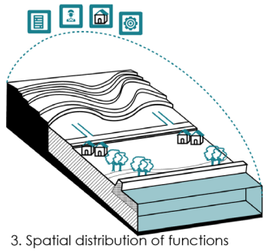
6. Multiutility transit systems



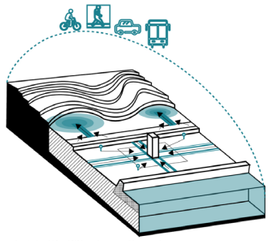
Protection

Principles

- Coastal regulations with nothing to be built 150 m from the coasts
- Demarcation for habitable and non habitable areas



3. Spatial distribution of functions



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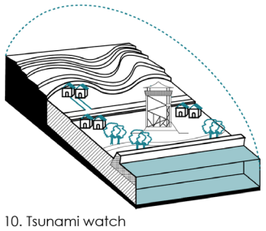
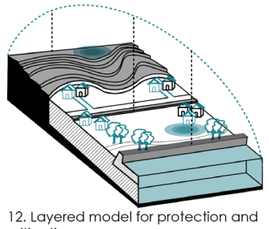
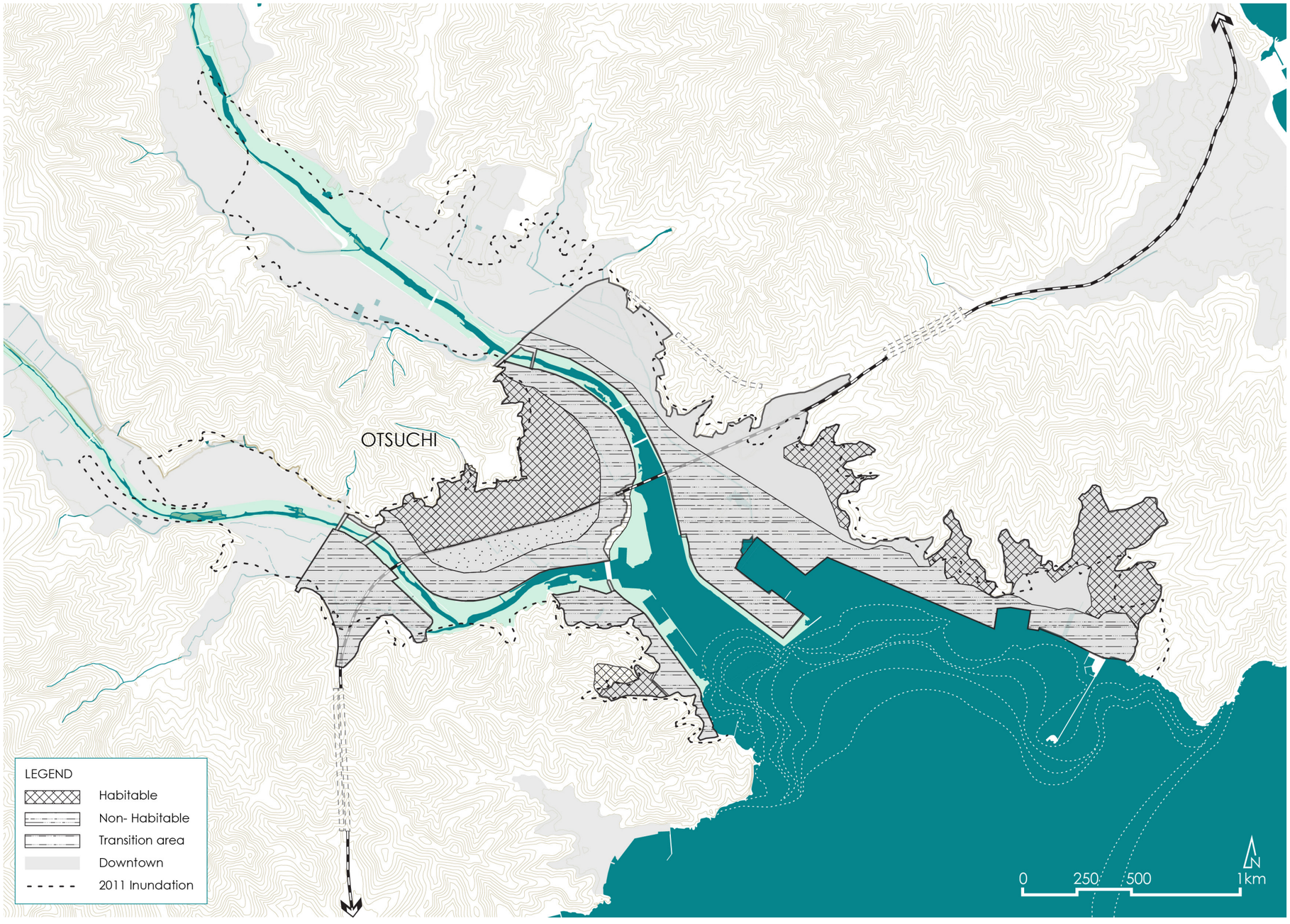


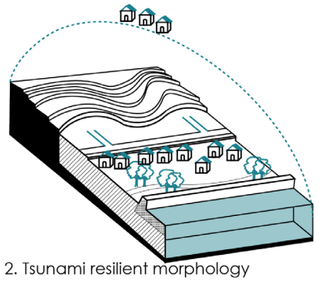
10. Tsunami watch



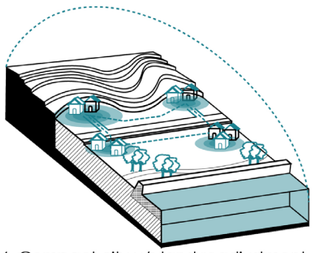
12. Layered model for protection and mitigation



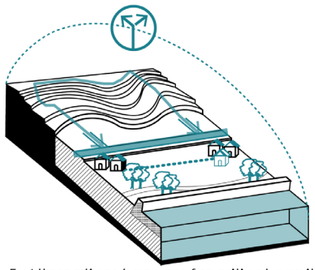
Connectivity



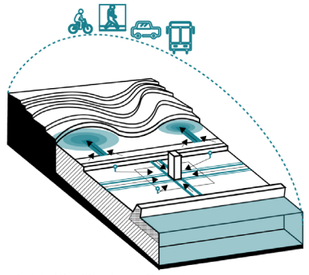
2. Tsunami resilient morphology



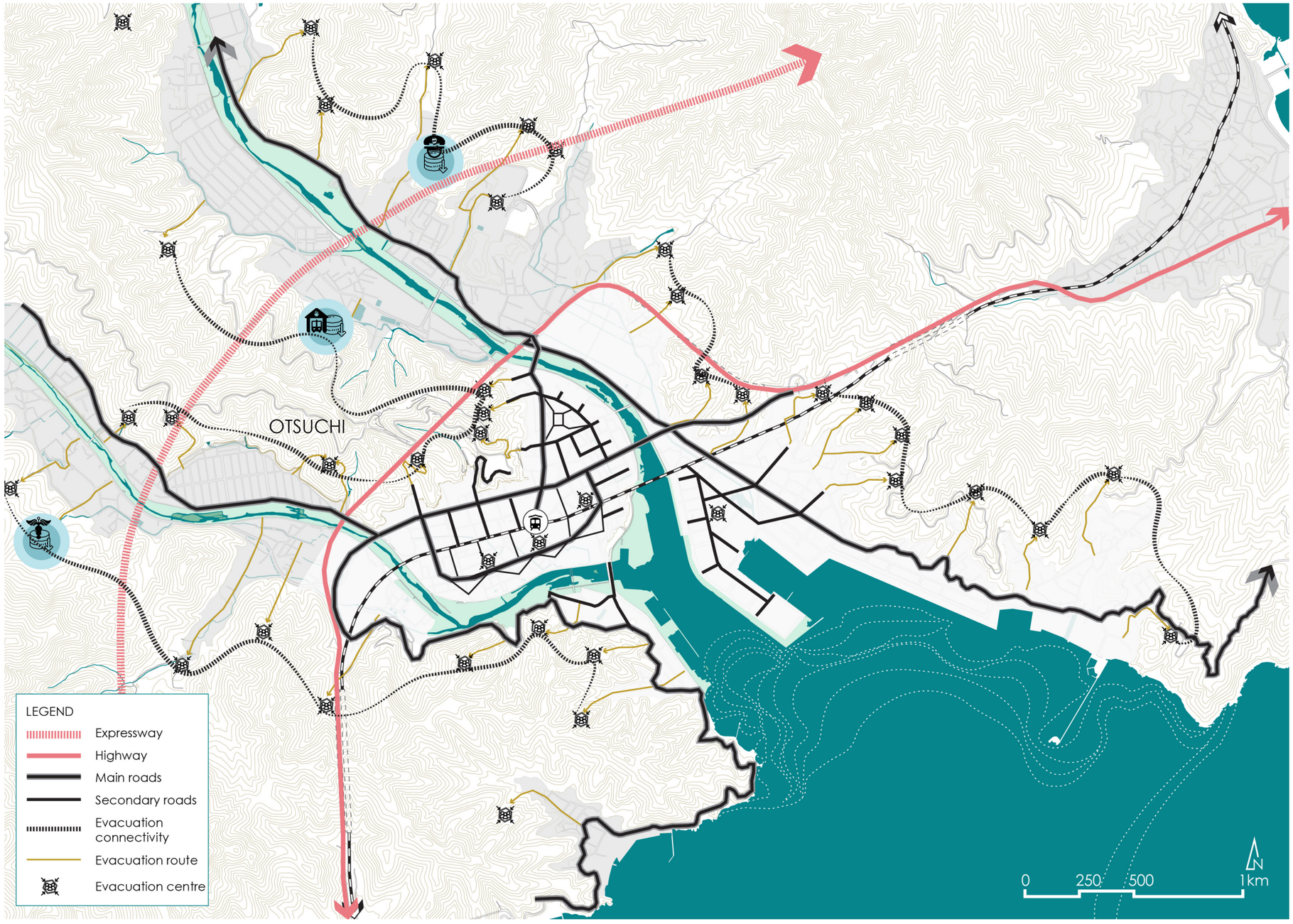
6. Compact city v/s land readjustment



5. Alternatives/ access for critical capital



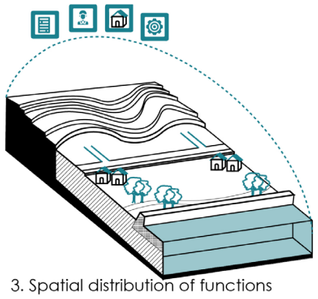
6. Multiutility transit systems



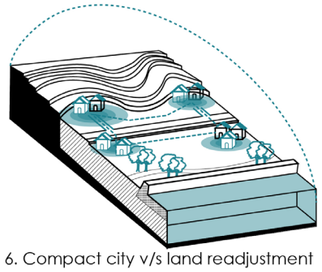
Longevity

Principles

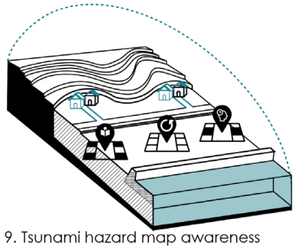
- Accessibility enhanced with highway beyond the inundation line
- Zoning with respect to hazard regulations
- 15 year plan for sea wall



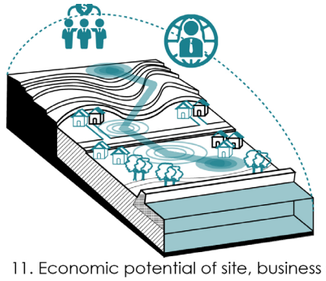
3. Spatial distribution of functions



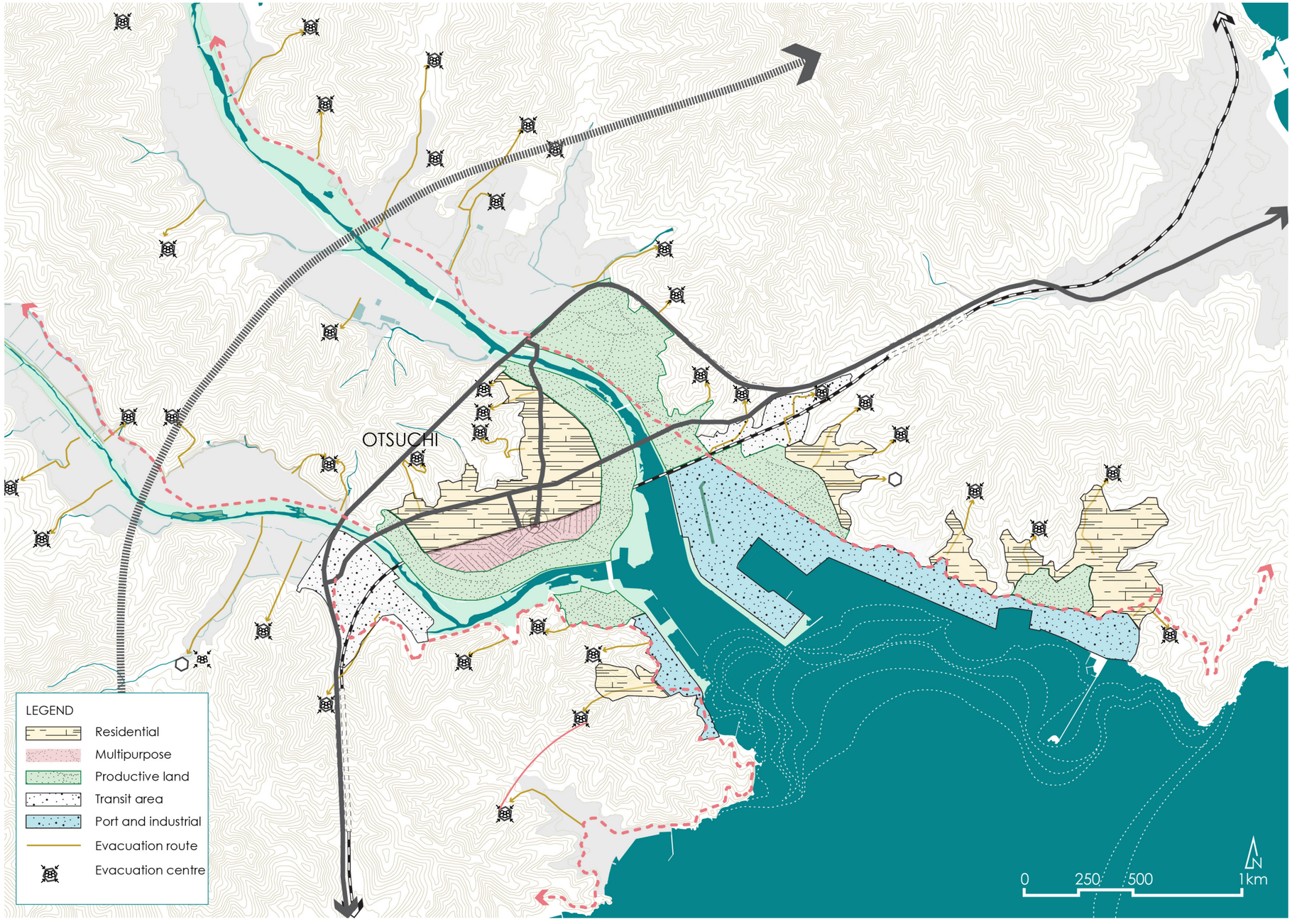
6. Compact city v/s land readjustment



9. Tsunami hazard map awareness



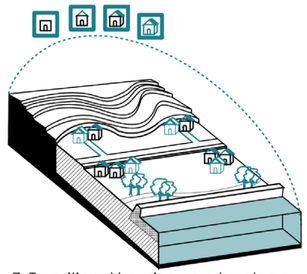
11. Economic potential of site, business as usual



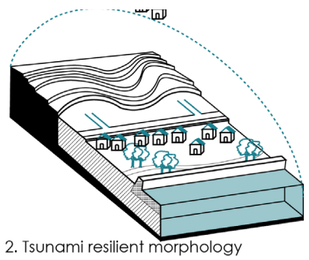
Revival

Principles

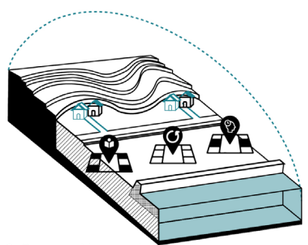
- Reviving the historic street with compact planning around the administrative area and cultural place
- Natural springs and s tsunami stones become the way-finding element during evacuation



7. Transitional housing as a typology



2. Tsunami resilient morphology



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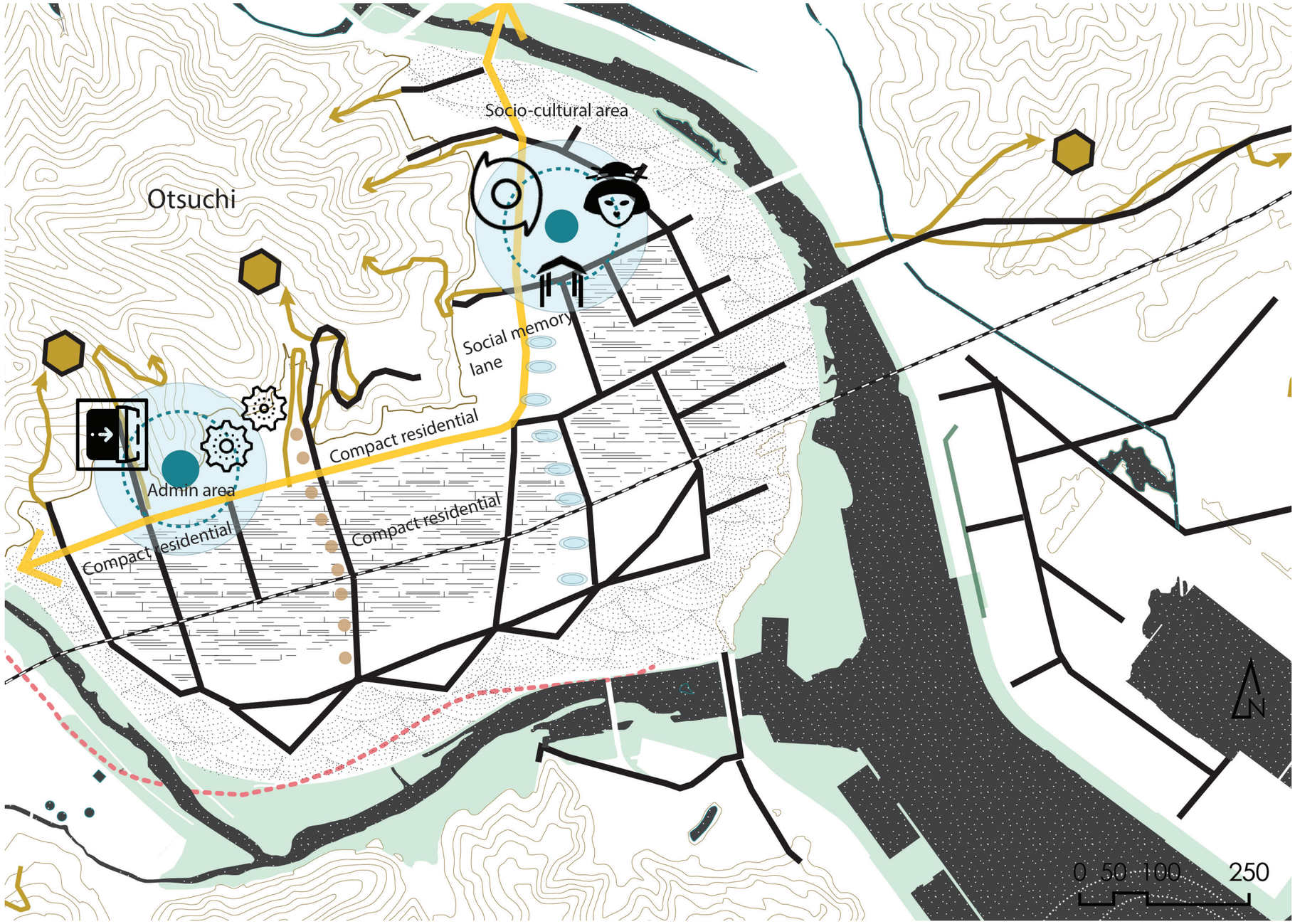
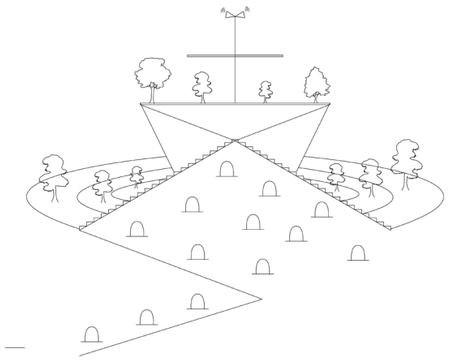
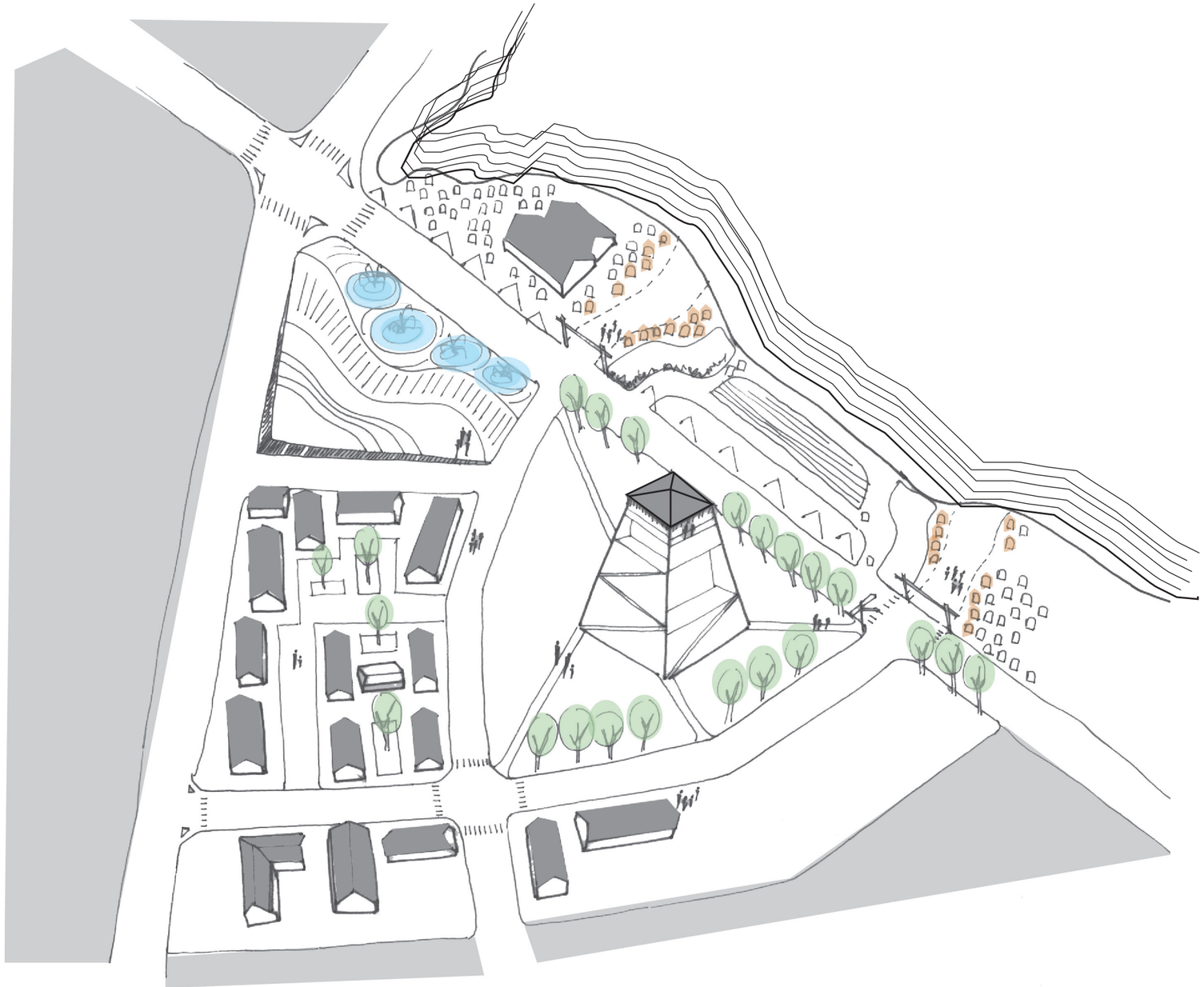


Sustenance

Principles

- Socio-cultural heritage of Otsuchi
- Tsunami tower and area for recreation, religious visit to the shrine.



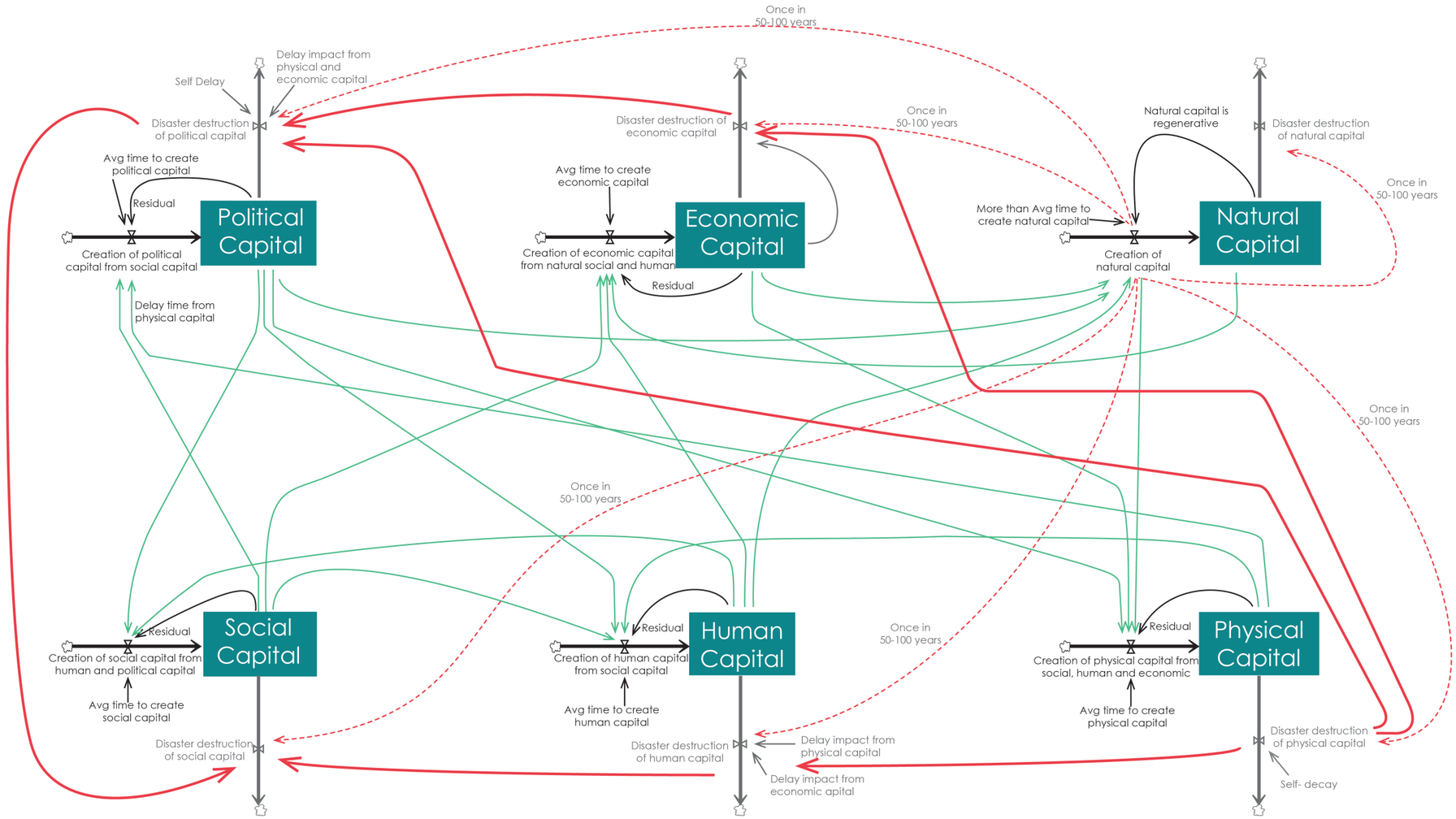


10.2 Simulated results

Critical capital model of dependencies

Based on the site analysis and the assessment of the capital model for 3.11, a new model was developed that considered the dependencies of the urban renewal plan and assists in making dependency conclusions that can assist in the spatial placement of critical services. The model also helps to simulate the result based on the changes in the resilience capacities of Otsuchi due to the decisions made in the new urban plan. This helps in assimilating the aspects of decision making that because they are spatial in nature also result in changing the resilience for longer term.

The model considers political capital and the social capital only to have network with outside of Otsuchi. This helps us in understanding the community parameters (self-contained) that contribute in the resultant dependencies. While decisions are made at the town level by the mayor who is the political capital. The decentralized political system and the exercising the directives of emergency helps in taking better decisions even with limited resource availability in the event of the disaster.



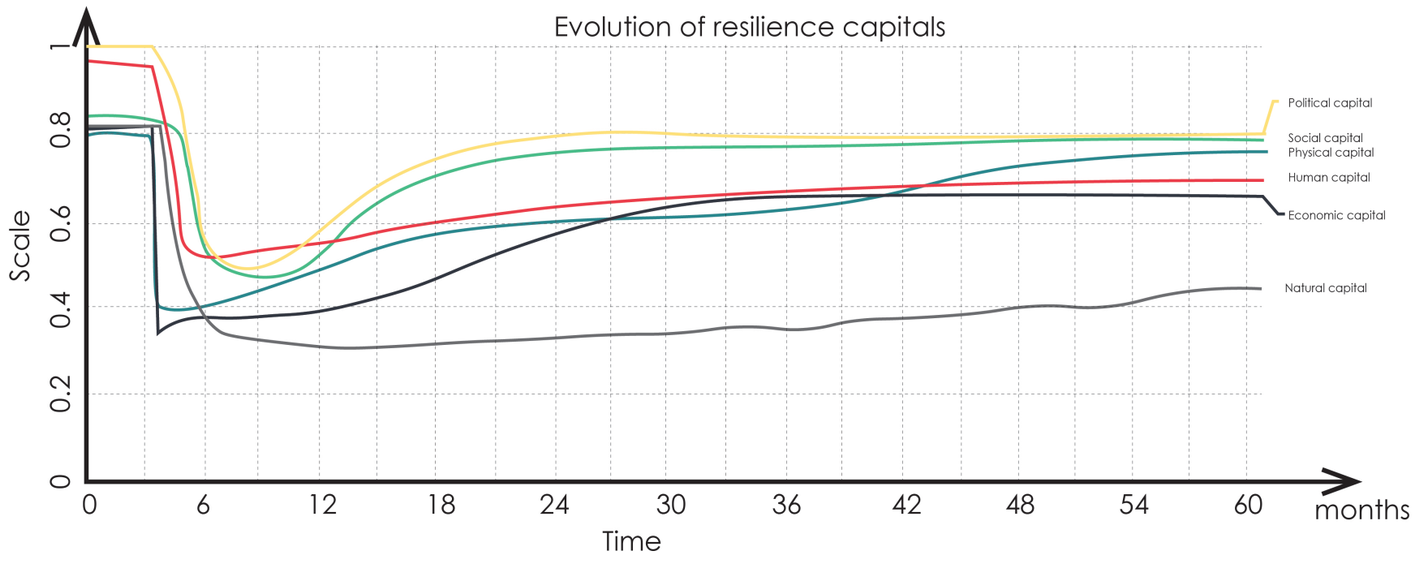
Capital being influenced in creation stage

Capital being influenced /destroyed in the destruction stage

10.2 Simulated results

Simulated resilience of recovered Otsuchi's

Based on the renewed urban design of Otsuchi and the altered state of critical capitals, simulation for the same impact as that of the 3.11 with 9M of earthquake tsunami is carried out. The results show not much difference for the physical, social and natural capitals but due to resilience improvement of the political, human and financial capitals there is less deflection in the state of the capitals, conclusively the impact felt is reduced. Due to the resilience thinking for a sustained recovery, strategies for livelihoods have a long-term impact. It is not known now if this also changes the demographic configuration of Otsuchi from the aging and shrinking society to a balanced state, but it does strategise towards achieveing that state without compromising the heritage and future of Otsuchi

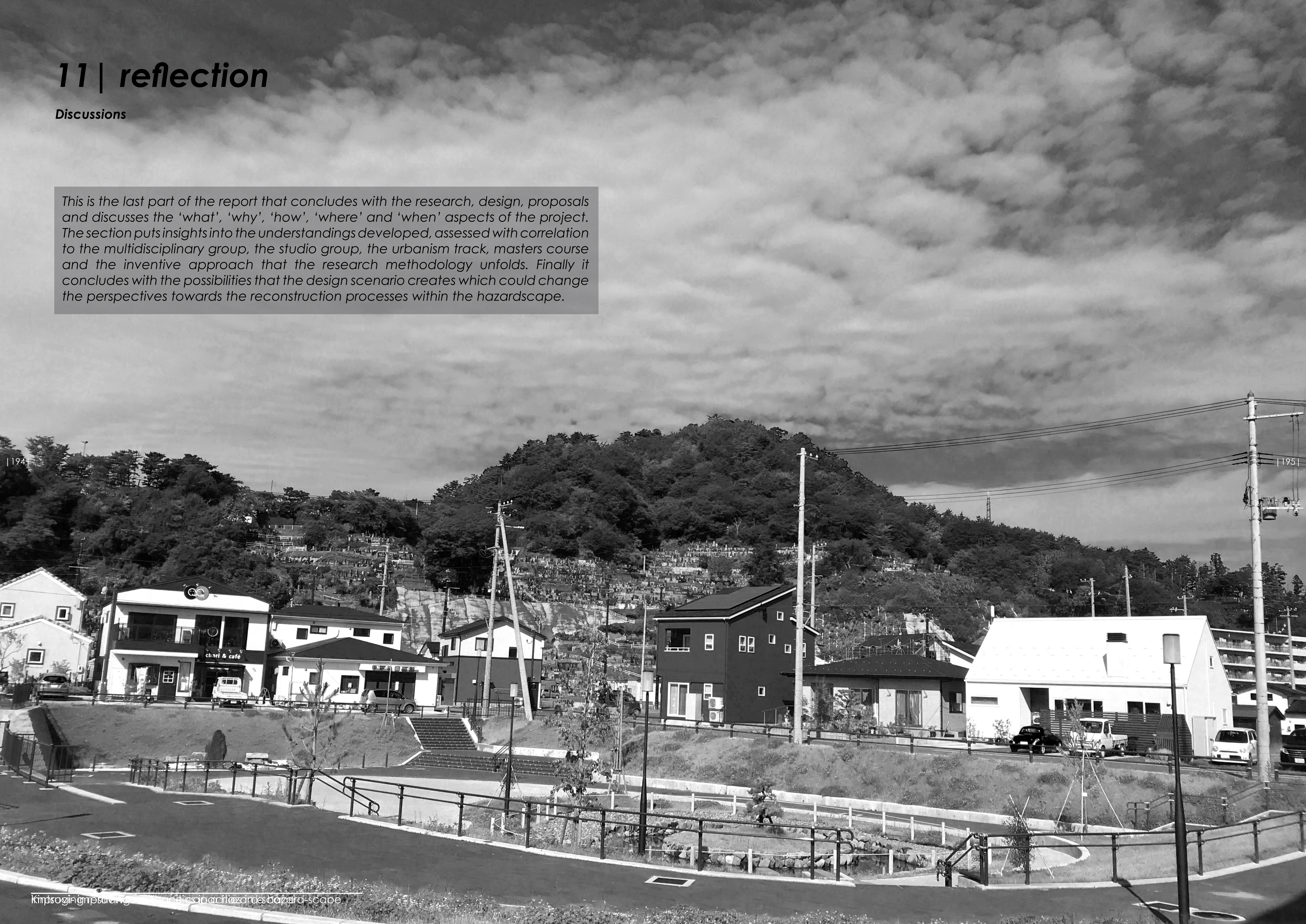


Figures 69– simulation of decisions for urban renewal at Otsuchi
Sources – Authors illustration

11| reflection

Discussions

This is the last part of the report that concludes with the research, design, proposals and discusses the 'what', 'why', 'how', 'where' and 'when' aspects of the project. The section puts insights into the understandings developed, assessed with correlation to the multidisciplinary group, the studio group, the urbanism track, masters course and the inventive approach that the research methodology unfolds. Finally it concludes with the possibilities that the design scenario creates which could change the perspectives towards the reconstruction processes within the hazardscape.



11 | reflection

11.1 project insights

This section of the reflection highlights the drivers for the workability of the project, direction for the research, collaborations of specific approaches and for the integrative thinking that the project required. These aspects not just affect the planning and design but also provide leverage to take decisions in emergent situations, navigate a course of reconstruction process while adapting to the policies principles of the site.

1. Reverse research methodology

The project has been conceived based on the outcomes of the workshops between the multidisciplinary students from of Japan and Netherlands. The understandings developed from the methods of scoping for the reconstruction of Otsuchi delineates the scope for the project. This approach while being inventive follows a reverse research methodology that is bottoms up, based on the recovery requirements generated by the site while realizing the ground reality and accordingly shifts from the lower scales to the upper scales of research frameworks. Particularly in the beginning it was realized that the reconstruction measures are neither holistic and nor long term in aspects, but by following this methodological approach the gaps in the proposals also came into focus. This clarifies the corresponding research, approaches, proposals and developments within the project.

2. Multidisciplinary influence

Collaboration in a multidisciplinary setting provided grip about the engineering aspects giving insight about the tsunami science, the deltaic morphologies and other peripheral urban sciences thereby presenting the holistic dimensions of the reconstruction processes. The physical nature of reconstruction was identified to have superseded all other aspects of reconstruction measures. While the majority of the town was left to dwindle the negative aspects of the tsunami and society shrinkage, the delayed aspect of planning resulted in conditions becoming worse. The scoping exercises done through the lens of the balance of 4Ps, proposed the desired nature for the reconstruction and considering them as hypothesis the research question was formulated.

3. Longevity of reconstruction processes

Research into the physical reconstruction measures revealed the superficial nature of the recovery measures being accelerated that are not thought for long term outcomes of the coastal community. Economy is a leverage for humanity to thrive and flourish. As the potential of the post tsunami scape was not understood fully. Reconstruction and recovery measures are seen to be nothing other than a resource overuse. To deal with hazardscapes decisions need to be emergent only in the crisis situations, post that stage for holistic recovery strategic actions are required that have a long-term perspective that are sensitive and contribute to the specificities of the location.

4. Socio-technical barriers of decision making

Crisis situation needs emergent decisions that are improvised strategically and reduce the possibility of further cascading impact of risks. This understanding adds a tremendous development to fill the gap for the decision making within the emergencies and the post disaster reconstruction aspects. The socio-technical elements within the hazardscape having spatio-temporal risk are evaluated based on the disaster resilience model developed in the research. This guides the decision making for the post disaster reconstruction.

5. Spatial nature of risks

In the hazardscape, the nature of risk is frequent, certain, intensifying and sometimes cascading that creates huge systemic failures and therefore disrupt quicker return to normalcy. This aspect of risk can be mitigated based on the

spatial nature of the socio-technical elements. This realization is to a larger extent also reflected in the post new urban design for the town of Otsuchi.

6. Idea of holistic recovery

While the initial inference for recovery and reconstruction was to have safe and resilient community. The underlying driver that essentially make the community resilient like the certainty of disaster, aspects of preparedness over protective, sustainable values and validity of measures for a cross generational benefit triggered guidelines and strategies for the project to become both integrated and yet holistic in nature. This outcome therefore aligns itself to the identity, behavior and community aspect of Otsuchi which was aspired as the main criteria for reconstruction of Otsuchi in the workshop as well “Revival of Otsuchi treasures”.

7. Resilience intrinsic of hazardscape

The key aspect that cumulatively shaped the project is the understanding of resilience in this context. This realization triggered the nature of critical thinking that developed for the site based on the conditions of feasibility, resilience capacities, damage proportions, wellbeing of the society and the integrative design strategy. The progression of resilience from concept, to community resilience becoming a scale for integration that is driven by the social capital developed a mature understanding of the possibilities to change resilience capacities. This observation in addition to literature reviews about the different frameworks in place for resilience qualified for considering it for the assessment within the performance domain which is reflected in the simulation studies of the various capitals based on the urban design.

11.2 Conclusion

The result of the project has been explained here in terms of the answers to the questions that were asked within the process of the research augmentation. The sections that follow explain the relation and relevance of the project.

Q1. How does the scope of spatial planning change under the influence of disaster cycle in a region, vulnerable to natural hazards?

This has been explicitly stated in the beginning of the research that for landscapes that face extreme and frequent disasters like tsunami, they must be considered special and planning for them should follow a specific typology. The methodology of planning should be emergent in the critical stages and strategic in the longer format, and therefore emergency planning that collaborates with other form of planning was realised for the hazardscape, called as emergent strategic urban planning. This was a result of the reverse research methodology followed for the project that understood the gaps and limitations within the planning processes in the hazardscape.

Q2. Is evacuation the only possibility in the warning stage of the disaster cycle and is it enough currently?

In the warning stage of the disaster cycle for a hazardscape the act of moving to a higher ground is the only solution due to the uncertainty of the behaviour of the tsunami. Though historical data could supplement in knowing the extent of the impact, but it should not be ‘written in stone’ which has ironically been the case in the hazardscape of Otsuchi. Changing nature of hazards and disasters need changes in the approaches to overcome which helps managing the scale of impact and recovery both. Therefore, evacuation should be supplemented with strategical planning of critical capitals and long-term recovery possibilities.

Research question

Q3. How to MOBILIZE inhabitants and land-use through SPATIAL DESIGN AND PLANNING to achieve COMMUNITY RESILIENCE in a HAZARD-SCAPE ?

This has been addressed throughout the scope of the research and design process. The hypothesis “if the population in the hazard-scape is prepared enough, such that the scale or the severity of the event amounts to very less human loss subsequently resulting in a better coping of the disaster and its impact psychologically, can then result in a faster and resilient recovery of the community and the environment” appear true through the research. Therefore, within the scope of preparedness in addition to making evacuation enough through vertical and horizonal methods and urban design of the area, the improvised spatio-temporal planning of alternatives of critical capitals help in transitioning towards a normal post disaster has been catered to.
This was made possible by the act of mobilising the alternatives of critical capitals (inhabitants and landuse) as a part of strategic planning for preparing for the disaster. The act of mobilizing was provided to by the knowledge of the capital dependencies that are governed based on the decision making for the capitals. The series of actions and decisions are resultant of the emergent needs observed from the field visits and ethnographic mapping literatures of the post 3.11 disaster.
The empirical data propelled the thinking for community resilience parameters as the scope of assessing and evaluating the resilience conditions to address the longevity of these solutions across generations and domains of recovery.

Community resilience

Q4. How is it possible to reduce disaster impact while creating awareness and preparedness and consequently contribute to improvement of community resilience in the hazard-scape?

Social capital is the driver for attaining community resilience, it is also the link that creates long-term possibilities within the other critical capitals. Understanding the dependencies between the capital through the capital dependency models the spatial and temporal nature of the socio-technical aspects of the capitals was understood that required development of a strategy emerging from the context and the historical disaster scenarios. By this strategy the assessment of changes in the resilience capacities is noticed that triggers changes in the scope of preparedness within the site. To enhance this contextually urban design of the landscape factors activating social memory within its fabric that is based on the time cycle of the event and not on the human and infrastructure lifecycles. With this, awareness of the event is kept alive across human cycles that enhances the preparedness and further the resilience in the scape.

Q5. What role does context play in the domain of community resilience? How significant is it ?
Q6. How can the study of community resilience contribute to disaster risk reduction governance elsewhere?

Context plays the most significant role in the development of preparedness and recover measures. It influences the resilience capacities that effect the long-term scope of any development planned. The natural factors of geography, ecology affect the human as well as societal factors in forming identity, behaviour, and coping to shocks and stresses, Likewise the economy as leverage and political factors as administrators and managers change the livelihood parameters. While this does not directly affect the resilience capacities, but their effect is felt through the decisions enforced. In general considerations (non-frequent hazard regions) the context might not affect to large extent on the community resilience but within the hazardscape they hold a very high value. Context of vulnerability further changes the way in which these critical capitals trickle down as changes within the fabric which needs to be researched upon. The transferability of the study has been explained in detail later.

Governance

Q7. How is the approach to mobilization of land-use made enough in a disaster vulnerable region?

Mobilization does not only mean only movement, but it also means evolve, change and reorganize in case of hazardscape. Frequent extreme disasters like tsunami give opportunities to change for better from the from the previous errors and blunders of urban planning and management. While the historical documentations provide a sequential order to the decisions made for the organization of elements, factors contributing to changed urbanization cater to the necessary direction in which the landuse should change. Since the context of Otsuchi was very homogeneous and conservative, decisions required to adhere the societal values and harmonize with their identity. Apparently, this should make mobilization of landuse effective and reliant which can be known in times to come.

Q8. In what ways can the study of governance measures for urban renewal improve resilience in the reconstruction of the disaster-scape?

Governance measures for urban renewal means the principles of emergent strategic planning for reconstruction in the hazardscape. These principles are based on the guidelines of emergency planning but factor in the integration of collaborative planning and urban planning at the operational, contingency and integration stage of the emergency planning. By factoring time, space and technology as a measure of planning and management in the hazardscape, it influences the decision-making capacities of the political capital, thereby changing the resilience.

Q9. Can resilience of critical capitals be undertaken by community-based disaster risk reduction systems and to what extent?

Yes, resilience of critical capitals can be undertaken majorly at the community levels for disaster risk reduction. Resilience capacities are influences by way in which critical capital are mobilised. Critical capitals are mobilised to attain holistic recovery. Mobilization of these capitals require the ability to understand and improvise decisions based on the capital dependencies. Capital dependencies are based on the spatio-temporal outlook of the critical capitals and socio-technical requirements of the space within the community. Therefore, other than social capital and partial political capital dependence on the outside all other capitals can be undertaken at the community levels. This undertaking also requires support from the operational domains for the technical aspects.

Planning and design

Q10. How can spatial design and planning strategies generate preparedness within the community in a disaster-scape ?
Q11. How can design and planning post disaster support the governance of spatial decision making?

Q12. What is the relation between research and design in the project?

Within the realm of spatial design and planning for preparedness all aspects of planning and design feature. In realizing the connections, they form with the engineering sciences, social sciences, management and ecology a methodology to address preparedness was formulated. Preparedness requires all aspects of the probable scenario of the impact planned prior to the event. This covers all disciplines that could factor changes in the hazardscape. By evaluating main criteria's that are essential for the hazardscapes continuity and prosperity, and which trigger other drivers that result in stimulating and improving the resilience capacities strategies were formed. People in the hazardscape continue to live there because of the economic leverage that the locations provide. They continue to exist even after the disaster as they have embraced the devastating impact of tsunami. This understanding of the nature of tsunami the approach towards designing for preparedness was made.
Concepts of feasibility, disruption, resilience and wellbeing shaped the strategies and planning of the area. While ideas of social memory, evacuation design, flexibility in designing, identity and potential of the place conjointly resulted in forming the design parameters for preparedness. When the preparedness for the disaster factors in all contingencies while leaving possibilities for improvisation the design and planning post disaster becomes uncomplicated, therefore providing opportunity for a smoother transition.
Reverse research methodology resulted in the parallel understanding of the reconstructed Otsuchi, that formed realization of the challenges and limitations of the existing reconstruction processes and methods. This methodology also factored to understand the requirements of the site and to develop possibilities to achieve

a holistic outcome. The design catered to the strategies and enhanced further the scope of recovery by being vital and sensitive to the context of Otsuchi.

Q13. In what ways spatial strategies influence mobilization of critical capitals to protect, mitigate and support recovery in the event of disaster?
Q14. How does long-term crisis management of resources affect the reconstruction process?

Spatial strategies effectuate 1) preplacement of functions, 2) possibility of improvisation, 3) contingency scopes and 4) provide alternatives in crisis. Comprehensively, they contribute in the mobilization of critical capitals in the disaster cycle. The formation of these spatial strategies as mentioned above is based on the principles of emergent strategic urban planning while adhering to the concept of balancing of the 4P's model that contributes towards sustainability. In doing so, it values the global norms of UNISDR about risk-informed sustainable development for disaster risk reduction.

Q15. How is emergency spatial planning different from the contemporary spatial planning? And in what ways it influences the reconstruction process?
Q16. How and in what ways is the relation between emergency planning in Tsunami scape, integrated with strategic urban planning and made specific to the hazardscape?

As described in the paper, the emergent planning is decision making and planning based on a sequence of behavior and patterns consistently observed that give impression of being deliberate. Whereas strategic planning is a formal strategy in planning, based on intended results and that is supported by planning tools and methods. Within the changing scope of the hazardscape it was realized that to influence the resilience capacities the planning strategy must be emergent of the historic, societal and political norms but also strategic in realizing the outcomes of the disaster risk reduction at Otsuchi. This prepares Otsuchi for a holistic and resilient future.
Post reconstruction is an opportunity for a better change. Planning in the crisis situation within the emergency phases is crucial. Applying emergent methods that are sensitive towards the cultures is key to being sensitive in the initial stages. This develops better mutual understandings within the many domains and critical capitals. This time is also important to improvise certain aspects that are adverse and unfavorable. In time, introducing strategic planning that is collaborative and integrates with these improvised and flexible emergent strategies further controls the form of resilience in the societies within the hazardscape. By realizing the planning and design aspects as mentioned above in answer to Q10,11,12 the final outcome becomes specific to the hazardscape.

Q17. How does the understanding of disaster risk contribute in the process of reconstruction for such hazard prone areas?

Understanding the nature, behaviour, impact, intensity, frequency and scale of risks from tsunami creates pandemonium while thinking for recovery. But unravelling the many layers of chaos and collaborating on many levels with different fields, it generates vitality and creativity to flourish. Tsunami like disaster are devastating and frequent. Many a times occur more than once in a human lifespan. Understanding this and continuing to be part of the same landscape requires resilience unparallel. Societies that embrace this are important and special. Providing the means for existence in all capacities should be the aim of planning and design towards the hazardscape. Acknowledging this through the inventive research methodology and the outcome of the proposals creates significant change from the existing reconstruction practises.

Q18. How do you assess the value of your way of working (your approach, your used methods, used methodology)? A reflection on the advantages and limitations of the chosen methodology.

The selected research methodology is a shift from the normative. The methodology realizes the gaps between decision making processes by understanding the ground reality. Following it as a part of the process and the research shifts from the bottom scale to the top scales i.e. from community to global perspectives. Because of this bottoms-up research, the realized final outcomes transmit to various layers within the reconstruction processes. It demonstrates the need to connect decisions taken at the micro levels with the macro levels through the outcome of the research. By proposing a typology of planning based on this reverse research methodology, in-depth insights and knowledge of the hazardscape is understood.

Q19. What is the relation between your graduation project topic, the studio topic, your master track (A/U/BT, LA, MBE) and your master programme (MSc AUBS)?

The relations between the graduation project topic; Improving resilience capacities in hazardscape, the studio topic; transitional territories within multidisciplinary groups of CITG and AUBS, the master track; Urbanism and the master programme AUBS are explained below.

The graduation design topic overlooks the case of urban futures within the current disaster frequent worlds. By carrying out research in this unfamiliar domain, it allowed exploration of advanced possibilities that contributed towards a learning skill set. While the explored themes of resilience socio-technical aspects, contingencies in crises, feasible and unfeasible fields of engineering possibilities, accounted and unaccounted domains of decisions making, and the contemporary but futuristic planning scenarios allowed the research to become valuable in its entirety.

While the studio topic through multidisciplinary groups contributed towards exploring advantageous possibilities by creating overarching views, knowledge sharing within multi-dimensions and discipline while also collaborating and integrating aspects for holistic outcome. Being part of the master track of urbanism it became convenient to assimilate from the inter connected fields of science and society towards understandings of changed urban landscapes. Dealing the reconstruction process through the lens of spatial planning while building back better required making difficult but simplistic and risky but sensitive choices that needed a lot of critical thinking, negotiations and a balance between bottoms up and top down approaches. This contributed in achieving a more holistic approach towards the reconstruction process. It not only puts in forth questions regarding spatial planning in the context of a hazardscape but also critically analyses the choices made within the many domains of decision making.

11.3 relevance

Societal relevance

Japan is a country which is 80% mountainous terrain and the rest is coastal plains which while suffering from earthquakes frequently triggers large scale tsunamis, landslides and volcanic eruptions. The reconstruction processes post disaster has been evolved from simple precursor religious belief based to protective infrastructure based on tsunami sciences and engineering. Throughout the generations of tsunami within the context of Japan the value for preparedness has always been the minimal and brief. The project realises this shortcoming within the planning and management domains and proposes for a strategy which is context specific, community oriented, interacts across domains of decision-making scales while being vital and sensitive to the culture and capacities of the Japanese society.

This project while being context specific, contributes in prescribing strategies to improve the resilience capacities of the critical capitals which gives economic powers to communities in the hazardscape and uplifts it from the dire circumstances it is facing because of aging and shrinkage.

The emergent strategic urban planning that forms the basis for the design strategy are deeply related to the public space networks and how Japanese people navigate in them. A disruption of this flow of services, due to direct damages to the networks leads to hampering of daily life but indirect cascades of the damage to other networks leading to even bigger losses. Contribution to the project allows to create urban conditions that will limit or reduce the extent of the disaster and its effects on the society's health.

Scientific relevance

For the difficult task of choosing the approach for well-advised strategies, the research and planning done within the project follows through as a propagated methodology that is not normative. This reverse research methodology provides contingent prescriptions(Wiechmann, 2007) that result in a holistic outcome. It is well structured, transparent and caters to the same desired possibilities as the normative research methodology.

Following this methodology from micro to macro scales produced valuable insights that were missed within the reconstruction decision makings. As this resulted in proposing solutions aimed in this specific direction that altered the scope of reconstruction process but contributed in the desired outcome of the reconstruction. This validates the scope of the methodology and demonstrates its workability.

The project draws substance from the societal, environmental and economic strengths of the region and develops strategies to prepare, mitigate and reduce the extent of impact by planning within the time cycle of tsunamis. There have been a lot of research done in the field of adaptability, resilience, vulnerability and disaster reconstruction but in the field of how to implement these concepts in a flexible design process is still limited. By integrating the planning fields of emergent and strategic decision making, it contributes in building upon the existing methods by leaving out possibilities for improvisation that is necessary for planning in the hazardscape. Adopting this approach, it portrays the degree to which it can also become transferable that adds value to the research and subsequently offers learning to outside disciplines and regions with similar contexts.

Ethical relevance

The project holds a distinct yet vital and sensitive stand in dealing with disaster reconstruction strategies and processes based on the elements that contribute in the balance of the 4Ps. Such understanding and planning trickles down onto the community's resilience capacities. "A prerequisite for turning danger into risk, either by accepting it or by being subjected to it, is acquiring knowledge about the danger, its nature and its probability"(Tannert, Elvers, & Jandrig, 2007), and by doing so the project deals with main aspects of planning in the hazard-scape while being sensitive to its ever changing nature.

While on the scientific and societal platform it addresses quite important aspects that are required to be dealt in cases of disaster that are frequent across generations. It maintains a firm grip over the investment decisions made now based on benefit, risks and costs, that last multiple generations. It conducts ethical balancing and trade-offs across generations by influencing the wellbeing of the communities now as well the future. By embracing this thinking and approach in for all the critical capitals of the hazardscape, a holistic outcome emerged. These elements were introduced deliberately and in hindsight. Deliberate because they are important and in hindsight as they were felt missing or if they were underlying. This explicitly can make decision for costs of operation and maintenance of the risk reduction possible which can become starting for further research. Consequently, doing something not devastating towards long run and making reconstruction process sustainable.

11.4 transferability

- As mentioned earlier many times, the methodology used for this project was not normative which was beneficial to understand the challenges at the grass-root level. As it suffices the scientific norms, therefore following it elsewhere should also reap beneficial outcomes.

- For the reconstruction elsewhere, it would be desired if the hazardscape has the same frequency behaviour as the tsunami scape i.e. 50-100 years, across generations.

- Dealing with reconstruction should be initiated with the understanding of the hazardscape in its effectual state i.e. exposure, state of vulnerability and the nature of hazard. This can vary based on the geography, urban context, scale of vulnerabilities, underlying or no resilience.

- Knowledge of the above factors with the historical, cultural and sensitivity analysis will guide to identify measures, shortcomings, gaps and omissions within the many disciplines and decision-making processes. This is a very crucial aspect for the reconstruction as it governs the scope for reconstruction and the basis for the formation of strategies.

- While differential nature of resilience capacities also greatly influences the reconstruction, measures within the planning and design fields can propose for solutions that are prescriptive in nature and ease the process of value addition for other locations, societies and hazard dynamics.

- While within the framework of strategies and processes designed for reconstruction it was not explicitly mentioned but due care was taken to incorporate the planning aspects necessary for climate change and resource consumption.

11.5 limitations and further research

Limitations

- Language as barrier

Though the information was in abundance it was inaccessible mostly otherwise requires a lot of struggle with translations. This knowledge barriers many a times could have discouraged to access much of the important information for the projects. In this case it was too time consuming.

- Rehearsed information

The field visit though was informative and provided diverse information on many disciplines, yet it was too structured and felt rehearsed. It was too sensitized that restricted rational thinking. Furthermore, due to this factual information about the site and the societal conditions of the people specific to the site was greatly missed in mapping. This detail of site could have resulted in a much richer outcome for observations of economic landuse and diversity of potentials for the design while being sensitive to Otsuchi only. The randomness of site surveys and might have changed the outlook of the designs for the downtown area.

- Limited workshop time

The overall time spent at site did not factor to observe and feel what living in Otsuchi could be like for the inhabitants. This was greatly felt while designing for the downtown area.

Further research

While the products developed within the process of the project are complete and reliable.

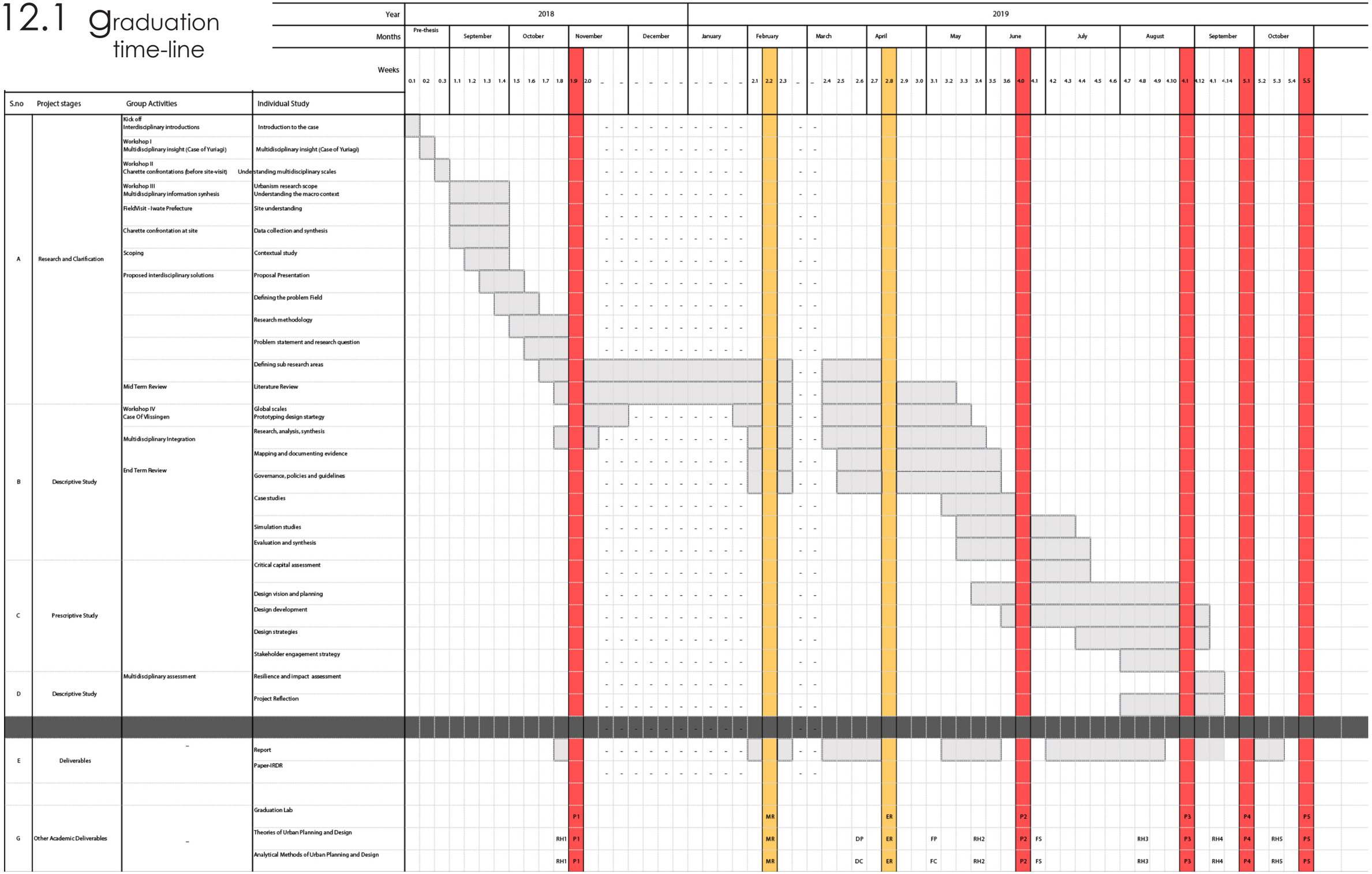
- For a more qualitative and quantitative results the capital model can be simulated for definitive outcomes for which the conceptual model can be run through the VENSIM software. The outcome can be elaborated for many scenarios and can be used as a starting point for further research into capital model dependencies within collective domains of organizations.

- Research points out that the spatial planning levels require information regarding the implementation of the decisions for the capitals. This requires research within the capitals for the scenarios under the pressures of feasibility, contingency and temporality while also having societal consensus

12 | appendix

12.1 graduation time-line

S.no	Project stages	Group Activities	Individual Study
A	Research and Clarification	Kick off Interdisciplinary introductions	Introduction to the case
		Workshop I Multidisciplinary insight (Case of Yuriagi)	Multidisciplinary insight (Case of Yuriagi)
		Workshop II Charette confrontations (before site-visit)	Understanding multidisciplinary scales
		Workshop III Multidisciplinary information synhesis	Urbanism research scope Understanding the macro context
		FieldVisit - Iwate Prefecture	Site understanding
		Charette confrontation at site	Data collection and synthesis
		Scoping	Contextual study
		Proposed interdisciplinary solutions	Proposal Presentation
			Defining the problem Field
			Research methodology
			Problem statement and research question
			Defining sub research areas
		Mid Term Review	Literature Review
B	Descriptive Study	Workshop IV Case Of Vlissingen	Global scales Prototyping design startegy
		Multidisciplinary Integration	Research, analysis, synthesis
			Mapping and documenting evidence
		End Term Review	Governance, policies and guidelines
			Case studies
			Simulation studies
			Evaluation and synthesis
C	Prescriptive Study		Critical capital assessment
			Design vision and planning
			Design development
			Design strategies
			Stakeholder engagement strategy
D	Descriptive Study	Multidisciplinary assessment	Resilience and impact assessment
			Project Reflection
E	Deliverables	-	Report
			Paper-IRDR
G	Other Academic Deliverables	-	Graduation Lab
			Theories of Urban Planning and Design
			Analytical Methods of Urban Planning and Design



RH -Report Handover MR -Mid Term Review ER -End Term Review DP -Draft Paper FP -Final Paper FC -Final Chapter

P -Periods 1,2,3,4,5

12.2 theory paper

Community Resilience A Methodology For Disaster Risk Reduction

Examining and evaluating parameters that Influence measurement of community resilience

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Abstract

As urban communities across the world are increasingly becoming vulnerable to natural and climate-change exacerbated disasters, many disaster risk reductions are being developed that focus on building community resilience. The preparedness level of community is essential for building disaster resilience. Yet in the planning fields, community resilience remains a concept often lacking (or overlooking) crucial aspects that are necessary for analyzing, assessing, and enhancing resilience of the area. This paper evaluates assessment parameters of community resilience, drawn from the literature of several disciplines and discusses which socio-technical factors are typically considered (or are omitted) in the different approaches towards building community resilience. Through the lens of a hazard-scape this paper addresses the vulnerability and the exposure of the local context and the aspects that result into failure of the resilience building within the communities. It reviews the different frameworks used to analyze community resilience and the different tools that are used in the assessment of community resilience. The findings from the paper shall help emphasize the urgent need of local community perceptions that should be recognized in the disaster risk governance initiatives of a hazard-scape like Japan.

Key Words- hazard-scape, natural disasters, community resilience, critical capital, community resilience assessment

Note;- The paper has been incorporated within this atlas as part of the research, methodology and theoretical framework.

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