BUILDING URBAN RESILIENCE THROUGH SPATIAL PLANNING FOLLOWING DISASTERS

THE GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI

DISSERTATION BY NADINE MÄGDEFRAU

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF ENGINEERING (DR.-ING.)

AT THE FACULTY OF SPATIAL PLANING OF THE

TECHNICAL UNIVERSITY OF DORTMUND

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"It is complicated."

This is one of the phrases that I heard most frequently throughout my research in Tohoku Region. It referred to the reconstruction process, but can equally be applied to the endeavor of writing a dissertation.

It was complicated to find an appropriate research topic. It was complicated to collect and understand the required data (mainly written in a foreign language) and to comprehend the complex processes that took and take place in Tohoku Region to recover from the Great East Japan Earthquake and Tsunami. It was complicated to sort through and analyze all of the collected data and to put all of the content together into this work.

I could not have done all of this without the support of many people. I would like to use this opportunity to express my appreciation for their help and encouragement.

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TABLE OF CONTENT

PART B

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF ABBREVIATIONS

ARCAB............. Action Research for Community Adaptation in Bangladesh
BMBF .... Federal Ministry of Education and Research, Germany
CoBRA............. Community Based Resilience Analysis
DFID .... Department for International Development, UK
EIA .... Environmental Impact Assessment
EIS .... Environmental Impact Statement
FAR .... Floor Area Ratio
FEMA............... Federal Emergency Management Agency
GEJE................ Great East Japan Earthquake
IDNDR .... International Decade for Natural Disaster Reduction
IDRAC.............. Ishinomaki Disaster Recovery Assistance Council
IISD.................. International Institute for Sustainable Development
IPCC................ Intergovernmental Panel on Climate Change
IRGC .... International Risk Governance Council
IRIDeS .... International Research Institute of Disaster Science
IRPUD.............. Institute of Spatial Planning
JIA .... Japan Institute of Architects
JMA .... Japan Meteorological Agency
JST................... Japan Science and Technology Agency
MOVE .... Acronym for the Research Project "Methods for the Improvement of Vulnerability Assessment in Europe"
NGO................. Nongovernmental Organization
NPO .... Nonprofit Organization
NTT .... Nippon Telegraph and Telephone
OECD.............. Organisation for Economic Co-operation and Development
PAR .... Pressure and Release
PV .... Photovoltaics
TAMD .... Tracking Adaptation and Measuring Development
UN .... United Nations
UNDP............... United Nations Development Programme
UNDRO............ Office of the United Nations Disaster Relief Coordinator
UNESCO.......... United Nations Educational, Scientific and Cultural Organization
UN-Habitat....... United Nations Human Settlements Programme
UNISDR .... United Nations Office of Disaster Risk Reduction
UNU-EHS......... Institute for Environment and Human Security
URBIPROOF .... Acronym for the Research Project "Increasing Resilience of Urban Planning"
USAID.............. United States Agency for International Development
WCDRR .... World Conference on Disaster Risk Reduction

PART

A

1. INTRODUCTION

At 14:46 in the afternoon of Friday, 11 March 2011, Japan was shaken by the largest earthquake recorded in the country's history (Matanle, 2011). However, it was not the earthquake which caused the majority of the damage, but the giant tsunami following it. The tsunami hit the Pacific coast of Tohoku Region – the most northern Japanese region on Japan's largest island Honshu – with waves that reached a maximum height of 9.3 m, causing the inundation of an area of 561 km^2 (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015). After the water retreated, the destruction slowly became visible in its entirety: About 122,000 buildings were either washed away or completely ruined and an additional 1 million buildings were half or partially destroyed. To make things worse, the tsunami also resulted in 18,500 people as either dead or missing (as of June 2016; Japan Reconstruction Agency, 2016). Moreover, the tsunami flooded the nuclear power plant Fukushima Daiichi, causing a nuclear meltdown and the release of radioactive material into the environment (Matanle, 2011, 2013). Residents living inside a radius of 20 km^2 around the power plant were forced to evacuate immediately. Later the evacuation area was extended even further (Iuchi, Maly, & Johnson, 2015). The Great East Japan Earthquake (GEJE) and Tsunami, as the event was termed, is only one example of disasters caused by natural events. Even though the global efforts in disaster risk reduction, which were established by the UN member states with the adoption of the International Decade for Natural Disaster Reduction (IDNDR) in the 1990s, slowly come to fruition in some countries, the disaster mortality in other countries still remains high (UNISDR, 2015b). Between 1990 and 2013, 1.6 million people lost their lives through internationally reported disasters. In the same time frame, the economic losses from disasters worldwide have grown steadily, reaching an annual average of US$250 billion to US$300 billion each year as of 2015 (UNISDR, 2015b).

It is expected that the changing temperatures and rising sea levels caused through global climate change will result in an aggravation of disaster risks (e.g., from heat stress, storms, flooding, landslides, air pollution, drought and water scarcity), particularly in urban areas (IPCC, 2014). This trend is exaggerated by the continuing trend of urbanization, which is projected to result in 66% of the people worldwide to live in cities in 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2014, p. 1). The most rapid urbanization in this time frame will occur in the lower-middle and low-income countries, putting a lot of pressure on existing cities to expand (United Nations, Department of Economic and Social Affairs, Population Division, 2014, p. 10). It is an important obligation of spatial planners to facilitate that this urban development follows certain standards, including safe housing and the provision of basic utilities and infrastructure and adequate health services (PreventionWeb, 2015; United Nations, Department of Economic and Social Affairs, Population Division, 2014). The proper management of urban development is of particular importance because poorly planned city structures are a distinct driver for disaster risk. Urban development can influence the hazard and vulnerability component of risk. If urban development alters the environment, e.g., through uncontrolled urban sprawl, or a city's sewage system is unable to drain the arising rain water, this can lead to the aggravation of existing or the emergence of new hazards. On the other side the concentration of citizens in hazardous areas leads to an increased vulnerability. It is mostly the vulnerable groups of the urban poor who are marginalized and therefore forced to live in these parts of the city (PreventionWeb, 2015).

Considering these developments, it becomes clear that there is a need to act. Resilience is one of the key concepts to address the challenge of disaster risk. If a city is resilient, it is able to "resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR, 2009, p. 24). Following this, the Sendai Framework for Disaster Risk Reduction 2015-2030, which was adopted by the member states of the United Nations (UN) at the Third UN World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan, on 18 March 2015, states "strengthen[ing] resilience" as its goal (UNISDR, 2015c, p. 12).

The adjustment of existing urban structures is time-consuming and cost-intensive; therefore, a resilient city can most efficiently be achieved when it is first developed (UN-Habitat, 2015) or after a disaster has erased the previously existing city structures (Olshansky, Hopkins, & Johnson, 2012). The time frame after the disaster can be considered as a window of opportunity for planners to build the city back better or – in other words – to build a resilient city. Although the relevance of spatial planners for the construction of resilient cities seems natural, there is little knowledge of spatial planning's capabilities to achieve this goal so far. Drawing from experiences on the reconstruction process after the GEJE and Tsunami in Japan's Miyako City and Ishinomaki City, this dissertation addresses this topic and explains which of the local spatial planning options can be used to build which aspect of resilience and how the toolkit of spatial planners can be improved in order to be more efficient to build urban resilience. Even though these spatial planning options differ from country to country and the focus of this research on Japan only enables a limited transferability of the research results, the experiences from Tohoku Region are able to contribute to the ongoing discussion about spatial planning and urban resilience after disasters. The work is addressed toward spatial planning practitioners and disaster risk researchers alike who would like to learn more about spatial planners' capabilities to build disaster resilient cities.

1.1 OBJECTIVE AND RESEARCH QUESTIONS

As outlined above, disaster risks already play an important role for cities across the globe and their relevance is expected to increase even further in the future. To address this challenge, it is important to acquire knowledge about the coherencies of the topic and to develop strategies to deal with them. In the last couple of years, the concept of urban resilience was introduced as a promising solution for this complex problem. In this context, the vulnerability of cities is supposed to be reduced by building resilience – the negative concept of vulnerability reduction is therefore exchanged with the positive concept of resilience building. Nevertheless, because the use of the concept of resilience for the reduction of urban disaster risk is fairly new, the international disaster risk community is just starting to begin with the development of guidelines and strategies how resilience building can be achieved. In 2010, the UNISDR launched their campaign *Making Cities Resilient*, which intends to "support sustainable urban development by promoting resilience activities and increasing local level understanding of disaster risk." (UNISDR, 2015a). The campaign includes the provision of a Disaster Resilience Scorecard, which was also used for the research of this dissertation. Another approach to the topic of resilience is the 100 Resilient Cities Initiative launched by the Rockefeller Foundation, a nonprofit organization (NPO), in 2013 in order to "[help] cities around the world build resilience to the economic, social and physical challenges that are increasingly part of the 21st century" (100 Resilient Cities, 2016). Even though these and other contributions help to advance the discussion, the actual role of spatial planning in this context is rarely considered. This is the reason why this dissertation attempts to investigate the ability of spatial planning to build urban resilience after a disaster. Thereby, the focus on the phase after a disaster was chosen because it is distinguished by a specific dynamic, which favors change and enables the implementation of plans much faster than in regular times. This phase is also called the *window of opportunity* and should be used as effectively as possible in order to achieve the aim to build a city's resilience after a disaster. Based on these considerations, the research objective of this dissertation is to answer the following two research questions:

› How can *spatial planning* help to build a *city's resilience* after a *disaster*?

› How can *spatial planning* use the *window of opportunity* effectively to improve a *city's resilience* after a *disaster*?

In this context – and based on George and Bennett (2005) – the research aims to explain the influence of the independent variable (spatial planning) on the dependent variable (a city's resilience). The occurrence of a disaster as a trigger for this process is a background characteristic, which influences the process under investigation, but is not further considered in the research. The window of opportunity, here interpreted as the chance to support a faster implementation of spatial plans in the aftermath of a disaster, is also considered as a background characteristic for the research. The definition of the terminology used in the research context can be found in illustration 1.

For the investigation of this topic, the reconstruction process in Japan's Tohoku Region after the GEJE and Tsunami in 2011 was selected. The reasons for this are the occurrence of a disaster as a background characteristic for the process under investigation. This limited the areas of research to the ones that experienced a major disaster in the recent past. This framework condition pointed towards Japan, a country that experienced one of the most severe disasters of this century so far. The tsunami destroyed an enormous area that required reconstruction (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015). In addition to this, Japan's long history with disasters (e.g., earthquakes, tsunamis, landslides) created a vast amount of experience that was adopted into the country's disaster risk management and spatial planning system over the years (see Chapter 4). One example for this is the country's existing building code that helps to prevent or at least limit major

SPATIAL PLANNING	In the context of this work refers to the spatial planning options that are availabe to address disaster risk in the risk governance phases assessment, management and communication. (see Chapter 2.4)
URBAN DISASTER RESILIENCE	"the ability of an urban system – [...] [and all its engineering, political-institutional, socio-economic and environmental component parts across temporal and spatial scales] – to maintain or rapidly return to desired functions in the face of a [...] [hazardous event], to adapt to change and to quickly transform systems that limit current or future adaptive capacity" (Meerow et al 2016, p. 36)
DISASTER	"[a] serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources". (UNISDR, 2009, p. 9)
WINDOW OF OPPORTUNITY	The opportunity for improvement that emerges in the aftermath of a disaster. Often also referred to as the chance to build back better. (see Chapter 3.3)

Illustration 1 | Definitions of the main terminology | Own illustration

damages through earthquakes. To preserve this state, the building code is frequently adapted to current standards. These experiences enable the international community of researchers and practitioners working in the field of disaster risk reduction to learn valuable lessons from Japan's spatial planners. Some of these lessons will be collected in this work. Another, more practical reason for the selection of Japan as the area of research was the author's participation in the research project *Increasing resilience of urban planning* (URBIPROOF), a project that was funded through the CONCERT-Japan framework by the Federal Ministry of Education and Research (BMBF) and the Japan Science and Technology Agency (JST). The project was conducted by the Institute of Spatial Planning (IRPUD) at the TU Dortmund University (Germany), the Department of Architecture and Buildings and the International Research Institute of Disaster Science (IRIDeS) at the Tohoku University (Japan) and the Agency for the Support of Regional Development Košice (Slovakia). The aim of the research project was to help European and Japanese cities to strengthen their resilience through the improvement of their "institutional and societal capacities and urban development strategies" (Greiving, Ubaura & Tešliar, 2016, p. x). The project's funding also enabled the realization of several research stays for the completion of this dissertation.

1.2 RESEARCH PARADIGM

This dissertation is based on empirical investigations (see Part B), which were conducted on the basis of the theoretical background presented in Part A of this work. Throughout the research process, aspects from both, the postpositivist and constructivist paradigm were used, whereby the emphasis was on the constructivist world-view because of the social context of the topic of investigation. Before the reasons for this decision are explained, the following paragraphs give a short introduction into the postpositivist and constructivist world-view and their characteristics.

Postpositivism traces back to Karl Popper, who refined the previously prevalent paradigm of positivism in order to address its shortcomings, such as the problem of induction (Popper, 1972). Postpositivism understands the world as real, objective and measurable. However, this reality can only be insufficiently perceived, which is why science tries to ascertain the truth, but can never fully achieve it. Postpositivism expects researchers to remain objective and to continuously question their findings (or have them questioned by the research community) because the generation of knowledge occurs through the falsification of hypotheses (in comparison to positivism, where hypotheses were also subject for validation). This means a hypothesis can be maintained as long as it could not be falsified and it is the purpose of the scientific community to aim for the falsification of as many aspects of a hypothesis as possible in order to approach the truth (Popper, 1972). The methodology of postpositivism reflects this intention to falsify hypotheses (Guba & Lincoln, 1994). Although the context requires an experimental and manipulative methodology, postpositivists also broaden their toolkit "by doing inquiry in more natural settings, collecting more situational information, and reintroducing discovery as an element in inquiry" (Guba & Lincoln, 1994, p. 110).

Constructivism, on the other side, understands realities to be "apprehendable in the form of multiple, intangible mental constructions" (Guba & Lincoln, 1994, p. 110). This means, that an objective world does not exist and realities solely depend on the observer's perception. In this context, the investigator is also considered as a subject to his or her subjectivist perceptions. For constructivists, knowledge is created through the exchange of the subjective knowledge between the researcher and the subject of investigation. The distinction between ontology (the form of reality) and epistemology (the relationship between the researcher and the subject of investigation) dissolves in constructivism. This is the reason why constructivist research often uses hermeneutic or dialectic methodology, which favors this ongoing exchange. The results from this iterative research process than can be used to extract a (new) consensus for research to agree on (Guba & Lincoln, 1994).

While the aim of postpositivism is to explain reality and use this knowledge for the prediction and control of processes, the aim of constructivism is to understand reality (Guba & Lincoln, 1994). This aspect was an important reason for the decision to lean towards a constructivist world-view for this research. Since the capabilities of spatial planning to build urban resilience after a disaster have not yet been investigated, it was the intention of the research to understand the ongoing processes and develop a theoretical background for further research. This point is also visible in the descriptive nature of the research question. Additional reasons for the preference of the constructivist world-view are that the topic of investigation – the reconstruction process in Tohoku Region after the GEJE and Tsunami – involves a variety of social interaction, which could not be manipulated in order to meet the requirements of the postpositivist paradigm. Furthermore, the topic's complexity required an iterative rather than a target-oriented research process in order to achieve optimal results.

However, even though the social context of this research is important and requires the acknowledgment of various realities, which are shaped through individual perceptions, the physical aspect of disasters as the topic under investigation cannot be denied. The decision to compromise between the postpositivist and constructivist paradigm in order to meet the contradictory characteristics of disasters and disaster risk correspond with the current understanding in literature (IRGC, 2005; Rosa, 1998; also see Chapter 2). As a pragmatic solution, this research understands the physical world as real (and as the subject of investigation based on a postpositivist approach), while the people's perception of this world is constructed. This can lead to different understandings of reality, but it can be accepted that the majority of people will agree upon hypotheses that have been unfalsifiable for a long time – and therefore most likely comply with the truth.

Some of the aspects for the decision about the borrowings from different research paradigms mentioned above, also apply for the selection of a case study design. These reasons are explained in detail in the following chapter.

1.3 RESEARCH DESIGN: CASE STUDY RESEARCH

To understand the reasons why a case study design was selected for this dissertation, it is important to understand the main characteristics of this research design. There are different understandings of case study designs, which makes it complicated to give one generally accepted definition. In his book "Case Study Research", which is frequently cited on this topic, Robert K. Yin gives the following definition of case studies (2014):

"A case study is an empirical inquiry that

› investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when

› the boundaries between phenomenon and context may not be clearly evident." (Yin, 2014, p. 16, emphasis added)

George and Bennett add one more point to this definition: Case study research investigates only a limited number of cases (George & Bennett, 2005, p. 18).

Now, why was a case study design selected for this research? First of all, the descriptive nature of the research question points to the suitability of this research design. The exploratory nature of case studies is especially useful for the investigation of such research questions. Additionally, the above mentioned characteristics match the needs that are required when investigating the research question.

The reconstruction process of the Tohoku Region after the GEJE that occurred in 2011 is still ongoing and therefore a contemporary phenomenon. The main objective of this dissertation is to collect the real-world experiences that were made in Japan and to make them available as key learning points for other countries that are required to deal with disasters. It is difficult to distinguish clearly between different causes and effects regarding the very complex reconstruction process after a disaster. This means it was impossible to set the exact boundaries for the investigation in the beginning of the research process. An in-depth engagement with each case was needed to understand all relevant factors and elaborate the research results. Furthermore, the situation's complexity makes it impossible to manipulate critical processes in a way that is required for quantitative research (Blatter, Janning, & Wagemann, 2007, p. 127). In addition, a simplification of the relevant processes would have resulted in defective results (Yin, 2014, p. 16). This means that the factors of interest in this in-depth case study research (or variables as they are called in quantitative research) exceed the compiled number of data points. To solve this problem, the research for this dissertation was structured based on a theoretical background and incorporated various methods as well as sources of data (see Chapter 7; Yin, 2014, p. 17). The selection of the reconstruction process in Japan's Tohoku Region after the GEJE and Tsunami, limited the number of possible cases available for investigation. This increased the relevance of each case for the investigation and is another reason for the selection of a case study design (George & Bennett, 2005, p. 18). As explained in Chapter 7, this research is based on two case study sites: Miyako City and Ishinomaki City.

Because each research design possesses a specific set of strengths and limitations, it is important to consider them before it is applied. This procedure ensures a proper integration of the research results into the overall context and helps to address a research design's limitations in order to reduce their effect on the research quality. Therefore, the following two chapters give an overview of the strengths and limitations of case study research.

1.3.1 Strengths of case study research

The strengths of case study designs are associated with the reasons why this type of research design was selected (see Chapter 1.3). Case studies are especially strong where quantitative research designs are weak and vice versa (George & Bennett, 2005). This chapter introduces the main strengths of case study research and explains why these aspects were relevant for the selection of this research design.

Case study researchers usually gather a variety of information, including aspects that they were not specifically looking for. This inductive approach enables the discovery of new and unexpected variables that quantitative research with its deductive approach and limited numbers of variables can hardly achieve. In the next step, these new findings can be used for the development of new hypotheses where the existing hypotheses reach their limit (George & Bennett, 2005). In addition to this, case studies offer the ability to explore causal mechanisms within a case that might be unexpected, but nonetheless important. The exclusion of variables that seem unimportant in statistical studies, restricts this chance to discover new aspects and relations. Although this abstraction is essential for statistical studies, the researcher must be aware that it deprives the researcher from developing a comprehensive picture of the subject of investigation (George & Bennett, 2005). For this research, these two aspect were of importance because of the limited amount of theoretical background that existed for the topic. Although the impact of spatial planning on disaster risk reduction is recognized, knowledge about spatial planning's ability to build urban resilience was still missing. To gather information to build new hypotheses, it was necessary to openly approach the research topic in order to experience the important aspects.

Variables that are interesting for social scientists are usually very hard to isolate and measure. The contextual framework is essential to figure out all relevant factors. This means not only some variables but the entire context of the phenomenon of interest must be considered. Unlike statistical studies, case study designs offer this possibility to widen the research frame and contribute to an understanding of all relevant correlations. Therefore, case study research is especially useful to take a closer look at specific processes that are often excluded from quantitative research (George & Bennett, 2005). However, this ability of case studies to "accommodate complex causal relations" (George & Bennett, 2005, p. 22) is traded off against the possibility to generalize the research results. This means the results of case study research can be developed into middle-range-theories at the most; more general theories can only be investigated with a broader data base and much more cases, such as in statistical studies (George & Bennett, 2005). In the context of this research, the main variables under investigation are spatial planning (independent variable) and urban resilience (dependent variable). The variables cannot be investigated in isolation, as it would be the case if statistical methods would be applied because the contextual framework is relevant for the usefulness of spatial planning options to build urban resilience. Using a case study research enables the examination of all aspects that need consideration. The trade-off against a restricted generalization had to be made because the detailed investigation of the relevant processes was necessary. How the possible pitfall of overgeneralization was addressed throughout the research, is discussed in the following chapter.

1.3.2 Limitations of case study research

Besides the abovementioned strengths of case study research, there are also some limitations that go along with this type of research design. It is important to understand those weaknesses and know how to handle them in the best possible way. Many limitations or pitfalls that are connected to case study research base on quantitative research standards that are applied to this more qualitative research approach (which does not mean that case study research cannot consider quantitative data). The most important points will be addressed in the following paragraphs. In addition to these misunderstandings, some important pitfalls when conducting case studies will be introduced and discussion will be provided as to how these points were handled in the research process.

One critique that is expressed in connection with case study research, is the selection bias. This term descends from a statistical background and "is commonly understood as occurring when some form of selection process in either the design of the study or the real-world phenomena under investigation results in inferences that suffer from systematic error" (Collier & Mahoney, 1996, p. 59). Such selection bias can occur when the researcher selects the cases for his or her research based on the value of the dependent variable and therefore willingly or accidentally distorts the results by underestimating the connection between the independent and dependent variables. Even though this is a highly relevant problem in statistical studies, it does not apply in the same way for case studies. This is, for instance, because case study researchers sometimes purposely choose cases that share the same characteristics. However, what might be right depends on the individual context. For case study research, the biggest problem in connection with selection bias occurs if the researcher selects cases in which independent and dependent variables both correspond with the theory under investigation and the researcher concludes from results of this small sample for generality. This problem of overgeneralization also applies when cases are limited in some way (e.g., geographically). In this instance, the generalization should never exceed the scope of the cases – may it be geographically or substantially, when other places share very similar key characteristics (George & Bennett, 2005, p. 19). For this research, this limitation of case study research was particularly considered for the development of the research results. Since the research was limited to two cases, the results can only offer a glimpse of spatial planning's possibilities for the creation of urban resilience in the aftermath of disasters – the results cannot be applied to other places with differing contexts or generalized. However, this does not mean, that it is impossible to learn from the experiences in Japan, even though the framework conditions in other countries are different.

Another constraint of case studies is their inability to estimate the exact weight of a certain variable's influence on the research topic. If this estimation is the purpose of research, quantitative research designs like statistical studies should be selected. Instead, case studies enable the researcher to get a comprehensive overview about all variables and influences that are relevant for a certain outcome. This means, "case studies [generally] remain much stronger at assessing *whether* and *how* a variable mattered to the outcome than at assessing *how much* it mattered" (George & Bennett, 2005, p. 25, emphasis in original). Related to this, there are some pitfalls that should be prevented: It is important to keep in mind that the necessity of a variable for a certain result does not specify how much it contributed to it. Therefore, it is impossible to draw conclusions about the weight of a variable's influence. Additionally, assertions can only be made for investigated cases. It is unreasonable to tell whether a certain variable is only necessary in the one special case that was studied, in all similar cases or if the findings are generalizable. For this reason, it is more applicable to state that a certain condition *favors* a certain outcome than to specify this contribution by terming it *necessary*. The researcher should also beware of transferring results from one or few case studies to general validity (overgeneralization – also see above) (George & Bennett, 2005, p. 19). As stated above, the results from this research were not transferred to other cases with differing contexts. Furthermore, the research refrained from rating the degree to which a certain condition (in this context: the application of certain spatial planning options) influenced a certain outcome (in this context: an increase of resilience). Instead, the intention of this research was to assess if and how spatial planning can influence resilience.

Case study researchers usually do not select cases based in their representativeness. Likewise, the acquired results are not representative and should not be labeled this way. To reach representativeness, the investigation of a large number of cases would be necessary. This would either limit the exploratory richness of the research results or result in an unmanageable amount of work. Case study researchers must be aware of this trade-off and decide if their research should explain a small number of cases in detail or if a higher degree of generalization is more desirable. Case study researchers generally choose to sacrifice a wide applicability of their theories for a high degree of analytical abundance (George & Bennett, 2005, p. 19). For this research, the main interest was to figure out how spatial planning options are able to build urban resilience after a disaster and not to explain the frequency of the occurrence of these factors in other cases. This problem could also be solved by paying attention to avoid falling into the trap of overgeneralization (see above).

Another accusation case study research has to face is related to its focus on understanding entire processes by explaining the interaction of numerous independent variables in only a small number of case studies. From the viewpoint of quantitative research, this can lead to the impression that the number of selected cases is too small to come to reliable results (degrees of freedom problem). However, because case study researchers understand variables differently than it is common in quantitative research, this problem does not directly apply (George & Bennett, 2005, p. 19). Case study research usually measures a wider set of attributes rather than combining those attributes into one superior variable like it is often done in quantitative research. To create a stringent chain of evidence that either corresponds to or falsifies a certain theory or reveals that this theory needs adjustments, case study researchers use process-tracing. Instead of increasing the number of variables, process-tracing embraces a detailed analysis of the relations between the dependent and independent variable, which bases on a theoretical background (Blatter et al., 2007, p. 158). This approach is also pursued in this research (see Chapters 8 and 9). Another related problem, that is not specific for case studies, is that the obtained evidence might match with more than one theory and it can be difficult to select the most appropriate. In cases where this applies, the researcher should try to at least narrow down the number of valid explanations (George & Bennett, 2005, p. 19).

Another problem that quantitative researchers often apply to case study research is the lack of independence between cases. Although this problem does not directly translate to case study research, it should be considered in a more general way when cases are selected. If the researcher is unaware of a lack of independence between cases, he or she can come to false conclusions. This difficulty can also be addressed by process-tracing, which enables the researcher to uncover possible linkages between cases. However, in research that attempts to reveal the influence of one case on another, the lack of independence between those two cases can be required and desired (George & Bennett, 2005, p. 19).

Finally, the nature of case study research can lead to the problem that the researcher gets lost in the variety of available data and collects much more data that can explicitly be considered for the analysis (Blatter et al., 2007, p. 180). This problem can be addressed through the development and strict application of guiding questions for the collection of data (Yin, 2014, p. 89). These questions help to structure the research process and keep the researcher focused on the collection of information that is relevant for the research topic. The guiding questions for this research are presented in the following chapter.

1.4 GUIDING QUESTIONS

As discussed above, case study research is characterized by a wide approach that considers a variety of aspects rather than focusing on a strictly limited number of variables. Nevertheless, this strength can only unfold if the researcher does not get lost in the complexity of the research process. To avoid this pitfall, the researcher is advised to develop specific guiding question, which frame the research process and structure the acquisition of data (Yin, 2014, p. 89). The guiding questions for this research can be divided into questions addressing the theoretical background for the research, these questions are answered in Part A of this dissertation. Questions that guided the empirical survey are addressed in Part B of this dissertation. Each question was answered based on the evidence from various data sources. Information that could not be acquired through other sources were retrieved from expert interviews. Further information about the data collection process can be found in Chapter 7. The illustration on the following page gives an overview of the dissertation's structure and work and displays which guiding question is answered in which chapter.

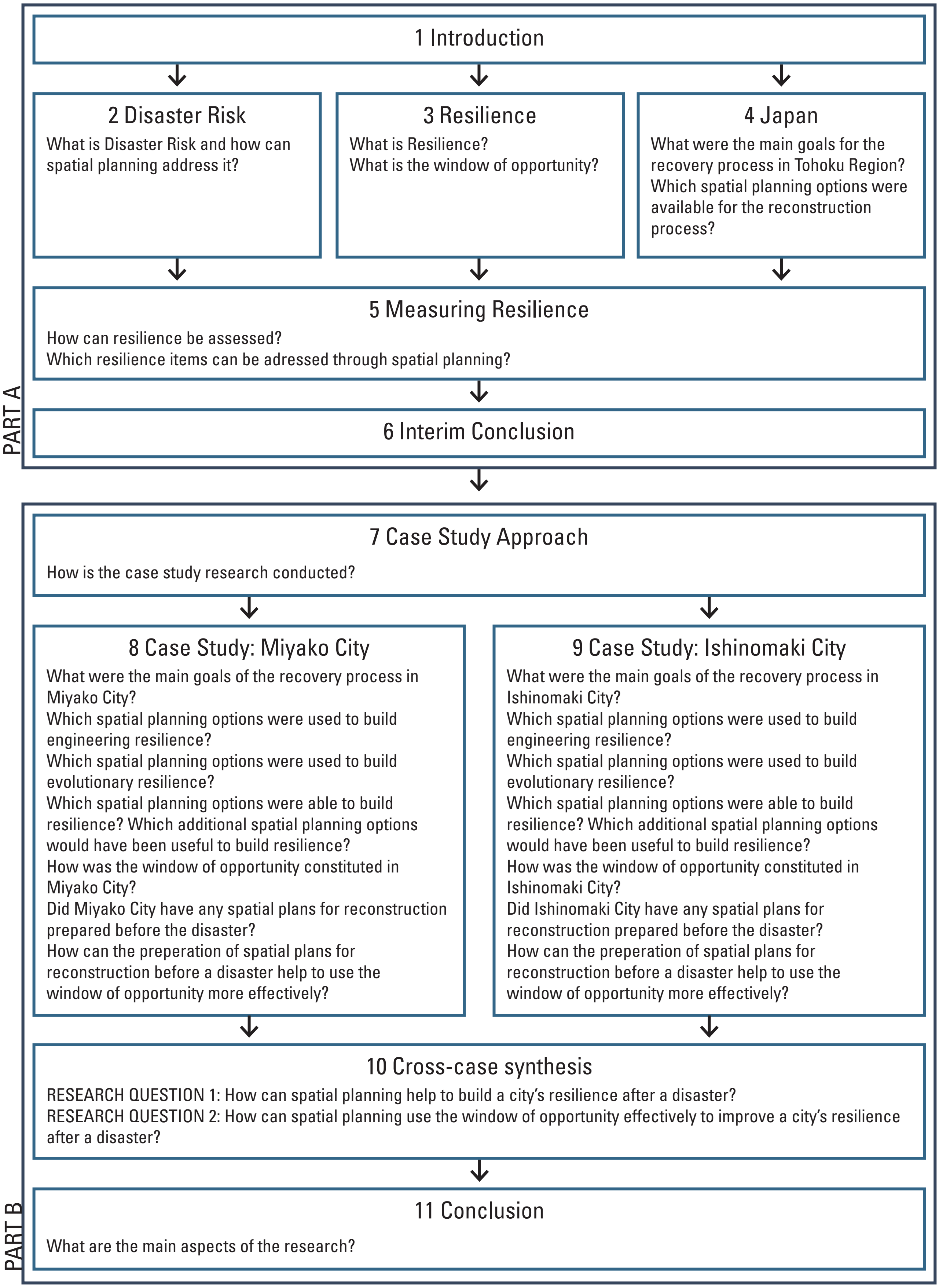


Illustration 2 | Research structure and guiding questions | Own illustration

1.5 CONDUCTING CASE STUDY RESEARCH: AN INTRODUCTION TO EACH CHAPTER

The following paragraphs give an overview of the three basic steps that were taken to conduct the case study research of this work. It must be kept in mind that a qualitative research process – like case study research – works iteratively. This means that the steps that are presented in a certain order below sometimes happened simultaneously or in loops throughout the actual research.

Research Design

At the beginning of the research process, a literature review to engage with the state of research was conducted. The information gathered through this review helped to identify the research gap and served as the basis for the development of the research question. After the main research questions were established, the dependent and independent research variables were roughly determined (see Chapter 1.1). The decision to use a case study design occurred based on the underlying research paradigm for this research (see Chapter 1.2) and considered the research design's specific strengths and limitations (see Chapter 1.3). In comparison to quantitative research, the operationalization of variables in qualitative research happened iteratively throughout the research process. For this reason, it was especially important to develop specific guiding questions (see Chapter 1.4) that framed the research process and clarified which data was actually required in order to advance the research process. Furthermore, guiding questions ensured that the collection of data occurred similarly for all cases and enabled the researcher to realize when needed data was unavailable, and when the research questions had to be adjusted accordingly (for more information on this iterative research process, see below).

The results from the literature review are presented in-depth in the Chapters 2-5 of this work: Chapter 2 introduces the terms disaster and risk, which are important for the topic of resilience. The chapter explains the history of the terms disaster and risk as well as its elements hazard and vulnerability before it examines spatial planning options to address disaster risk. The complex topic of resilience is presented in Chapter 3. The chapter first gives an overview of the development of the concept and explains its relevance for spatial planning. It then proceeds to discuss the aspects of urban resilience for this research and explains the window of opportunity. The study area is introduced in Chapter 4. The chapter includes an overview of the geographical and demographic context before it continues to take a closer look at the Japan's proneness to natural hazards in general and the GEJE and Tsunami specifically. The chapter furthermore introduces Japan's disaster risk management and spatial planning framework. One possibility to assess resilience – the Disaster Resilience Scorecard developed by the United Nations Office of Disaster Risk Reduction (UNISDR) is presented in Chapter 5. The scorecard was selected as a framework to evaluate the influence of spatial planning options on a city's disaster resilience. The main points from all of these chapters are summarized in Chapter 6.

Field Work

Simultaneously with the development of the research design, the researcher was engaged with possible cases. A more detailed description of the research procedure during the data collection phase is presented in Chapter 7. The basis for this was a comprehensive literature research about the cases, which included scientific and non-scientific literature. The knowledge about the cases was extended through conversations with local experts that were able to contribute specific knowledge about the reconstruction process in various cities in Tohoku Region. This phase of "soaking and poking" (George & Bennett, 2005, p. 89) is an important part of case study research and offers the researcher the possibility to stay open for new and unexpected information he or she might find. Although this phase can already be guided by a contemplated research question, it is necessary to reconsider and adapt the question if it seems appropriate. Throughout the data collection phase, a large amount of information was collected. This data was reviewed for usefulness and the relevant information was rehashed into chronological order before it was analyzed. In this way, all relevant dates and relations could be identified and considered for the analysis. Based on the chronological summary the theory-driven analysis of the collected data was conducted (see Chapter 8 for Miyako City and Chapter 9 for Ishinomaki City).

Results and conclusions

After the data was analyzed for each of the case study sites, a case-study synthesis was developed to elaborate similarities and differences, and – even more importantly – to answer the research questions by discussing which spatial planning options were able to build resilience in Miyako City and Ishinomaki City after the GEJE and Tsunami and how spatial planners could possibly be enabled to use the window of opportunity effectively (see Chapter 10). Finally, the conclusion in Chapter 11 summarizes the main findings of the research and presents further research needs.

2. DISASTER, RISK AND SPATIAL PLANNING

The following chapter introduces the main terminology of disaster risk research. The chapter first examines the origins of disaster, as the materialization of risk, and then considers the various understandings of risk and establishes the definition that is used for this research. In this context, hazard and risk as the two components of risk are also explained. Based on the general background, spatial planning options that are available to address disaster risk are presented. The chapter concludes with a summary of the most important aspects.

2.1 DISASTER

Each definition of disaster is closely linked with the environment that developed it and with "the purposes or interests of the definer" (Perry, 2007, p. 2). It is especially difficult to come to a generally accepted definition of disaster because disaster researchers stem from various fields, including geography, spatial planning, sociology and psychology. David Alexander (1993, pp. 13–14) identified the following six schools of thought that shaped the term disaster: the geographical approach (Barrows, 1923; White, 1945), the anthropological approach (Oliver-Smith, 1979; Torry, 1979), the sociological (Church, 1974; Dynes, 1970; Glass, 1970; Quarantelli, 1978) and psychological (Glass, 1970; Church, 1974) approach, the development studies approach (Chen, Chowdhury, & Huffman S.L., 1980; Davis, 1978; Knott, 1987), the disaster health sciences approach (Beinin, 1985) and the technical approach (Bolt, Horn, Macdonald, & Scott, 1977; El-Sabh & Murty, 1988). The following paragraphs take a closer look at the geographical approach because of its relevance for spatial planning.

The geographical approach puts natural hazards that cause disasters (e.g., earthquakes, tsunami, and volcano eruptions) at the center of research (Perry, 2007; Quarantelli, 1998). Within this context "a disaster is viewed as an extreme event that arises when a hazard agent intersects with a social system" (Perry, 2007, p. 9). Accordingly, the "social system" is solely understood as a passive component at risk that is comparable to today's understanding of exposure. This disaster approach is termed socio-technical or hazard focused and follows a realist world-view. It dates back to the flood hazard research that geographer Gilbert F. White (1945) conducted for his dissertation *Human adjustment to floods* and follows the general understanding of geography as human ecology[1] as it was proposed by Harlan H. Barrows (1923) at the University of Chicago in the 1920s (Alexander, 1993). Later, this perspective was further developed by Burton and Kates (Burton & Kates, 1964; Burton, Kates, & White, 1978).

Over the following decades, there was an ongoing exchange of hazard researchers with sociologists, whose definition of disaster was shaped by Charles E. Fritz. Fritz defined a disaster as "an event, concentrated in time and space, in which a society, or a relatively self-sufficient subdivision of a society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented" (Fritz, 1961, p. 655). This

[1] The human ecological understanding of geography addresses the relationship between natural environments and human activities (Barrows, 1923, p. 3).

socio-cultural approach clearly focuses on the vulnerability of social fabric and emphasizes the disruption of social order and consequential negative impacts on societies as disaster's main characteristics (Perry, 2007, p. 6). With this content in mind, disaster researchers started to understand disasters as social events because "[t]heir origins, their manifestations, and their consequences are all basically social" (Quarantelli, 2005, p. 346). This constructivist understanding of disaster as a social construct, was also adopted by proponents of the hazard centered approach to disaster. In their article *Taking the naturalness out of disaster*, O'Keefe, Westgate, and Wisner (1976) emphasize the importance of socio-economic factors for vulnerability and assert that "vulnerability of the population as the real cause of disaster" (p. 567) must be included into disaster research. In 2005, David Alexander, who was previously a hazard centered disaster researcher, stated: "[D]isaster is not defined by fixed events, or immutable relationships, but by social constructs, and these are liable to change" (Alexander, 2005, p. 29).

What does this mean for today's researchers? Although the discussion about the definition of disaster is still ongoing, there is a general understanding of disaster as a composition of natural elements (hazards) and social elements (vulnerability): "[T] here cannot be a disaster if there are hazards but vulnerability is (theoretically) nil, or if there is a vulnerable population but no hazard event" (Wisner, Blaikie, Cannon, & Davis, 2004, p. 49). Within this very general understanding of disaster, scientists in the various fields of disaster research continue to discuss and refine definitions of disaster in accordance with their focus. It is an ongoing process and might never reach a final conclusion. Nevertheless, because disaster research usually is carried out in an inductive way, where case studies are conducted and observations are made to derive theories (which is also the case for this dissertation), a generally accepted definition of disaster is not (yet) required. Especially "descriptive studies, can easily continue in the face of only a little consensus regarding what is meant by a disaster" (Perry, 2005, p. 323). In this context, a consensus about the definition is unnecessary; it suffices if each researcher decides on a definition for his or her work (Perry, 2007, p. 15). For this research, this task is done in the following paragraph.

Building on Fritz's definition, the author understands disaster as a social event, that is disruptive to a degree where a community can no longer handle the problem autonomously. For the purpose of this research, the author adopts the definition from the UNISDR, which defines a disaster as "[a] serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" (UNISDR, 2009, p. 9). Accordingly, events that do not meet these conditions are referred to as "hazardous events" in this work.

2.2 RISK

Disasters are the materialization of risks (Britton, 2005, p. 76; see illustration 3). Likewise, disaster risk is defined as "[t]he potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period."(UNISDR, 2009, pp. 9–10). This definition of disaster risk as a potential or a possibility offers humans the op-

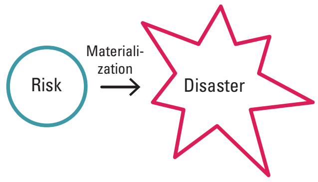


Illustration 3 | Disaster as materialization of risk | Own illustration

portunity to influence risk and reduce or prevent the undesirable effects it can cause; accordingly, a disaster can be understood as a risk that was not managed sufficiently (Cardona, 2011, p. 112). Likewise the proper management of a hazardous event can prevent it from turning into a disaster.

To manage risk before it turns into a disaster, two basic conceptual approaches that address disaster risk are widely used. They correspond with the realist and constructivist world-view introduced above. The socio-technical approach that derives from applied sciences and economics is based on statistical predictions and the analyses of probabilities. This approach assumes that events can be objectively measured "in terms of physical damage to persons and ecosystems" (Cardona, 2011, p. 109). This simplification has its benefits and downsides. While it makes risk quantifiable and countermeasures comparable, the abstraction of social aspects can also lead to an oversimplification of complex processes (Cardona, 2011, p. 109).

The socio-cultural approach, is based on a constructivist world-view and understands risk as a social phenomenon. It can be further divided into individualist and structuralist approaches: The individualistic approaches of psychology understand risk as the perception of each single individual (Tversky Kahnemann 1973, 1974, Slovic, Fischhoff Lichtenstein 1981), while proponents of the structuralist approach see risk as a construct of society or culture and consider cultural theory to be the most appropriate way to address risk (Thompson & Wildavsky, 1982). While the socio-cultural approach allows to take people's varied understandings of risk into account, it lacks operability for public policy. In practice, this approach "requires knowledge of individual perceptions and social representations, and of the interactions between the different social actors" (Cardona 2011: 111). Accordingly, this understanding of risk requires comprehensive participation processes. Both, the socio-technical approach and the socio-cultural approach have their justification. This is why the research community came to the conclusion to comprehend risk as "a social construct as well as a physical reality, and the two aspects are intimately linked" (Organisation for Economic Co-operation and Development, 2003). For a more precise elaboration on this topic, the reader is referred to Mayo and Hollander (1994), Rosa (1998) and Renn (2008).

The different fields of research that addressed risk over time, resulted in a variety of definitions in use. At an expert meeting in 1979, that was organized by the Office of the United Nations Disaster Relief Coordinator (UNDRO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) the first attempt to unify the understanding of risk and to clarify its components was made (UNDRO, 1980, 5ff). Since then, the definition has been further developed and today it is widely accepted that risk can be defined as a simplified equation of hazard and vulnerability (as first proposed by Fournier d'Albe, 1985, p. 77 and later adopted by UNISDR, 2004):

RISK = HAZARD X VULNERABILITY

The understanding of risk as composed of the components hazard and vulnerability was adopted for this research (see illustration 4). Until recently, the hazard component was commonly considered to be the quantifiable component of risk. Researchers relied on the hazard's (assumed) continuity to forecast future events based on past experiences. This view was widely accepted until the influence of climate change on certain natural hazards was discovered. This changed the perception of hazards and will most likely result in different definitions of hazards in the future. The discussion about vulnerability, on the other hand, has been ongoing since its introduction into the risk context in the 1970s. The reason for this is that the social context of vulnerability leaves a broad interpretive framework. The following chapter gives an overview of the two risk components hazard and vulnerability and the ongoing discussions surrounding them.

2.2.1 Hazard

Until the 1970s, hazards have often been treated as the main or, in some cases, even the only component of disaster risk (Cardona et al., 2012, p. 108; Hilhorst & Bankoff, 2004, pp. 1–2; Perry, 2007, pp. 8–9). This changed when the social component of vulnerability was introduced, and today the social coherencies of risk are at the center of disaster research (Perry, 2007). As the equation above shows, hazard is a necessary condition of risk; without hazard there is no potential for disaster. Hazards are the "possible, future occurrence of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements" (Cardona et al., 2012, p. 69). Accordingly, the term hazard refers to a "threat or potential for adverse effects, not the physical event itself" (Lavell et al., 2012, p. 32). The term hazard also includes the "probability and magnitude" of an event. Socio-technical risk approaches especially focus their technical risk assessment on what they considered to be the objective element of disaster risk. They evaluate statistical data to determine a hazard's probability of future occurrence. Based on this knowledge, they intend to address the causes for possible negative effects, e.g., through engineering solutions (Renn, 2008, p. 12).

Recently the research community discovered that this understanding was erroneous. The misconception was realized when the influence of climate change on weather related physical events like heat waves droughts or floods was discovered (IPCC, 2014, p. 53; Lavell et al., 2012). The European Commission termed this change of the environment as an "evolving baseline" (European Commission, Directorate-General for the Environment, 2013, p. 33). Geological hazards, like the earthquake and tsunami this research focuses on, are not (yet) linked to the effected of climate change. Nevertheless, there is an ongoing discussion about the influence of the climate on geological hazards (McGuire & Maslin, 2013), which has not come to a final conclusion. Accordingly, the effects

Illustration 4 | Vulnerability and hazard as the elements of risk | Own illustration

of climate change on disaster risk, are not further considered for this research. Readers who are interested to learn more about this topic are referred to Field et al. (2012). The recognition of the uncertainty concerning the hazard component of risk helps to acknowledge the relevance and understanding of vulnerability as the second component of risk (Lavell et al., 2012, p. 37).

2.2.2 Vulnerability

Vulnerability is a concept that was introduced into the disaster risk discussion by O'Keefe, Westgate and Wisner (1976) in the 1970s. It was the reply to the hazard focused approach of the past and emphasized the importance of social factors for disaster risk. Including social processes opens the opportunity to address disaster risks before they manifest into disasters (Cardona et al., 2003; Cardona et al., 2012). Vulnerability can be defined as "the propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by hazard events" (Cardona et al., 2012, p. 69). The concept of vulnerability was adopted into various fields, which is why there are various conceptual frameworks for vulnerability. Cardona et al. identify the following four (2012):

1. *The pressure and release (PAR) model* (Blaikie, Cannon, Davis, & Wisner, 1994; Wisner et al., 2004) focuses on less developed countries and emphasizes that vulnerability is created through socio-economic conditions, such as gender, age or socio-economic status, in everyday life. Although the approach acknowledges the necessity of hazards to generate disasters, its main focus is on explaining the various social causes that form vulnerability. Hence, the PAR model does not consider factors such as building structure or settlement in hazardous zones as components of vulnerability (Wisner et al., 2004).

2. *The human-environmental approach* links vulnerability to a broader human and environmental context and thereby connects the concept of vulnerability with sustainability science (Turner, Kasperson et al., 2003; Turner, Matson et al., 2003). The complex concept was developed by the Research and Assessment Systems for Sustainability Program and emphasizes the importance of considering a system's various linkages

to understand its vulnerability. According to this approach, vulnerability is composed of the elements exposure, sensitivity (of human as well as environmental components) and resilience (including coping/ response, impact/ response and adjustment and adaptation/ response) (Turner, Kasperson et al., 2003).

3. *The holistic disaster risk approach* aims to combine all existing risk perspectives into one interdisciplinary concept (Cardona, 2011, p. 111). The concept divides vulnerability into exposure, susceptibility and coping capacity/ resilience. One major part of this approach is the feedback loop "which underlines that vulnerability is dynamic and is the main driver and determinant of current or future risk" (Cardona et al., 2012, p. 71). This approach is also used in the field of spatial planning (MOVE, 2011).

4. *The climate change adaptation approach* defines vulnerability as "a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2007, p. 21) and was used by the IPCC in its Fourth Assessment Report. This vulnerability approach differs from the ones used in disaster risk management because it focuses on gradual changes, such as climate change, as an element of vulnerability (IPCC, 2007, p. 21). The approach therefore is not intended to explain specific events, but the change that occurs between present and future through slowly proceeding stresses.

The variety of these frameworks shows that the discussion about vulnerability and its main elements is still ongoing. This makes it complicated to acquire a comprehensive picture and develop an individual understanding of the topic. The practical application of the four approaches introduced above, shows that the PAR model is most commonly used in social science, while the human-environmental approach finds application in the social-ecological context (Cardona et al., 2012). The climate change adaptation approach is especially useful to understand and address slowly changing conditions (like climate change) and is therefore widely used in this context, e.g., in the IPCC's Fourth Assessment Report (IPCC, 2007). The comprehensive perspective of the holistic disaster risk approach makes it useful for an application in the field of spatial planning (MOVE, 2011). This approach's core element, the feedback loop, which enables learning from past experience, was also adopted for this research (see illustration 5). Although each of the various frameworks emphasizes different points, there are elements that are consistently related to vulnerability (Smit & Wandel, 2006, p. 286) and are also used for this dissertation. These elements are:

› *Exposure and physical susceptibility* refers to spatial exposure of people and their assets to hazards, based on their location (e.g., living in a flood prone area), as well as the physical susceptibility of their built structures (e.g., buildings that cannot withstand an earthquake). Exposure and physical susceptibility are the "hard" components of vulnerability. They are closely connected to the hazard (Cardona, 2011, p. 114), and spatial planning's impact on them (e.g., through land-use planning or the application of building codes) is obvious. Although some works consider exposure as a separate component of risk (e.g., IPCC, 2012), it can also be considered as one element of vulnerability, "because it is implicit in the notion of vulnerability. In other words, one cannot be 'vulnerable' unless one is 'exposed'" (Cardona, 2011, p. 113). For this research, exposure is considered to be a component of vulnerability.

› *Fragility or sensitivity* refers to the "soft" factors of vulnerability that manifest themselves in social, economic and ecological predispositions that result in diverse vulnerabilities for different groups of people. These aspects usually are not hazard dependent. Determinants for fragility can be the gender, age, religion or race of a person (social), a person's occupation (economic) or his/ her reliance on nature (ecological). Critics state that limiting vulnerability to the elements exposure, susceptibility and fragility, results in a "negative concept of vulnerability" (Gaillard, 2010, p. 220). It restricts vulnerable systems to solely rely on actions from the outside to overcome this state. To address this problem and broaden the understanding of vulnerability, the concept of capacity was introduced in the 1980s.

› *Capacity* takes people's ability to cope with hazards into account and "reflect[s] the emergence of the vulnerability paradigm" (Gaillard, 2010, p. 222). Capacity increases a system's ability to recover or evolve and can be linked to entire systems, partial groups or individuals. Thereby, capacity enables people to actively encounter risks, instead of helplessly enduring them (Gaillard, 2010, p. 222). Capacity can either refer to adaptive or coping capacity, whereby adaptive capacity is preparatory and directed into the future and coping capacity is responsive and influences present risk. Adaptive capacity is "[t]he ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2013, p. 2). The term emerged from the climate change discourse which made it necessary to adapt to changing climatic conditions without the necessity to experience a hazardous event as a trigger, e.g., by adapting to climate change based on climate projections. Today the concept has a broader context and also includes other changes such as soil erosion (UNISDR, 2009, p. 4). Adaptive capacity addresses future risks through measures that are implemented today (e.g., changing land-uses to reduce future risk), but does not influence today's risk (Greiving et al., 2015). Coping capacity on the other hand is defined as "[t]he ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters" (UNISDR, 2009, p. 8). This means coping is the ability of a system to immediately react to a hazardous event – and is therefore typically linked to a hazardous event as a trigger. In contrast to adaptive capacity, coping capacity directly addresses present risks (Greiving et al., 2015).

To conclude, exposure, susceptibility and fragility are system predispositions that may cause harm when a hazard interferes with them. Capacity on the other hand prescribes the ability to cope with this harm, either before (anticipation, adaptation) or while/ after (response, recovery) a hazardous event occurs. Likewise, adaptive capacity addresses future risks, while coping capacity addresses present risks. Accordingly, the current adaptive capacity can be used to build tomorrow's coping capacity if the appropriate measures are taken. By this means, a system's capacity is able to prevent that a future hazardous event turns into a disaster (understood as a serious dysfunction that exceeds a systems own resources) or support the recovery process after a disaster occurs.

There is an ongoing debate about the relation between capacity and vulnerability (Cardona et al., 2012; Cutter et al., 2008; Gaillard, 2010): Some researchers understand capacity – or a lack thereof – as one element of vulnerability (e.g., Pelling, 2003; Cardona, 2011; Turner, Kasperson et al., 2003). In this context, vulnerability is "seen as the remainder after capacity had been taken into account" (Cardona et al., 2012, p. 73).

Davis, Haghebaert, and Peppiatt (2004), on the other hand, called attention to the shortcomings of this view by pointing out that capacity and vulnerability cannot always be measured on the same scale. In some cases, communities are vulnerable in some aspects although they possess considerable capacities in other domains. Therefore, it is advisable "to confine all the resources and capabilities of communities under the term 'capacity' and to restrict the word vulnerability to factors that contribute to putting people at risk" (Davis et al., 2004, p. 2). Considering this, capacity and vulnerability are two separate elements that are able to mutually influence each other. This understanding is also adopted for this research because defining capacity as one component of vulnerability restricts the opportunities that the concept of capacity has to offer. This is because the goal of eliminating a risk is reached when vulnerability is reduced to nil. Whether capacity is built on top of this minimized vulnerability, is irrelevant; it cannot be considered within this context. To clarify this line of thought, the following quote from Jonathan Larson's rock musical Rent (1996) is used. The quote was first used in the context of resilience and vulnerability by Thomas P. M. Barnett in his blog (Barnett 2016)[2]: "The opposite of war isn't peace, it's creation." – The quote emphasizes that the absence of a destructive force is not necessarily the opposite of this force. To oppose the destructive force of war, a productive force – creation – is needed. When transferred into the context of disaster risk, this means that the opposite of a disaster is not its absence (which can be achieved by reducing vulnerability to nil), but the ability to create (which can be achieved through building capacity). Including capacity into vulnerability therefore deprives the concept of this ability to create. Although it certainly is possible to include these considerations into the concept of vulnerability, it seems more appropriate for this research to extract capacity from the concept of vulnerability and understand them to interact. This means that building capacity can decrease vulnerability and a decline of capacity can lead to an increase of vulnerability. Nevertheless, this interaction is complex and differs for various aspects (physical, political-institutional, social, economic, environmental) and over time. Consequently, a system is able to hold capacity regarding one aspect and still be vulnerable regarding another (Davis et al., 2004). For instance, the degree of vulnerability often varies between different socio-demographic groups (e.g., poor/ rich, women/ men) and building the capacity of one group does not automatically reduce the vulnerability of another.

2 Because Barnett framed the terminology differently, his line of thought is not adopted for this research.

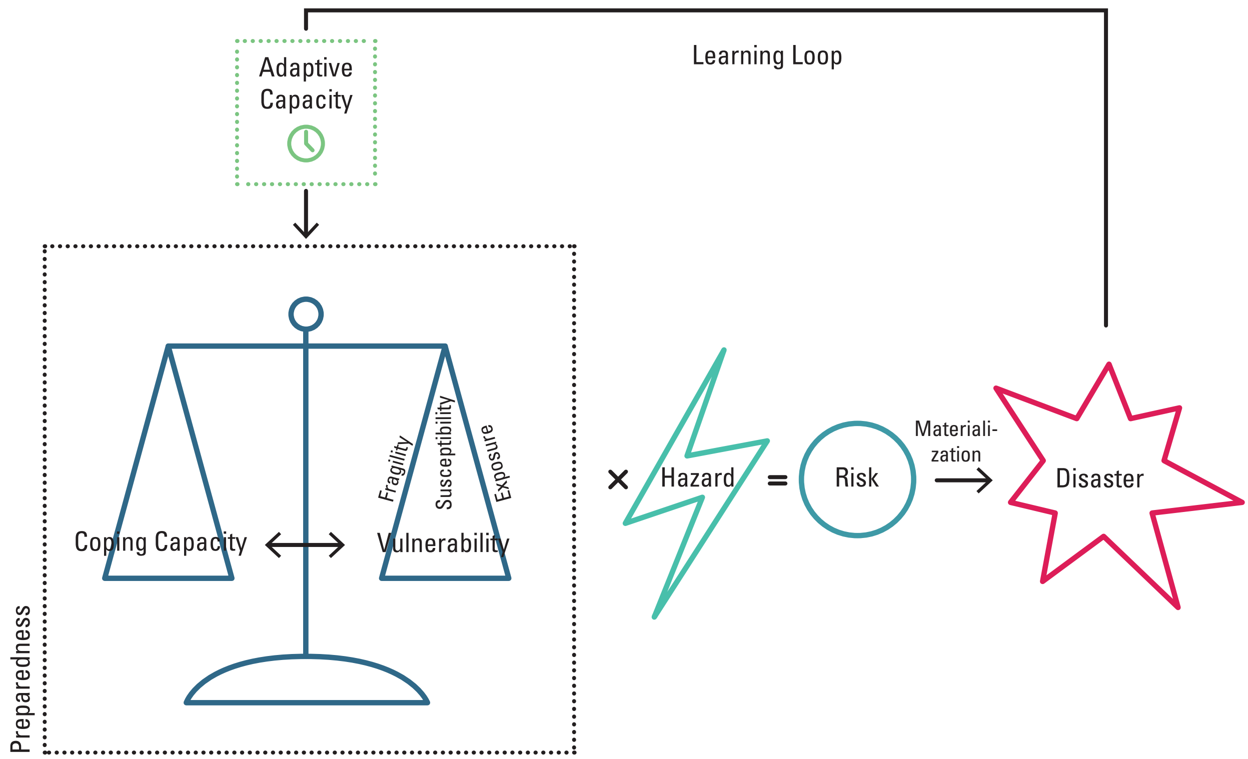


Illustration 5 | The disaster risk framework | Own illustration

Understanding capacity as a separated element from vulnerability, extends the risk equation by another factor. Instead of merely considering vulnerability and hazard, the component of capacity is added (see illustration 5). While coping capacity directly influences vulnerability, adaptive capacity can only interpose its influence delayed in time, which is illustrated by the clock. In accordance with the holistic disaster risk approach (Cardona, 2011) and because the ability to learn from a disaster, is an important element of disaster risk reduction, the learning loop arrow was added. It enables the system to use a disruptive event as a chance to build coping capacity and reduce vulnerability to deal with future hazardous event. In the best case, this process can prevent a disaster from happening.

It is a common perspective to identify capacity with resilience (Cardona, 2011; Cardona et al., 2012). The reason for this lies in the aspiration to unify the separately developed capacity and resilience concepts. As discussed above, there is a difference between coping and adaptive capacity, which begs the question which kind of capacity is equivalent to resilience. The difference between coping and adaptive capacity can roughly be described with the following quote: "While coping aims to maintain the system and its functions in the face of adverse conditions, adaptation involves changes and requires reorganization processes" (Cardona et al., 2012, p. 73) or as Birkmann summarizes: "[C]oping encompasses immediate measures that might help to deal with an actual hazard event (impact), adaptation measures should allow for a longer-term adjustment (change)" (Birkmann, 2011, p. 1117). This means, coping capacity exists at a specific moment while adaptive capacity unfolds over a period of time. To answer the question regarding the relationship between resilience and capacity, it is important to learn more about the emergence and current understanding of the concept of resilience. These will be elaborated in-depth in Chapter 3. First, however, spatial planning's ability to manage disaster risk is explained in the following section. Nevertheless, it should not be concealed that it was impossible to come to a conclusive result about the complex connections between the terminology used in the disaster risk context. This especially concerns the relation between coping/ adaptive capacity, resilience and vulnerability. For the research of this dissertation the outline of the most important aspects will have to suffice.

2.3 RISK GOVERNANCE

Risk governance "deals with the identification, assessment, management and communication of risks in a broad context. It includes the totality of actors, rules, conventions, processes and mechanisms and is concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken" (IRGC, 2008, p. 4).

In accordance with the Risk Governance Framework established by the International Risk Governance Council (IRGC) (2005, 2008) and the application of this framework into the context of spatial planning by the URBIPROOF project (Dzurdženík et al., 2015), risk governance can be structured into the phases risk pre-assessment, risk assessment, risk appraisal and characterization and risk management. These phases are framed by a comprehensive communication process, which is depicted in the middle of illustration 6.

Risk pre-assessment includes the broad analysis that has to be carried out before the actual risk appraisal begins. It includes the identification of relevant stakeholders for further risk governance process and the development of a common definition of relevant risks between these stakeholders (risk framing) (Dzurdženík et al., 2015).

Risk appraisal is composed of two consecutive steps. First, a scientific analysis of the risk's physical characteristics is conducted. This analysis includes the identification of the risk determinants hazard and vulnerability (including exposure, physical susceptibility and fragility) and assesses possible impacts that can be caused through their interaction. In a second step, the results from this analysis are used to assess the social impacts that these risks have for the relevant stakeholders. This analysis also includes the consideration of existing capacities and is termed concern assessment. The result of the risk appraisal phase, is a comprehensive understanding of risks (Dzurdženík et al., 2015).

Risk characterization includes a thorough consideration and scientific analysis of the information collected during the risk appraisal phase. This analysis includes the estimation of the probability of specific effects to occur and also considers mutual influences and trade-offs between different risk determinants. It is possible to either conduct the analysis based on quantitative (resulting in numerical values) or qualitative methodology (resulting in the attribution of categories such as high, moderate, low). In any case it has to be considered that the results of this risk characterization can be biased and always include uncertainties. Based on the risk characterization results, the step of risk evaluation in conducted. Risk evaluation includes a normative evaluation and therefore is considered to be the

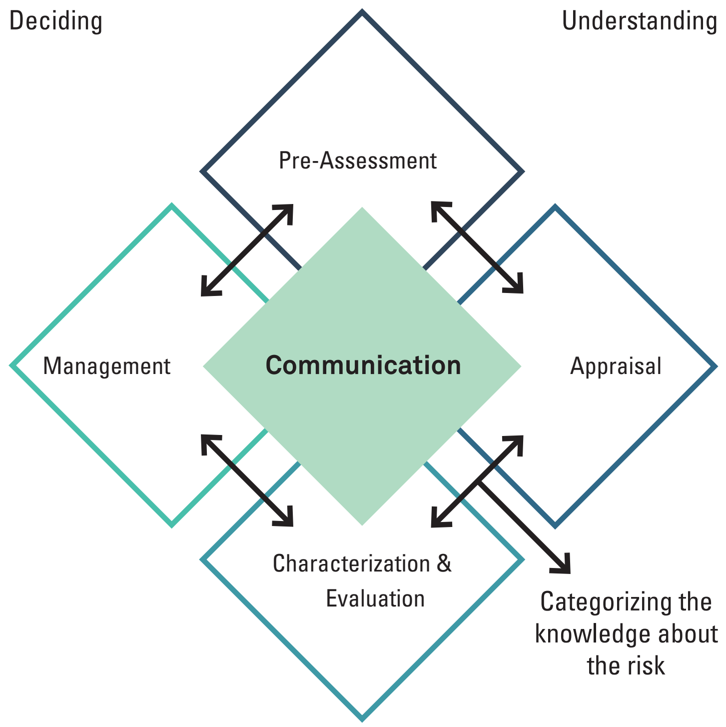


Illustration 6 | IRGC Risk Governance Framework | Own illustration based on Dzurdženík et al., 2015, p. 2 and IRGC, 2008, p. 8

most controversial step in the risk governance process. In this step, decisions are made based on personal values rather than scientific evidence. Accordingly, the comprehensive participation of all relevant stakeholders is crucial. The step of risk evaluation concludes with a categorization of risks as either acceptable, tolerable or intolerable. Based on this evaluation, decisions are made if and how certain risks are addressed in the risk management phase (Dzurdženík et al., 2015).

Risk management includes the decision-makers' decision about strategies to address risks that require action, their implementation and monitoring. If risk management is carried out successfully, it is able to reduce the impact of these risks and minimize negative consequences for the society. The selection of the most efficient risk management strategies depends on the risk's degree of complexity, uncertainty and ambiguity (Dzurdženík et al., 2015).

Communication is a crucial aspect of the risk governance process and should be continuously carried out throughout all of the steps introduced above. The necessity for comprehensive communication and participation processes is based on the constructivist understanding of risk as socially constructed, but it is also of special importance if normative decisions are made, which is the case during risk evaluation (Dzurdženík et al., 2015).

In spatial planning, these risk governance steps can be integrated into the framework of the Environmental Impact Assessment (EIA). This is useful because spatial planners are usually familiar with this procedure for the assessment of environmental impacts of large scale construction projects. Furthermore, the risk governance phases correspond to the steps of the EIA as

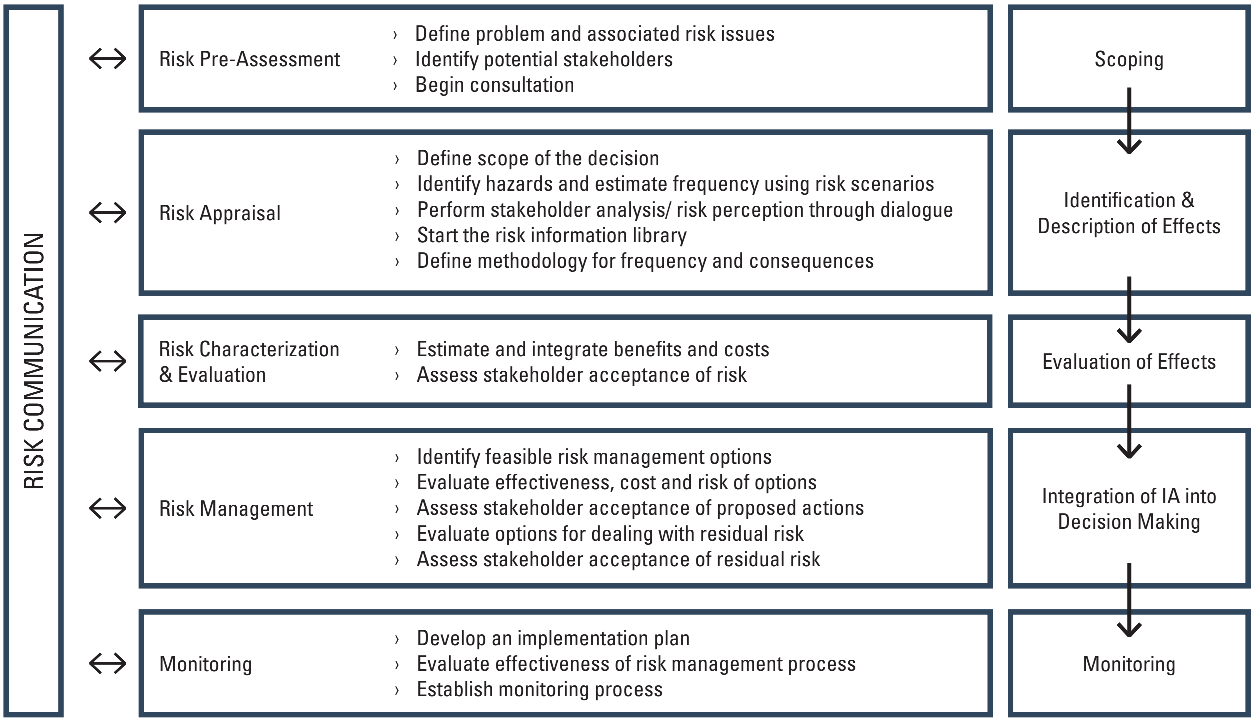


Illustration 7 | Risk governance and Environmental Impact Assessment | Own illustration based on Dzurdženík et al., 2015, p. 3

presented in illustration 7. The monitoring step, is not included in the risk governance framework, but should still be considered. It enables the review and improvement of the course of action used to govern risk.

For each risk governance phase, there are certain spatial planning options that can be applied to reach the goal of this phase. The following chapter gives a general overview of these options. The spatial planning options for the risk pre-assessment, risk appraisal and risk characterization and evaluation phases partially overlap and are therefore subsumed under risk assessment in this research. The following chapter therefore explains the spatial planning options for risk assessment, risk management and risk communication.

2.4 SPATIAL PLANNING AND RISK GOVERNANCE

Spatial planning's relevance for risk governance was first introduced by Raymond J. Burby (1998) and David R. Godschalk and colleagues (1999). While this connection was only acknowledged by policy makers and spatial planners at first, it is now widely accepted and reflected in the consideration of spatial planning (or the related terms land-use planning or urban planning) in policy documents like the Hyogo Framework for Action 2005-2015 and – its replacement – the Sendai Framework for Disaster Risk Reduction 2015-2030 (Dzurdženík et al., 2015). In addition to this, poorly planned urban structures are considered to be one driver for disaster risk with the ability to influence the hazard as well as the vulnerability component (PreventionWeb, 2015). The following three chapters give a general introduction of the spatial planning options used in the risk assessment and risk management phase of the risk governance process and explain how important continuous communication throughout the entire process is. An elaboration of spatial planning options available in Japan can be found in Chapter 4.

2.4.1 Spatial planning and risk assessment

Risk assessment includes the assessment of hazardous areas and the analysis of how these areas intersect with vulnerable land-uses. After the risk is identified, it has to be evaluated and decisions as to how it should be addressed have to be made. During the risk assessment phase spatial planners can, for instance, cooperate on the development on hazard and risk maps. Hazard maps illustrate the spatial impact of different hazards (e.g., landslides, earthquakes and tsunamis) and are prepared on the basis of geographical hazard information. If hazard maps are extended with the spatial information of vulnerable land-uses, risk maps can be developed. Hazard and risk maps serve as an important foundation for the development of risk evaluation maps. Risk evaluation maps add a normative component to the deterministic foundation of hazard and risk maps: These maps incorporate risk priorities for the different protected goods (i.e., air, water, soil, flora, fauna, landscape and human beings) and thereby decide where there is a need to act (Dzurdženík et al., 2015). As explained in Chapter 2.3, the EIA, can be used to frame the risk governance process. This is especially helpful because its intention is to enable the weighing of interests between different protected goods and to reach a conclusion.

2.4.2 Spatial planning and risk management

Based on the results from the risk assessment phase, spatial planners have several options available to address disaster risk. These can be summarized into the following four aspects, which are introduced in the following paragraphs based on Greiving and Mägdefrau (2016): minimization of exposure of urban areas, differentiated land-use decisions, adaptation of building structures and hazard mitigation. The first three options intend to govern risk by reducing the damage potential. These are the options where spatial planners carry the main responsibility (Greiving, 2002, p. 8). The last option intends to reduce risk through hazard mitigation and requires spatial planners to intensify their cooperation with the responsible sectoral planning departments.

2.4.2.1 Minimization of exposure of urban areas

To minimize the exposure of urban areas, the following two options are available: Preventing the future development of residential land-uses in hazardous areas and reducing the amount of existing residential land-uses in hazardous areas. The first option, to prevent the urban development of hazardous areas that are not yet developed in order to limit an advancement of risk, usually has priority because it is easier to implement. To achieve the prevention of the future development of hazardous areas, the local spatial planning system must provide the possibility to designate hazardous areas and restrict development in these zones. These restrictions have to be strong enough to ensure their observance. The configuration of planning instruments to achieve the minimization of exposure of urban areas, differ from country to county. For Japan, they are explained in Chapter 4. The second possibility is to enforce the retreat from hazardous areas that are already developed. This possibility is much more complicated because existing settlements are protected by private property rights in many countries worldwide (Japan is one of them). Accordingly, the designation of built-up areas as hazardous usually results in the need to pay huge compensation payments to the landowners in order to make them sell their land and leave (Greiving & Mägdefrau, 2016). For this reason, this option is only used occasionally in normal times ("normal times" refers to times in which an area did not recently experience a disaster). Nevertheless, the destruction of built structures through a disaster opens a window of opportunity for the relocation of citizens who used to live in hazardous areas to safer locations (Greiving & Mägdefrau, 2016; see Chapter 3.3).

2.4.2.2 Differentiated land-use decisions

Different land-use types have different susceptibilities to hazards. For instance, residential land-uses are especially vulnerable because they accommodate citizens not only while they are awake, but also when they are asleep. The vulnerability of industrial or commercial land-uses can be lower, but depends on the actual establishments that are situated in these areas. With the designation of areas for specific land-uses, spatial planners are able to prevent their use for residential purposes, but enable the establishment of industrial or commercial businesses. The decision of which land-uses should be facilitated in areas that are exposed to natural hazards is normative and is usually based on the hazard's impact on the area (e.g., inundation depth) and the intention to protect certain goods (e.g., human lives, economic assets, critical infrastructure, ecosystem services) (Greiving & Mägdefrau, 2016), which is the reason why citizen participation is of specific importance in this context.

2.4.2.3 Adaptation of building structures

This point aims to reduce the susceptibility of buildings in order to reduce disaster risk on the local level. The procedure to achieve the adaptation of building structures differs between newly constructed and already existing houses. To ensure the realization of resilient building designs for newly constructed buildings (e.g., through the exclusion of the ground floor from residential uses), the adjustment of building codes or the decree of certain requirements in order to get a building permission are useful options. To achieve the adaptation of existing buildings, it is important to convince residents and landowners of the importance to invest into this endeavor in order to increase their personal safety. In this context, risk awareness raising campaigns or incentives can be helpful options (Greiving & Mägdefrau, 2016). Furthermore, spatial planners are also responsible to provide a sufficient amount of public housing to ensure the safe accommodation of people who are unable to afford private houses.

2.4.2.4 Hazard mitigation

While the options introduced above address the vulnerability component of risk, it is also possible to take measures to reduce risk by addressing the hazard component. In this context, spatial planners are required to work together with the sectoral departments that are responsible for the mitigation of the respective hazard (e.g., water authorities for the protection from river floods). Possible measures that fall under this point are the construction of protective infrastructure (e.g., seawalls or river embankments to protect the city from tsunamis or river floods or slope protection measures to prevent landslides) and the adaptation of the urban structure (e.g., adapting the sewage system to protect the city from flooding from heavy rainfall or land raising) (Greiving & Mägdefrau, 2016).

2.4.3 Spatial planning and risk communication

Communication is an essential part throughout the entire risk governance process. Nevertheless, the normative nature of the decision of which goods should be protected from hazardous events particularly calls for a broad public participation process (Fleischhauer et al., 2012). The importance to include "relevant stakeholders" to "[strengthen] disaster risk governance to manage disaster risk" (UNISDR, 2015c, p. 17) has also just recently been emphasized in the Sendai Framework for Disaster Risk Reduction 2015-2030 by the UNISDR. There are different reasons why the inclusion of citizens is essential. In context of the normative nature of decisions, the most important reason is to enable the citizens to contribute their opinions to the decision-making process. The purpose of this is based in the constructivist understanding of risk as being socially constructed (Slovic, 1999) and that defining risk is an act of power, which sets the basis for the ultimate decisions of how a risk is addressed (Slovic, 2001). Ethical aspects require the consideration of the public's opinion in the decision making process because these decisions can directly or indirectly impact the society (Mägdefrau & Sprague, 2016). In this context, the involvement of citizens corresponds with their empowerment (Arnstein, 1969, p. 216). In addition to this, the contribution of the citizen's knowledge can also improve the quality of decisions and plans (Glass, 1979, p. 181). The reason for this is that (according to the constructivist understanding of risk) the definition of risk changes with the public's perception of risk. To reach an adequate definition of risk, it is therefore necessary to include the public's view on risk (Mägdefrau & Sprague, 2016). This relevance for citizen participation grows in relation with the increase of the risk's uncertainty and/ or complexity (Evers, 2012 referring to Hajer & Wagenaar, 2003, p. 10). Furthermore, the inclusion of citizens into the decision-making process can increase the transparency of the outcomes and raise the citizens' "trust and confidence in government, making it more likely that they accept decisions and plans and will work within the system when seeking solutions to problems" (Glass, 1979, p. 181). Including citizens can therefore help to simplify or speed up the implementation of the intended measures and plans. Nevertheless, it must be considered that there is no guarantee for the citizen's acceptance, even if they are part of the decision-making process (Mägdefrau & Sprague, 2016, p. 297).

Based on Sherry R. Arnstein's Ladder of Citizen Participation, the level of citizen participation can be differentiated by the degree of involvement. The original Ladder included eight rungs (manipulation, therapy, informing, consultation, placation, partnership, delegated power, citizen control), which were categorized into three categories (Arnstein, 1969, p. 217).

Mägdefrau and Sprague "separate[d] the different levels of participation between one-way and two-way forms of communication. One-directional communication pathways can be considered as a passive form of participation. This refers to a one-way provision of information – either from the administration towards the stakeholders/ public (eg information events) or from the stakeholders towards the administration (eg by commenting on draft versions of plans). In this form of participation, there is typically very limited to no exchange of information and ideas between different parties, nor a continuous or iterative process of dialogue" (Mägdefrau & Sprague, 2016, p. 299).

Thereby, manipulation, therapy and information can be considered as one-way forms of communication that do not actively include the public into the decision-making process and are therefore located below the edge of participation (see illustration 8).

Manipulation is a factitious form of "participation", which influences citizens to support the decisions taken by those in power. Accordingly, it encompasses measures that influence the citizens to accept the will of the authorities (Mägdefrau & Sprague, 2016, p. 300). *Therapy* sees each citizen with a dissenting opinion as in need of curing (Arnstein, 1969). Instead of trying to understand the citizen's opinion and solving disagreements through discussions on a level playing field, power-holders decide how the people should be "treated" in order to "cure" them from their problematic opinion. Therapy tries to keep the interference with citizens to a minimum and is only conducted in order to simplify the implementation of the power-holders interests (Mägdefrau & Sprague, 2016, p. 300). *Information* forms the foundation for two-way forms of communication and is therefore an essential part of meaningful participation (Evers, 2012). It includes the citizens' provision of material and knowledge regarding ongoing decision-making processes and the citizens' privilege and ability to influence the decisions' outcomes (e.g., through websites, newsletters or information events). Information is considered as a one-way form of communication and does not intend to interactively discuss opinions. The decision to locate information below the edge of participation was taken because information is usually understood in a passive way which does not allow influence in shaping the decision-making (Mägdefrau & Sprague, 2016, pp. 299–300).

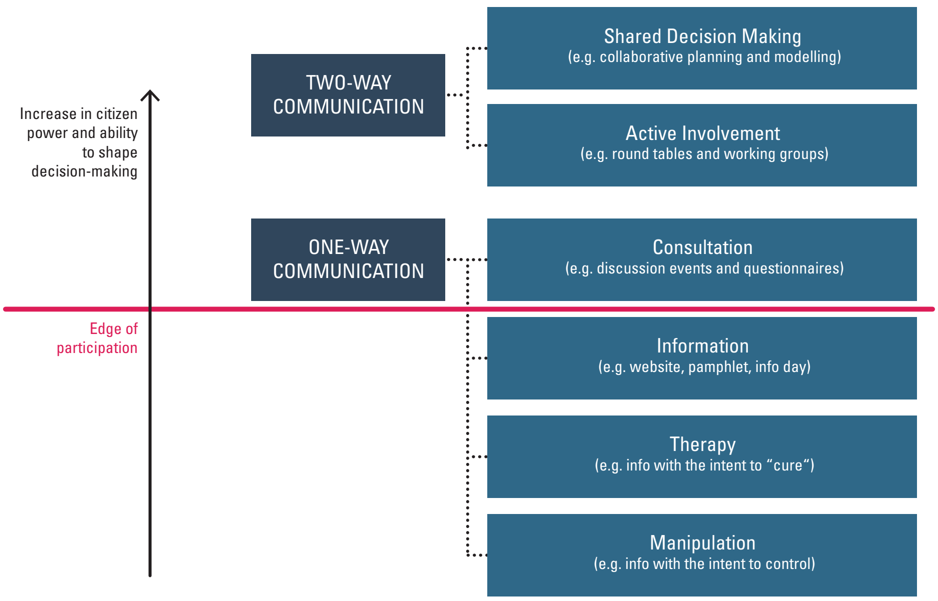


Illustration 8 | Levels of participation | Own illustration based on Mägdefrau & Sprague, 2016, p. 299; content adapted from Evers, 2012 and inspired by frameworks from Arnstein, 1969 and Firus, Fleischhauer, Greiving, Grifoni, & Stickler, 2012

Consultation, active involvement and shared decision-making are located above the edge of participation. *Consultation* is the lowest genuine form of participation. It enables citizens to give their opinion on the decision-making process and can occur via public hearings or the submission of questionnaires or written comments. It is still regarded as a one-way form of communication because the public is not actively included into the decision making process and authorities are able to disregard public opinions if they do not consider them to be relevant enough (Mägdefrau & Sprague, 2016, p. 301). *Active involvement* is a form of participation that allows citizens to seriously engage themselves into the decision-making process, e.g., through the participation in round tables or working groups. The public's direct exchange with authorities enables their voices to be heard and discussed. Active involvement enabled decision-makers to personally address the citizen's concerns and support the consensus building. The citizen's active involvement in the decision-making process "provides the opportunity for a higher sense of ownership" (Mägdefrau & Sprague, 2016, p. 302). *Shared decision-making*, as the highest form of participation, is achieved when representatives of the government make their decisions in cooperation with the citizens (Fiorino, 1990, p. 229). This means that "all involved persons or parties have equal rights" (Evers, 2012, p. 8). Shared decision-making can be found in community-led committees, which are entitled to take their own decisions and are responsible for their implementation. The difference between active involvement and shared decision making is that the latter includes "equal ownership between the involved parties in the decision-making process" (Mägdefrau & Sprague, 2016, p. 302). For more information on each step, see Mägdefrau & Sprague, 2016.

As explained above, public participation has various advantages. Nevertheless, participation processes are also connected to certain disadvantages: These processes are money and time consuming and cannot guarantee results. Public participation can produce unrealistic expectations, which can lead to disappointment if these expectations are not met. If participation is implemented in the aftermath of a disaster, the requirements can overwhelm traumatized citizens and place an additional burden on them (Mägdefrau & Sprague, 2016). It is therefore advisable to condition the decision of which participation form to use (referring to consultation, active involvement or shared decision-making) on the characteristics of the specific situation.

2.5 INTERIM CONCLUSION

This chapter illustrated that disaster risk can be influenced by three components: hazard, vulnerability and capacity. To handle risks, the risk governance framework provides three main steps: risk assessment to understand risk, risk management to use this information to address risk and risk communication to continuously inform all important stakeholders (incl. the public) about ongoing processes and include them into the decision-making processes. As this chapter explained, spatial planning can play an important role for all of these steps.

For the risk assessment phase, spatial planners are able to provide information for the development of hazard maps or simulations and implement EIAs. The

DISASTER	"[a] serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" (UNISDR, 2009, p. 9).
DISASTER RISK	"[t]he potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period." (UNISDR, 2009, pp. 9–10).
HAZARD	"possible, future occurrence of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements" (Cardona et al., 2012, p. 69).
VULNERABILITY	"the propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by hazard events." (Cardona et al., 2012, p. 69).

Illustration 9 | Definitions of disaster, disaster risk, hazard and vulnerability | Own illustration

risk management phase works towards the reduction of risk either through the mitigation of the hazard, the reduction of vulnerability or the increase of capacity. One option that spatial planners have at hand to manage risk, is the mitigation of the hazard component. In this context, the construction of protective infrastructure (e.g., seawalls or river embankments) or the adaptation of urban structure (e.g., through widening roads) are useful options. When dealing with vulnerability, spatial planning's influence is most noticeable in connection with the "physical" elements of vulnerability – exposure and susceptibility. In this context, land-use planning can be used to completely restrict hazardous areas from future urban development or guide the land-use in these areas. Moreover, the relocation of existing urban land-uses from areas exposed to hazards can be necessitated. Building codes or the enforcement of additional requirements for the construction of buildings in areas exposed to hazards are able to reduce the buildings' susceptibility and by this means contribute to the reduction of vulnerability. In addition to these basic spatial planning options, planners are also able to support the increase of community cohesion to reduce social fragility. This goal can be achieved through comprehensive risk communication and public participation. These processes are especially useful to reduce fragility if they are used to incorporate the needs and requirements of vulnerable population groups into the decision-making process.

This chapter illustrated spatial planning's ability to address disaster risks. As a next step it needs to be elaborated what this means for spatial planning's ability to build resilience. To address this topic, it is important to get a thorough understanding of the concept of resilience and how it is connected to the concept of disaster risk introduced in this chapter. Based on this information, the following chapter explains the connection between spatial planning and resilience.

3. RESILIENCE

Resilience derives from the Latin term *resilire* and means to rebound. Back in ancient times, the term was used in physics and mathematics to "describe the stability of materials and their resistance to external shocks" (Davoudi et al., 2012). In the 1940s the term was adopted into the field of psychology (for a review of the literature in this field, see Waller, 2001). In 1973, Holling introduced a new understanding of resilience. In his article *Resilience and stability of ecological systems* he argued that systems are not necessarily limited to one state of equilibrium. Systems that are exposed to disturbances – as it usually is the case in ecology – tend to possess a wider range of adequate possible conditions (Holling, 1973, p. 1).

Holling distinguished between two forms of resilience: Engineering resilience (in his 1973 article called stability) "is the ability of a system to return to an equilibrium state after a temporary disturbance. The more rapidly it returns, and with the least fluctuation, the more stable it is" (Holling, 1973, p. 17). This understanding equals the understanding of resilience common in physics and engineering and matches with the "engineer's desire to make things work, not to make things that break down or suddenly shift their behaviour." (Holling, 1996, p. 38). This understanding of resilience therefore "emphasizes [...] the maintenance of a predictable world" (Holling, 1973, p. 21). Although a stable state might seem desirable from an engineer's point of view, nature often confronts people with unforeseen events and uncertainties that cannot be managed sufficiently with the narrow definition of engineering resilience. In this context, the concept of ecological resilience is more appropriate. Ecological resilience (in Holling's 1973 article simply called resilience) is defined as "the magnitude of disturbance that can be absorbed before the system changes its structure" (Holling, 1996, p. 33). This means that a system does not have to return to its former state to preserve its basic structure; it is aligned to "existence" rather than "efficiency" (Holling, 1996, p. 33). Due to their ability to reorganize and adapt to new and uncommon conditions ecologically resilient systems are more robust to changing environments (Folke, 2006, p. 257). Accordingly, the engineering understanding of resilience demands a system to bounce back, while ecological resilience enables a system to bounce forward (Davoudi et al., 2012).

From ecological resilience to evolutionary resilience

In the following years, Holling's ecological resilience was widely discussed and adapted to various fields: e.g., ecological economics, cultural theory, human geography and particularly disaster management (Folke, 2006; Manyena, 2006). Based on the interdisciplinary work on the topic of resilience, social systems were combined with the ecological understanding of resilience and the term socio-ecological resilience was formed (Adger, 2000). This is reasonable, because humankind depends on ecosystem services, which links the resilience of ecological and social systems with each other. Although the transfer of resilience from ecological to social sciences also has its opponents (Adger, 2000), today the socio-ecological understanding of resilience is widely acknowledged. Socio-ecological resilience combines the interaction of social systems with their surrounding ecological systems and acknowledges their capacity to withstand perturbations (e.g., through hazardous events) by sustaining their self-organizing ability and learning from the past to build up capacity for the future (Adger, Hughes, Folke, Carpenter, & Rockström, 2005) or as Carl Folke states: "In a resilient social–ecological system, disturbance has the potential to create opportunity for doing new things, for innovation and for development" (Folke, 2006, p. 253). Furthermore, the understanding contains the idea that systems can change over time even if no external disturbance influences them (Davoudi et al., 2012). Since this understanding of resilience has similarities to the evolutionary theory (Simmie & Martin, 2010), it is also referred to as evolutionary resilience (Davoudi et al. 2012: 302). The understanding of evolutionary resilience turns natural scientists' understanding of the world upside down: What used to be understood as well-ordered and predictable, now is viewed as chaotic and uncertain (Davoudi et al., 2012).

Holling and his colleague Lance H. Gunderson explain this new understanding of resilience with the metaphor of adaptive cycles that they introduced in 2001, after working on the topic for many years. The approach tries to link resilience with the systems of ecology, politics, institutions and management (Holling, 2001, p. 391). Each adaptive cycle runs through four different phases that are characterized by different levels of potential (meaning possible future options of the system), connectedness between the different factors of the system and resilience against possible external disturbances (Holling, 2001, pp. 393–394). Those four phases are exploitation (r), conversation (K), release (Ω) and reorganization (α); they are depicted in illustration 10. This means, a system's reaction to external shocks depends on the phase it currently remains. During the long lasting process between the exploitation and conversation phase (from r to K), resources are slowly gained. In return, the backwards oriented and shorter process between the release and reorganization phase (from Ω to α) has the potential for innovations (Holling, 2001, p. 394). The conversation phase is marked not only by a high amount of potential and connectedness, but also by a low amount of resilience, which resulted in Holling prescribing a system in this phase as "an accident waiting to happen" (Holling, 2001, p. 394).

Following the accident, a window of opportunity opens and enables the system to invent and test new approaches and structures before it re-enters into another adaptive cycle (Olsson et al., 2006). In the disaster risk context, this accident is the occurrence of a disaster, which can cause the collapse of the existing adaptive cycle and thereby enable the system to enter into a fresh cycle. In this context, the disaster can be considered as a trigger to open a window of opportunity for improvement.

Because adaptive cycles are not isolated from their surroundings, Gunderson and Holling developed the concept of *panarchy*, a word synthesized from the Greek God Pan and the word hierarchy. Panarchy stands for the interconnection of different adaptive cycles with each other. This connection of adaptive cycles that work on different spatial and time scales enables them to interact with each other (Holling, 2001). "Each level is allowed to operate at its own pace, protected from above by slower, larger levels but invigorated from below by faster, smaller cycles of innovation" (Holling, 2001, pp. 398–399). If systems are confronted with severe disturbances, it is possible that this connectedness can lead to the

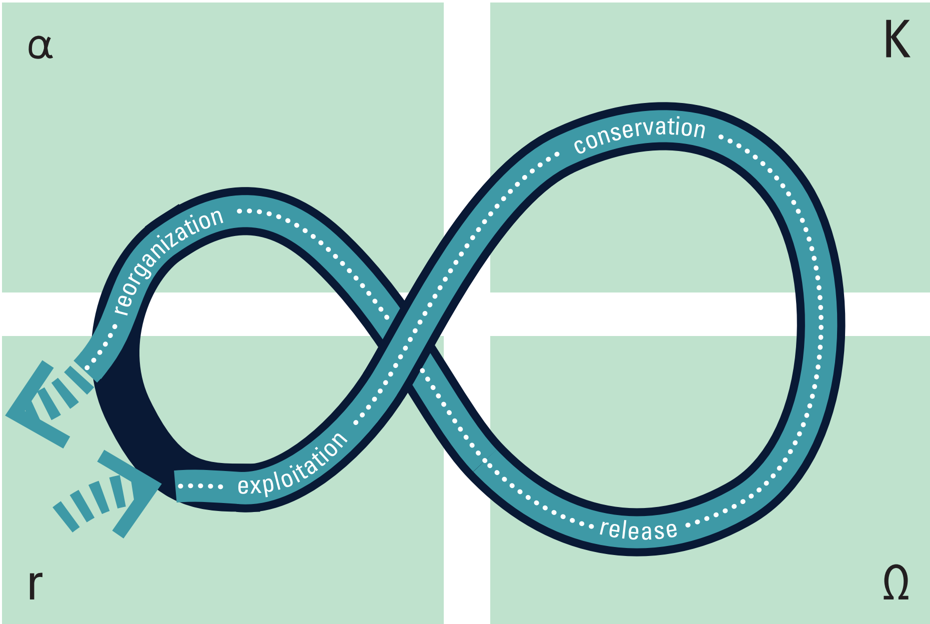


Illustration 10 | The adaptive cycle | Own illustration based on Holling, 2001, p. 394

complete destruction of certain levels of the panarchy (Holling, 2001). "It is this panarchy model of adaptive cycle that underpins the evolutionary meaning of resilience" (Davoudi et al., 2012, p. 304).

When resilience is discussed, the distinction between the different understandings can lead to problems. There is a huge difference between the engineering resilience, that seeks to bounce back to the original state of equilibrium as fast as possible, and the evolutionary resilience, that sees systems in a status of current change and disturbance as a chance to change into a more desirable system state. This differentiation should be kept in mind when the concept of resilience is adapted to the urban context.

3.1 URBAN RESILIENCE

Cities are considered as highly complex and networked systems (Batty, 2007; Godschalk, 2003; Meerow, Newell, & Stults, 2016) and the growing size of urban area worldwide (United Nations, Department of Economic and Social Affairs, Population Division, 2014) as well as the evolving baseline trend (see Chapter 2) are expected to increase these uncertainties and complexities even more. The concept of resilience's ability to comprehend such complex processes offers a useful approach to understand and deal with this complexity. This explains why the resilience topic quickly grew in popularity between spatial planners after it was first introduced into this context in the 1990s (Meerow & Newell, 2016; Tasan-Kok, Stead, & Lu, 2013).

The variety of disciplines contributing to the concept of resilience enabled its establishment as a "boundary object" (Meerow et al., 2016, p. 39). A boundary object is a concept that is broad enough to use it across multiple disciplines, but stable enough to retain its meaning (Star & Griesemer, 1989). On the other side, this general applicability also results in ambiguity, which complicates the operationalization of resilience. Accordingly, Klein, Nicholls, and Thomalla (2003, p. 42) state: "[T]he problem with resilience is the multitude of different definitions and turning any of them into operational tools […]. After thirty years of academic analysis and debate, the definition of resilience has become so broad as to render it almost meaningless."

As Meerow et al. (2016) describe, the definition of urban resilience is based on the corresponding understanding of urban systems: While some scholars focus on the socio-technical aspects or urban systems (Geels & Schot, 2007; Graham & Marvin, 2001; Guy, Moss, & Marvin, 2001), others emphasize socio-ecological networks (Alberti et al., 2003; Pickett, Cadenasso, & McGrath, 2013; Resilience Alliance, 2007, 2010). Ernstson et al. (2010) suggest to combine these two understandings and consider urban systems as composed of both, socio-technical and socio-ecological networks. This is reasonable, if one considers urban systems to consist of various subsystems, which are linked through socio-technical and socio-ecological connections. According to the Resilience Alliance (2007) and Meerow et al. (2016), urban systems are composed of the following four subsystems: the governance network, the social-economic dynamics, the material and energy flow network, and the urban infrastructure and form (see illustration 11).

The governance network includes the connections between various actors relevant for the urban system. This includes various governmental levels, nongovernmental organizations (NGOs) and industrial companies (Meerow et al., 2016; Resilience Alliance, 2007). Socio-economic dynamics refer to the city's social

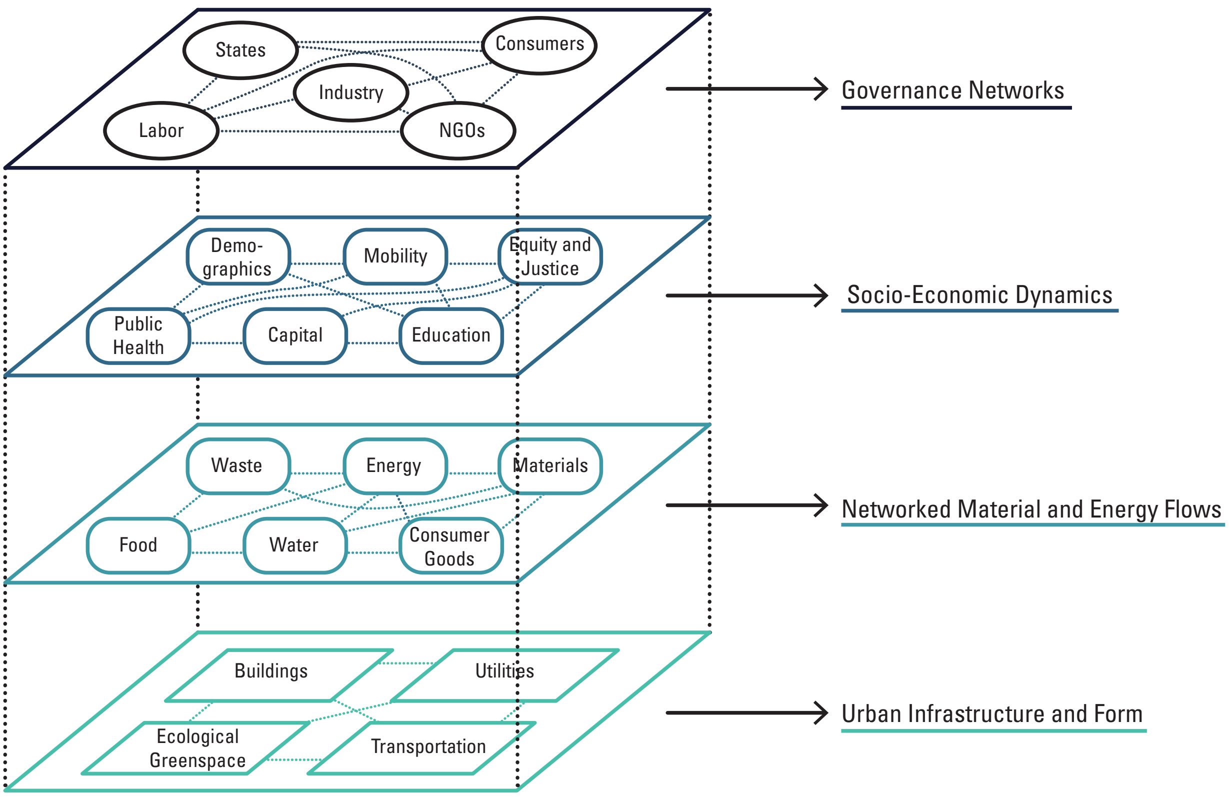


Illustration 11 | A simplified conceptual schematic of the urban system | Own illustration adapted from Meerow et al., 2016, p. 45; design inspired by Dicken, 2011 order, which depends on the city's demographic structure, its social norms and monetary assets. This also includes hierarchies developed and based on an uneven distribution of wealth and power. These characteristics therefore highlight issues of justice in urban systems (Meerow et al., 2016; Resilience Alliance, 2007). The material and energy flow network includes processes that provide a city with required services, such as water, energy or food supply and waste removal (Meerow et al., 2016). These facilities often rely on ecosystem services (e.g., provision of freshwater, fossil or renewal energy sources, food), which is why this layer is linked to the functionality of the environment (Resilience Alliance, 2007). Furthermore, these services require a working utility infrastructure and thus are also connected to the built environment. A city's urban infrastructure and form is the underlying structure where all the other processes take place. It includes the city's utility infrastructure (incl. communication, energy, water/ sanitation and transportation networks), buildings, and green spaces (Meerow et al., 2016).

When considering these aspects of the urban system, it becomes apparent that a city's urban infrastructure and form can be associated with the socio-technical approach to the urban system. The remaining three – the governance network, the social-economic dynamics, the material and energy flow network (which relies on the functionality of the environment) – on the other hand, can be considered as socio-ecological networks.

The understanding or urban resilience is directly connected with these understandings or urban systems. Technical structures require a single equilibrium to which they can return in order to survive. This corresponds with the engineering understanding of resilience. For instance, if an earthquake distorts a building, the building can either return back to its former state or, if it crosses a certain threshold, collapse. The building, as an engineered structure, does not possess multiple states of equilibrium. It therefore is unable to change its structure in order to adapt to a changing environment[3]. Accordingly, an engineer's resilient city includes, e.g., buildings that are able to withstand earthquakes, hazardous areas that are free from residential land-uses, and seawalls to protect the city from floods and tsunami. These structures are built to protect the status-quo against hazardous events. Even though urban infrastructure and form are bound to an engineering understanding of resilience, spatial planners infrequently get the chance to support the city's built structure evolve (according to an evolutionary understanding of resilience). This is the case after a disaster destroyed the pre-existing urban structure and opens a window of opportunity for improvement (see Chapter 3.3). Nevertheless, because urban infrastructure and form are rarely adjusted during normal times, it is appropriate to declare that they are usually bound to an engineering understanding of resilience.

[3] Even though built structure generally cannot change without great expense, there are currently new strategies under discussion that are able to address this problem. One example for this is the adaptable levee in Germany ("Klimadeich") that can be raised with only little effort if the climate change induced sea-level rise requires it. These strategies were developed to deal with the growing uncertainties that are related with disaster risk reduction and are helpful to incorporate evolutionary resilience into built structures. Nevertheless, these strategies are not yet widely applied. Therefore, they are not specifically considered for this research. For more information on this topic, see Greiving (2016).

Socio-ecological networks, on the contrary, possess the ability to change from one equilibrium to another when the surrounding conditions require it. They are therefore connected to an evolutionary understanding of resilience. These networks include political-institutional, social, economic and environmental aspects that continuously interact with each other. If a disaster – or any other event – disrupts these structures, they are able to evolve to a new state that serves the current situation better. Examples for this are the improvement of shortcomings in the governmental sector that complicated or delayed the reconstructions process or the establishment of NGOs in the aftermath of a disaster in order to improve social networks and community cohesion (Birkmann et al., 2010). The improvement of these processes helps the system to evolve into a new state of equilibrium.

Because of this ability to evolve, the research community currently leans towards an evolutionary understanding or resilience. Liao (2012, 3) even declares that engineering resilience is an "outdated equilibrium paradigm". Nevertheless, the existence of engineered structures as an important part of cities means that a total neglect of engineering resilience can lead to shortcomings: It is highly unlikely that built urban structure is remodeled after a short amount of time only because scientists discovered that this new structure would result in a higher degree of urban resilience. In most cases, large scale changes of urban structure only happen after a disaster demolished the pre-existing urban structures and thereby reduced the opportunity costs for this change (Olshansky et al., 2012, p. 176). In accordance with Godschalk (2003), it can be summarized that urban resilience includes both, engineering and evolutionary resilience: A resilient city possesses resilient physical systems to protect it from hazardous events (illustrated in the bottom layer of illustration 12) and – at the same time – obtains resilient socio-ecological structures that are able to handle the situation, cope and evolve if the physical infrastructure fails (illustrated in the top layer of illustration 12).

In accordance with Meerow et al. (2016), urban resilience can be defined as "the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (p. 39).

In the context of this research, "maintain or rapidly return" refers to the engineering resilience of the built structure and "to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" refers to evolutionary resilience.

Although urban resilience is currently widely applied, it is seldom accurately defined who (or what) is resilient to what (Carpenter, Walker, Anderies, & Abel, 2001; Elmqvist, 2014; Meerow & Newell, 2016; Vale, 2014). The fields of application for the resilience concept are various: Cities can be resilient to natural hazards (Adger et al., 2005; Cutter et al., 2008; Manyena, 2006), climate change (da Silva, Kernaghan, & Luque, 2012; Friend & Moench, 2013; Leichenko, 2011; Satterthwaite, 2013), terrorist attacks (Godschalk, 2003; National Research Council, 2002) or economic shocks (Martin & Sunley, 2015; Rose, 2007; Simmie & Martin, 2010), to name a few. The decision which threat should be addressed is an important step towards the operationalization of resilience (Car-

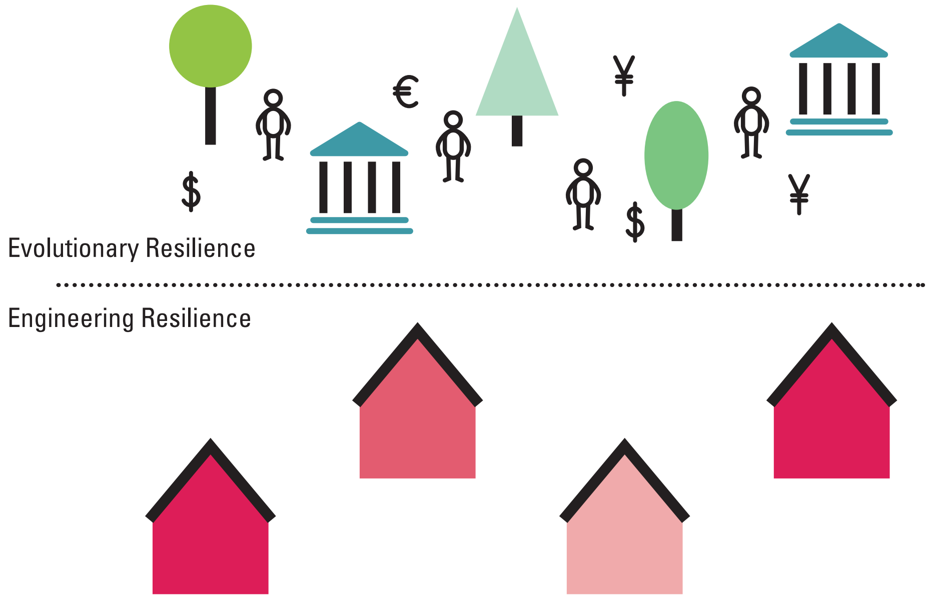


Illustration 12 | Urban resilience consists of engineering and evolutionary resilience | Own illustration

penter et al., 2001) and – similar to the constructivist understanding of risk described in Chapter 2.2 – of normative nature. This directly relates to the question "*Who* counts as 'the city'?" (Vale, 2014, p. 197, emphasis in original) or, in other words, who is included into the decision-making process. Stakeholders usually only represent their own interests, therefore it is especially important to include vulnerable population groups into the decision-making process. A necessity which is rarely the case in reality (Adger, 2006; Vale, 2014).

While the "who" question has to be answered for each specific case, the question regarding the kind of resilience that this research investigates can be more generally answered. This research deals with resilience to disaster risks with a focus on acute shocks (e.g., earthquakes, tsunamis) rather than slow stresses (e.g., climate change, environmental pollution) and focuses on building urban disaster resilience. Accordingly, the following chapter explains how urban resilience in the disaster risk context is defined.

3.2 URBAN RESILIENCE IN THE DISASTER RISK CONTEXT

On the basis of the information presented above, this chapter returns to the question how the concept of resilience fits into the disaster risk context. As explained in Chapter 2, resilience is often identified with capacity (Cardona, 2011; Cardona et al., 2012), which can be differentiated into coping and adaptive capacity. Coping capacity refers to a system's current state that helps the system to deal with the occurrence of a hazardous event. Adaptive capacity, on the other hand, is the system's ability to adjust to changing framework conditions (see Chapter 2.2). If compared to the understanding of resilience introduced above, it becomes apparent, that engineering resilience resembles coping capacity and evolutionary resilience resembles adaptive capacity (see illustration 13).

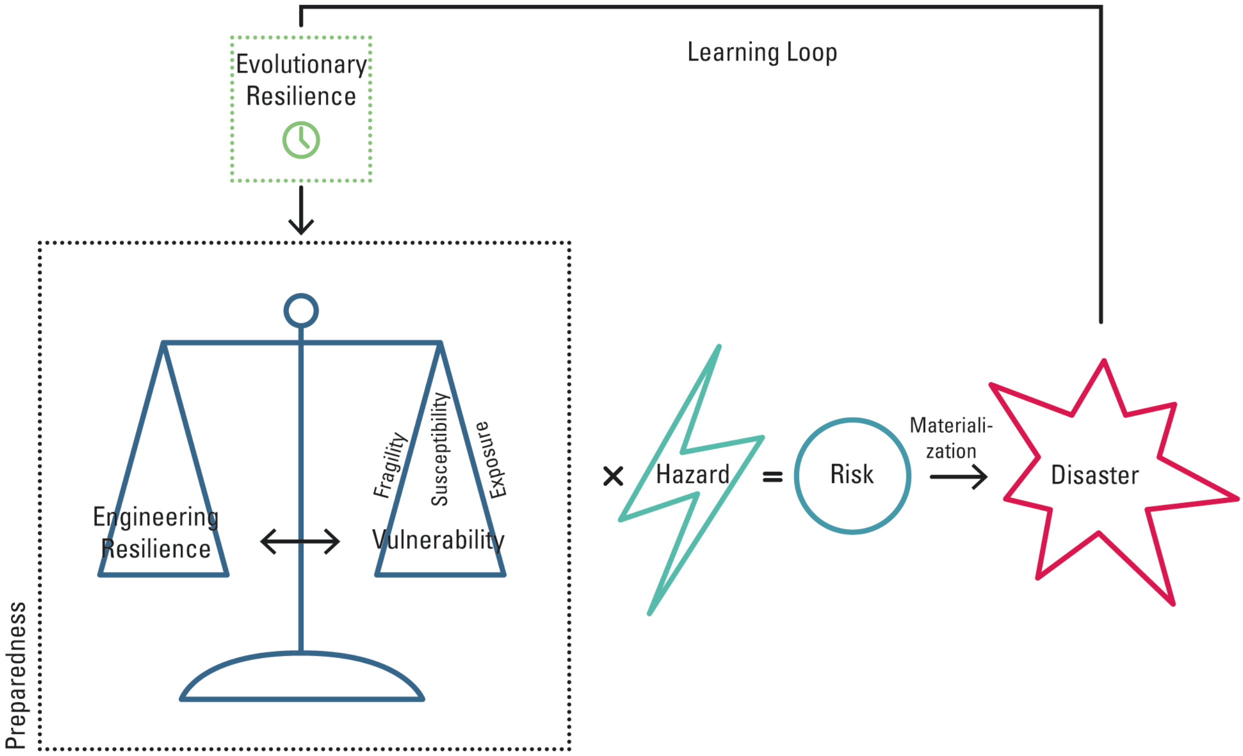


Illustration 13 | Engineering and evolutionary resilience as parts of the disaster risk framework | Own illustration

When linked into this context, it becomes clear why resilience is a key concept of disaster risk reduction. Nevertheless, many definitions of resilience do not acknowledge the twofold nature of resilience. The UNISDR (2009) defines (disaster) resilience as "[t]he ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (p. 24). By taking a closer look at the understanding or resilience that this definition incorporates, its age becomes noticeable: "resist, absorb, accommodate [...] and recover" as well as "preservation and restoration" all refer to an engineering understanding of resilience and the intention to have the city "bounce back" as fast as possible. As explained above, limiting resilience to engineering resilience is no longer state of the art.

In comparison to the UNISDR's definition, the IPCC (2012a) defines resilience as "[t]he ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (p. 563). Even though this definition's focus also relies on an engineering understanding of resilience (which results from its similarity to the UNISDR's definition), this definition also acknowledges the system's ability to improve itself as one aspect of evolutionary resilience.

The UNISDR's Disaster Resilience Scorecard for Cities (2015d), which is used to operationalize resilience for this research (see Chapter 5), defines resilience with a rather normative notion as "the ability of a city to understand the disaster risks it may face; to mitigate those risks; and to respond to disasters that may occur, in such a way as to minimize loss of or damage to life, livelihoods, property, infrastructure, economic activity and the environment" (p. 2). In this definition, the focus lies on the result "to minimize loss" rather than the system's ability to achieve this aim. It therefore does not specifically address the engineering and evolutionary understanding of resilience.

In its publication "How to make cities more resilient: A handbook for local government leaders", the UNISDR determines the following four spheres of resilience (UNISDR, 2012):

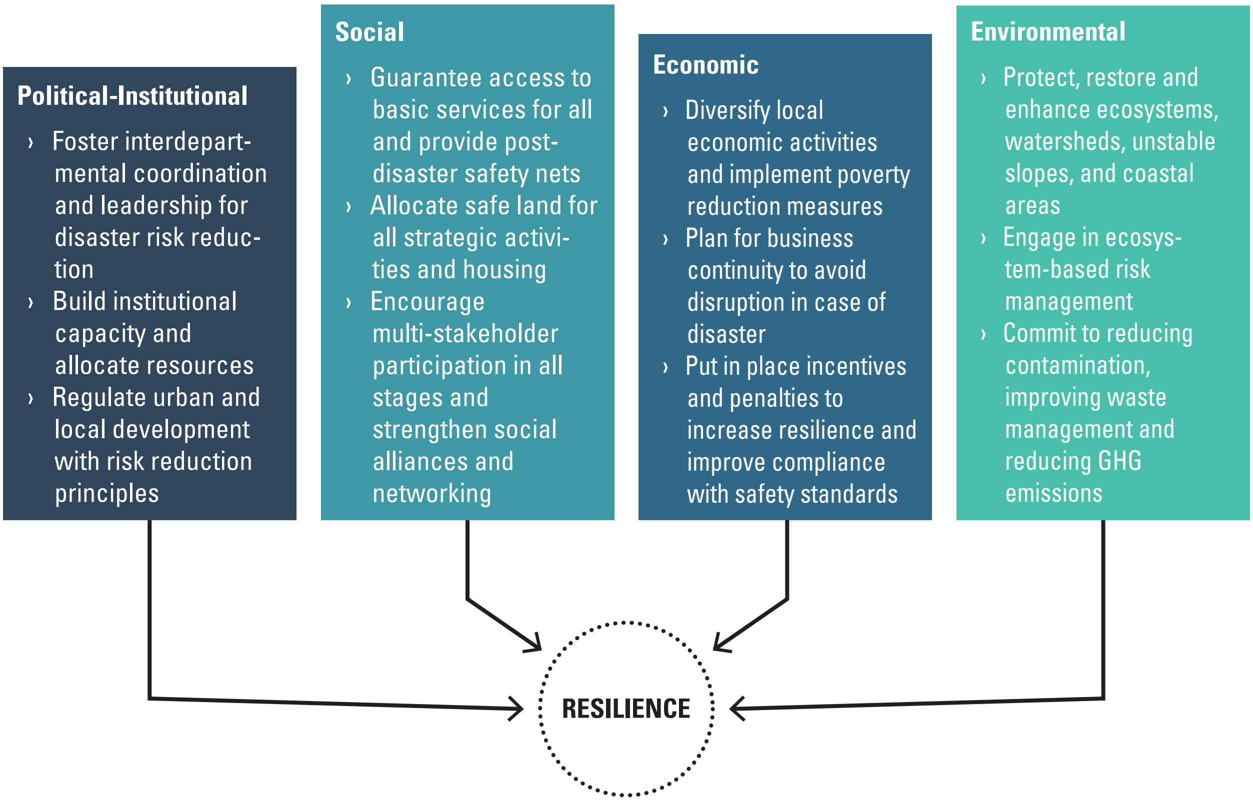


Illustration 14 | The four spheres of resilience | Own illustration based on UNISDR, 2012, p. 18

By taking a closer look, it can be noticed that these four spheres correspond to three of the layers of the urban system introduced in Chapter 3.1:

- The political-institutional sphere corresponds with the governance networks. It includes the coordination of disaster risk reduction between various stakeholders (e.g., the government, NGOs and industry), the creation of institutional capacity and responsibility to deal with risk and ensures that urban development incorporates the principles of disaster risk reduction (UNISDR, 2012). In this research, the political-institutional sphere is commonly referred to as political-institutional resilience.
- The social and the economic sphere correspond with the city's socio-economic dynamics. These two aspects include the access to basic services in case of a disaster, the allocation of safe housing and the inclusion of relevant stakeholders in the planning process (social sphere)

as well as the diversification of local economy, business continuity planning and the provision of incentives to increase the companies' safety standards (economic sphere) (UNISDR, 2012). In accordance with the socio-economic dynamics of the urban system, these two spheres are jointly considered as the socio-economic sphere, which is referred to as socio-economic resilience in this research.

› The environmental sphere can be linked to the material flow and energy networks, since most of the services provided in these networks depend on environmental functions. This sphere includes the protection, restoration and improvement of ecosystems, the inclusion of ecosystems into disaster risk management and measures to decrease environmental contamination (e.g., through more efficient waste management systems or a decreased emission of greenhouses gases) (UNISDR, 2012). The environmental sphere is of special importance because people are dependent on the functionality of ecosystem services to survive. Ecosystem services are "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment, p. 40), e.g., clean air and water. For this research, the environmental sphere is commonly referred to as environmental resilience.

As explained in Chapter 3.1, these three spheres correspond to an evolutionary understanding of resilience. They are supplemented by the fourth layer of the urban system, which follows an engineering understanding or resilience:

› The infrastructural sphere includes urban infrastructure and form. According to Jha, Miner, and Stanton-Geddes (2013), infrastructural resilience refers to "a reduction in the vulnerability of built structures, such as building and transportation systems" (p. 11). This includes housing, utility and social infrastructure, especially critical infrastructure (Jha et al., 2013). The infrastructural sphere is referred to as engineering resilience in this research because this is the only resilience sphere, which is following an engineering understanding of resilience.

As illustration 15 shows, this research understands evolutionary resilience to be composed of political-institutional, socio-economic and environmental resilience. Evolutionary resilience is supplemented by engineering resilience, which incorporates a city's built structure into the context.

Based on these considerations and the disaster resilience definitions introduced above, the definition of urban resilience from Meerow et al. (2016) introduced in Chapter 3.1 was adjusted, so that urban disaster resilience can be defined as follows:

Urban disaster resilience is "the ability of an urban system – […] [and all its engineering, political-institutional, socio-economic and environmental component parts across temporal and spatial scales] – to maintain or rapidly return to desired functions in the face of a […] [hazardous event], to adapt to change and to quickly transform systems that limit current or future adaptive capacity" (p. 39).

This definition specifies that comprehensive urban disaster resilience can be achieved by taking measures that address all four spheres of resilience intro-

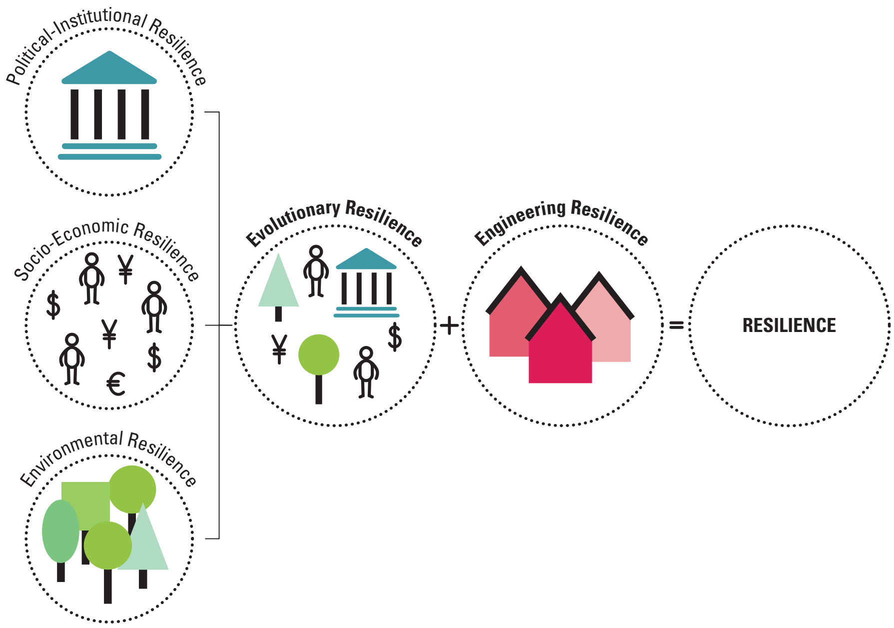


Illustration 15 | The resilience framework for this research | Own illustration

duced above. Even though building resilience can never ensure complete safety from disaster risks, it is an important step towards disaster risk reduction. Furthermore, resilient structures can help to overcome the negative impacts of a disaster much faster, if it occurs. Resilient structures can also help to use the window of opportunity more effectively. The window of opportunity is the city's opportunity to evolve after a disaster. It can also be used to build a city's resilience. The following chapter explains the processes that support the window of opportunity and how problems regarding it can be addressed.

3.3 THE WINDOW OF OPPORTUNITY

Even though a disaster is linked with large scale destruction and the disturbance of the political-institutional, socio-economic and environmental structures and networks, it also offers the opportunity to review these pre-existing structures and improve them where or when useful. This moment is also termed the *window of opportunity* or the chance to build back better and is directly linked with the evolutionary understanding of resilience (the system is able to evolve). It can be noted that this opportunity especially occurs if a disaster is big enough to reveal the shortcomings of pre-existing urban structures and networks (Birkmann et al., 2010). The Sendai Framework for Disaster Risk Reduction also acknowledges the importance of the window of opportunity, when it states: "In the post-disaster recovery, rehabilitation and reconstruction phase, it is critical to prevent the creation of and to reduce disaster risk by 'Building Back Better'" (UNISDR, 2015c, p. 19).

The fields for improvement are various and can concern a city's political-institutional, socio-ecological, environmental and engineered structures and networks alike (Birkmann et al., 2010; Olshansky, 2005). In particular, the evolutionary nature of political-institutional, socio-ecological and environmental networks enables them to continuously adapt to changing conditions. On the other hand, cities are bound to their urban infrastructure and form, which gradually changes over many years under normal conditions (Olshansky, 2005). These structures include the communication, energy, water and sanitation, and transportation networks as well as the buildings and green spaces and are especially relevant for spatial planners (see Chapter 3.1).

The large-scale destruction of the existing city structure after a disaster offers the rare opportunity for the city's built structure (typically bound to an engineering understanding of resilience) to evolve and adapt to the changed environment. From an economic perspective, the disaster leads to a "dramatic increase in capital services reaching the end of their useful life [...] [which] opens unusual opportunities for reorganizing or relocating capital facilities. Strategies of replacement may become available that would not be worth pursuing at normal rates of capital replacement" (Olshansky et al., 2012, p. 174). In this context, the "disaster reduces the opportunity costs of changing things" (Olshansky et al., 2012, p. 176). For instance, these improvements can be the relocation of residential land-uses or changes of the utility infrastructure (Olshansky et al., 2012). The ability of a system to use this opportunity to evolve is also termed transformative resilience (Gotham & Campanella, 2010).

The sudden loss of built structures after a disaster, creates an urgent need to act. A situation that Olshansky et al. (2012) termed "compressed in time" (p. 173). Although this time compression is an important factor for the possibility to improve a city's built structure after a disaster, it is also a big constraint. After a disaster, the citizens want to return back to their previous lives. Which makes them demand a fast reconstruction of the known urban structures. Haas and Kates already noticed this tendency in their first comprehensive study on disaster recovery *Reconstruction following disaster* (1977): "There is already a plan for reconstruction, indelibly stamped in the perception of each resident – the plan of the predisaster city. The new studies, plans and designs compete with the old" (p. 268). The development of new plans that are able to improve the urban structures usually requires a larger amount of time and money than the reconstruction of the former urban structures. Accordingly, spatial planners are conflicted between speed and careful consideration (Olshansky et al., 2012; Olshansky, Johnson, & Topping, 2006; Rubin, Saperstein, & Barbee, 1985). This conflict has to be resolved under huge time pressure. Therefore, speedy rebuilding is often considered to be the better option (Olshansky et al., 2012). This is the reason why the potential of the window of opportunity is often left unused in reality (Birkmann & Teichman, 2010; Serrao-Neumann, Crick, Harman, Schuch, & Choy, 2015).

To solve this tension between time and quality, various experts have proposed the idea to develop a reconstruction plan before a disaster occurs (e.g., Greiving & Schmidt,-Thomé, 2008; Olshansky, 2005; Schwab, 2014; Serrao-Neumann et al., 2015). The preparation of a post-disaster plan in advance of a disaster can help to speed up the reconstruction planning and ensure that additional challenges (e.g., climate change or demographic change) are not overlooked in the hectic post-disaster planning process (Serrao-Neumann et al., 2015). To achieve optimum results, the plan should not only include regular land-use planning, but also cover the recovery process after the disaster. Like any plan to manage risk, the development of this plan should also be realized on the basis of a comprehensive participation process (Olshansky, 2005).

The question how the development of pre-event developed reconstruction plans can help to effectively use the window of opportunity after a disaster, is answered in context of the second research question *How can spatial planning use the window of opportunity effectively to improve a city's resilience after a disaster?* based on the empirical research conducted in Miyako City and Ishinomaki City (see Chapter 10).

3.4 SPATIAL PLANNING AND RESILIENCE

Parallel to the discussion about urban resilience, there is also an ongoing discussion about resilient urban planning. In this context, the focus is not merely on building resilient cities, but adapting spatial planning to meet the changing requirements it has to face. The popularity of the resilience concept in this context founds on the growing necessity of spatial planners to deal with increasing uncertainties and complexities. Evolutionary resilience enables spatial planners to break free from the previous understanding of space as "neutral containers, but [instead sees them] as complex, interconnected socio-spatial systems with extensive and unpredictable feedback processes which operate at multiple scales and timeframes" (Davoudi et al., 2012, p. 304). This approach to spatial planning assumes the breakdown of the Euclidean world-view (Friedmann, 1993) with its "hallmarks of certainty, blueprints, forecasting and equilibrium" (Davoudi et al., 2012, p. 329) and instead emphasizes "fluidity, reflexivity, contingency, connectivity, multiplicity and polyvocality" (Davoudi & Strange, 2009, p. 37) – aspects that are also important characteristics of the evolutionary resilience concept (Davoudi et al., 2012).

In order to understand and handle these dynamic framework conditions, spatial planners should begin to see fluidity as one of the world's main characteristics. In this world, "assuming change and explaining stability [is more appropriate than] […] assuming stability and explaining change" (Folke, Colding, & Berkes, 2003, p. 352). Brendan Gleeson even demands that resilient urbanism "should relinquish any belief in […] a stabilised, end-state urban system. The premise is evolution, ceaseless in motion and restless in form, for that most essential human creation, the city. […] The living must accept the inevitability of evolution, the necessity of adaptation, and embrace the hope of resilience" (Gleeson, 2008, p. 2658). Nevertheless, the question how this goal can be achieved for a city's built structure, which has to remain in place for a certain amount of time to be profitable, remains unanswered.

When different interests compete, a comprehensive spatial planning approach is highly relevant because decisions in favor of the wrong interest may lead to drawbacks for the general public (White & O'Hare, 2014). In this context, spatial planners can use the evolutionary concept of resilience to link various aspects that previously were characterized by silo thinking (Davoudi et al., 2012).

In summary, it can be stated that the concept of evolutionary resilience offers spatial planning various new and helpful ideas to address current and future challenges. Nonetheless, in reality practitioners continue to use the engineering resilience concept even though the research community widely understands evolutionary resilience to be the state of the art (Engle, 2011; White & O'Hare, 2014). This raises the question if spatial planning – with its history as an engineering discipline and instruments that mostly still serve this paradigm – has the ability to build evolutionary resilience (White & O'Hare, 2014) or if it is necessary that spatial planning evolves and redefines itself as a "professional practise that specifically seeks to connect forms of knowledge with forms of action in the public domain" (Friedmann, 1993, p. 482).

The first research question *How can spatial planning help to build a city's resilience after a disaster?* fits into this context. It intends to understand which spatial planning options are useful to build which kind of resilience. To answer this question, the spatial planning options to address disaster risk introduced in Chapter 2.4 are reviewed for their ability to build engineering, political-institutional, socio-economic and environmental resilience. Based on the results of this analysis, it can be concluded which spatial planning options might currently be missing to build a city's overall resilience.

3.5 INTERIM CONCLUSION

This chapter introduced the concept of resilience and broadly explained its application in various fields. Many areas of application either lean towards an engineering or evolutionary understanding of resilience. Therefore, the chapter clarified why both of these two differing concepts of resilience are important for this research: A city's urban infrastructure and form are the result of engineering work. Accordingly, they are bound to an engineering understanding of resilience, unless a disaster removes large parts of the built structure and a window of opportunity enables the city to evolve. Political-institutional, socio-economic and environmental functions, on the other hand, have the ability to (at least theoretically) evolve continuously, although this ability is rarely used during normal times.

The understanding of resilience elaborated in this chapter serves as a broad framework for the examination of the main research questions. In Part B of this work, each of the resilience spheres introduced in this chapter (engineering resilience, political-institutional resilience, socio-economic resilience and environmental resilience) is investigated for its controllability through the spatial planning options for risk assessment, risk management and risk communication introduced in Chapter 2. Nevertheless, before this analysis can begin, insights into the unique spatial planning options and framework conditions of the research area are provided in Chapter 4. The chapter gives an introduction touching on geographic and demographic structure, the impact of the GEJE and Tsunami and the spatial planning options available for the reconstruction process. Subsequently, Chapter 5 operationalizes resilience and its four spheres engineering, political-institutional, socio-economic and environmental resilience to enable the determination of the spatial planning options' influence on their improvement.

4. JAPAN

Japan was selected as the setting for the case studies because of its long and frequent history with disasters. The WorldRiskIndex 2016 ranked Japan in the 17th position, attesting Japan the highest risk of all developed countries. This position is due to Japan's extremely high exposure to natural hazards, especially floods and earthquakes (Japan is the 4th most exposed country in the world). At the same time, Japan has a very low vulnerability, which is based on the effective infrastructure it has in place and its ability to cope with hazardous events (Bündnis Entwicklung Hilft & United Nations University EHS). This combination of a vast amount of experience and effective strategies to cope with hazardous events, makes Japan a valuable study area. Moreover, the ongoing reconstruction process after the GEJE and Tsunami – one of the largest disasters in the younger history – offered the opportunity to investigate the research topic in the field.

To understand Japan's basic characteristics, the following chapters give an overview of the country's geography and its basic governmental structure. Then, the demographic development and its consequences for the reconstruction process are explained. After an overview of the GEJE and Tsunami, the Japanese disaster risk management system is introduced and the most relevant spatial planning options to address disaster risk are presented. The chapter concludes with a summary of the aims and approaches of the reconstruction process after the GEJE.

4.1 JAPAN'S GEOGRAPHY AND GOVERNMENTAL STRUCTURE

Japan is located in the northern Pacific Ocean in front of the Asian mainland. The island nation consists of four major and more than 6,300 smaller islands that amount to an area of approximately 380,000 km^2 (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015). The country stretches over 3,200 km from Hokkaido in the north, over Honshu, Shikoku and Kyushu to Okinawa in the far south (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015). The majority of Japan's approximately 127 million citizens (as of 2014) lives in the largest cities located in the lowland area along the coast because of the country's mountainous geographical structure; almost 80 percent of the country is covered with mountains and hills (Karan, 2005; Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015).

Japan's Constitution, which came into effect on 3 May 1947, separates the governmental power into legislative, executive and jurisdiction. On the national level, the legislative power is exercised by the Diet, which consists of the House of Representatives and the House of Councilors, the executive power rests with the Cabinet, which is composed of the Prime Minister and other Ministers of State. The judicial power belongs to the courts (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015). Besides the national government, Japan has two levels of local governments: the prefectural and the municipal level. On 1 April 2015, Japan consisted of 47 prefectures and 1,718 municipalities (plus 23 wards (*ku*) in the Greater Tokyo Area). The number of

Illustration 16 | Map of Japan's regions (Okinawa is part of Kyushu Region) | Own illustration based on D-maps, 2016a

municipalities has significantly decreased since the beginning of the 21st century. For comparison, in March 1999, Japan still consisted of 3,232 municipalities (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015). The reason for this reduction is the merging of municipalities "[in] order to strengthen the administrative and fiscal foundation of the municipalities" (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015, p. 189). The merging of municipalities resulted in some very large-sized municipalities (e.g., the current size of Miyako City is ca. 1,260 km^2 and the area of Ishi-

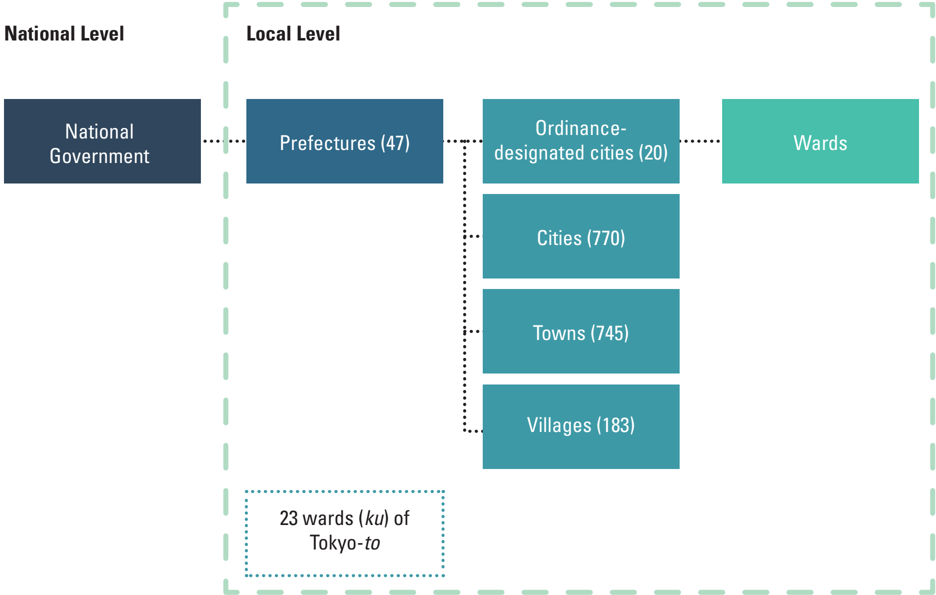


Illustration 17 | Japan's administrative levels | Own illustration based on Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015, p. 190

nomaki City is ca. 555 km^2). Municipalities, with a population of 500,000 people or more, are able to receive most of the administrative and fiscal authorities usually performed by the prefectural government by becoming cities designated by government ordinance. In April 2015, there were 20 of these cities (Sendai being the only one in Tohoku Region[4]). The remaining municipalities break down to 770 cities, 745 towns and 183 villages (see illustration 17).

Japan has a long history of centralized governments (Sorensen, Koizumi, & Miyamoto, 2009, p. 35). Although the establishment of the Constitution after the Second World War appointed the prefectures with self-administrative powers, it was not until 1999 when the prefectures finally were able to use this power. Until then, they were required to "carry out a number of state functions known as Agency Delegated Functions (*Kikan Inin Jimu*)" (Kadomatsu, 2007, p. 4), which also included spatial planning competences. This situation changed with the decentralization reform, which was passed in 1999 and intended to "introduce a more limited framework of state supervision over local governments" (Kadomatsu, 2007, p. 6). The reform also transferred many spatial planning competences (e.g., zoning) from the prefectures to municipalities. Nevertheless, in 2006 some of these competences (e.g., responsibility for quasi-city planning areas) were transferred back to the prefectural level after it became apparent that they could better be coordinated on a higher level (Kadomatsu, 2007; for more information about the contemporary Japanese spatial planning system, see Chapter 4.6).

Japan's stagnating economy and the shrinking population in combination with the necessity to maintain basic utility and social services, puts a high financial burden especially on smaller and rural municipalities. Even though the merging of municipalities was supposed to solve some of these problems (Yokomichi, 2007), many municipalities still suffer with their finances (Ubaura, 2015), a con-

[4] Tohoku Region is one of Japan's eight regions (see illustration 16) and consists of the following six prefectures in the northeast of Honshu: Akita, Aomori, Fukushima, Iwate, Miyagi and Yamagata.

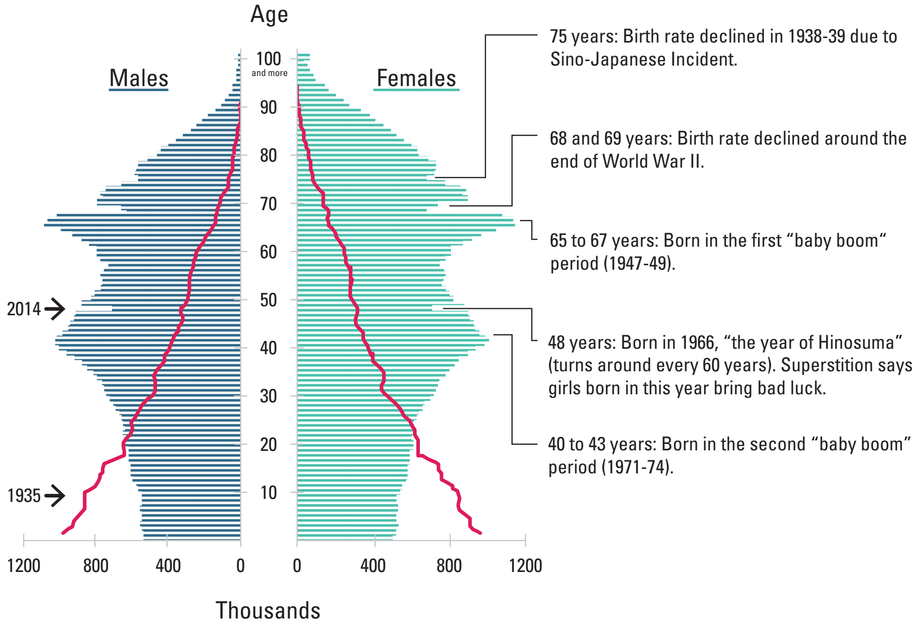


Illustration 18 | Population pyramid of Japan | Own illustration based on Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015, p. 8

dition which restricts the local governments' ability to act (also in the context of spatial planning). This problem intensifies when the "real debt expenditure burden ratio" exceeds 18%. In this case, the municipality is required to obtain permission from the national government to issue municipal bonds (Ubaura, 2015). The demographic development plays an important role in this context because local governments receive a significant amount of their revenues through local taxes.

4.2 JAPAN'S DEMOGRAPHIC DEVELOPMENT

In 2014, Japan had a population of 127.08 million people, which made it the tenth most populous country in the world. Nevertheless, Japan's low total fertility rate[5] (1.43 in 2013) in combination with the country's small immigration rate (in 2014, only about 2.1 million foreign people lived in Japan) lead to a population decrease of about 0.2% each year between 2010 and 2014. This development is predicted to lead to a population decrease to about 97 million people by 2050 (Projection from January 2012). At the same time, the number of people who are 65 years and older increases. While the number of citizens, who are 65 and older, amounted to 26.0% in 2014, there are expected to be 38.8% of people in this age group in 2050. The population pyramid illustrates this development (see illustration 18). While the pyramid was expansive until the middle of the 20th century, the pyramid for the year 2014 was constrictive and this development is expected to evolve even further until 2050 (all data in this paragraph are received from Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015, 2016b).

5 Total fertility rate: "The average number of children that would be born alive to a hypothetical cohort of women if, throughout their reproductive years, the age-specific fertility rates for the specified year remained unchanged" (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015)

The demographic development also influences the household sizes and, associated with this, the demand on the housing market. The aging population as well as the pluralization and individualization of lifestyles results in an increased number of one-person households, while the number of nuclear-family and three-generation households decreases. In 2010, the average household size only consisted of 2.42 people. Despite the shrinking overall population, the demand for housing space currently still remains high. This is a result of the decreasing household sizes (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015, pp. 11–12). The increasing number of elderly people also changes the requirements for living space: accessibility becomes more important with advancing age. In 2010, citizens who are 65 years or older represented 37.3% of the private households. Of these households with elderly people, ca. 24.8% only comprised one person, while ca. 27.2% were composed of couples (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2015, pp. 11–12). It can be expected that the growing number of elderly people will lead to an increased demand for smaller housing solutions that meet the requirements of elderly people.

Of course, all of these developments are important aspects to be considered when spatial planners use the reconstruction process after major disasters, such as the GEJE and Tsunami, to build cities that are resilient for the challenges of the future. This is also the reason why the *Basic Act on Reconstruction in response to the Great East Japan Earthquake* specifically mentions the importance to include the changing demographic structure in the reconstruction process (Basic Act on Reconstruction in response to the Great East Japan Earthquake, 2011). The following chapter explains why reconstruction work after disastrous events is a frequent responsibility in Japan.

4.3 JAPAN'S VULNERABILITY TO NATURAL HAZARDS

Japan's geography and topography makes the country prone to a variety of natural hazards, "including earthquakes, volcanic eruptions, flooding, typhoons, torrential rain and heavy snowfall" (Iuchi, 2016, p. 20). Many rivers in Tokyo are situated in narrow and steep channels above the urban area surrounding them. Accordingly, the potential inundation area in case of a flash flood is large. The agglomeration of 50% of the city's population and 75% of its total assets in areas exposed to floods indicates the importance to manage hydrometeorological risks (Iuchi, 2016, p. 20). Furthermore, Japan's geographic position at the edge of four major tectonic plates, the Pacific and the Philippine oceanic plates and the Eurasian and North American continental plates, which is also referred to as the Pacific "ring of fire" makes the country prone to geological hazards such as earthquakes, tsunamis and volcanic eruptions (Barnes, 2003). The country's proneness to earthquakes manifests in the fact that almost 20% of the global seismic activity with a magnitude of M_w=6.0 or higher between 2004 and 2013 occurred in Japan, although the country only covers 0.25% of the earth's land area (Cabinet Office, Government of Japan, 2015a). Japan's long history with earthquakes includes the Great Kanto Earthquake on 1 September 1923, which caused a fire in the urban area of Tokyo and resulted in the deaths or missing of approximately 105,000 people and the Great Hanshin-Awaji Earthquake that

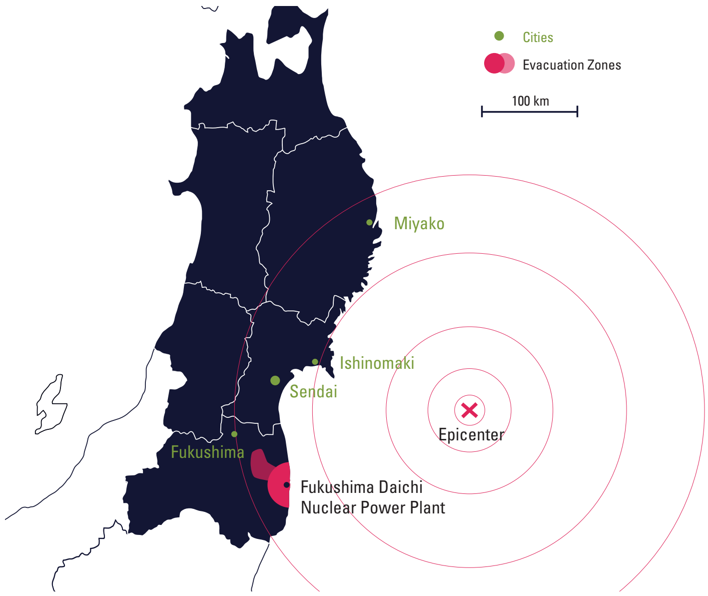


Illustration 19 | Location of the epicenter of the GEJE | Ahlers et al., 2015, p. 91 based on Schauwecker, 2011

struck Kobe on 17 January 1995 and caused the deaths or missing of 6,437 people (Cabinet Office, Government of Japan, 2015b). Tohoku Region was also frequently affected by earthquakes and tsunamis: On 15 June 1896, the Meiji Sanriku Earthquake and Tsunami with a magnitude of M_w=8.3 caused the death or missing of approximately 22,000 people. The Showa Sanriku Earthquake and Tsunami on 3 March 1933 with a magnitude of M_w=8.1 left 3,064 people dead or missing (Cabinet Office, Government of Japan, 2015b; Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015).

4.4 THE GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI

On 11 March 2011 at 14:46, the list of disasters was extended, when the GEJE occurred 130 km off Sanriku Coast in the Pacific Ocean (see illustration 19). The earthquake with a focal depth of about 24 km reached a magnitude of M_w=9.0, making it the largest one in Japan's history on record (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015). Both, earthquake and tsunami were caused by the bouncing back of the North American Plate after it was dragged down by the Pacific Plate (see illustration 20).

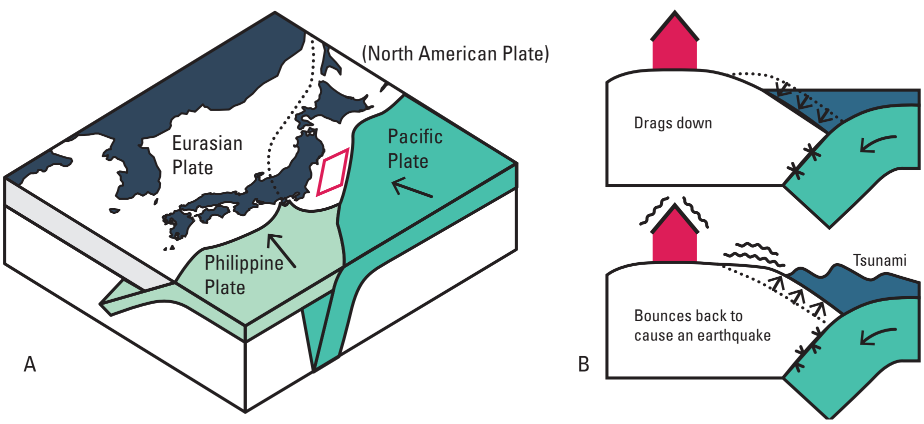


Illustration 20 | (A) Tectonic around Japan (red rectangle shows location of the GEJE) | (B) Schematic diagram of a subduction zone earthquake | Own illustration based on Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 22 citing Okada, 2012, p. 2

First waves of the tsunami were registered at the Tohoku Coast at the same time as the earthquake occurred (e.g., in Kamaishi City and Ofunato City in Iwate Prefecture and Ishinomaki City in Miyagi Prefecture). At this time, the waves did not exceed 20cm. Minutes later, the Japan Meteorological Agency (JMA) issued a major tsunami warning for the prefectures Iwate, Miyagi and Fukushima, estimating a tsunami height of 3 m. Later the expected tsunami height was increased to 6 m (at 15:14) and 10 m (at 15:30). Unfortunately, some places had already been hit by the tsunami by this time and failures in the communication network restricted the accessibility of some areas (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 23). When the largest tsunami waves arrived at the coast, they reached heights up to 9.3 m and run-up heights up to 35 m (Iuchi, 2016, p. 20). The water inundated an area of about 561 km^2 in 64 municipalities in Aomori, Iwate, Miyagi, Fukushima, Ibaraki and Chiba Prefecture (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 27). Overall, the scope of damages was recorded with 15,894 people dead, 2,558 missing and 6,152 injured; more than 120,000 houses were completely and more than a million half or partially destroyed (see table 1).

Human Casualties	
Deceased	15,894
Missing	2,558
Injured	6,152
Damaged Buildings	
Completely destroyed	121,806
Half destroyed	278,575
Partially Destroyed	726,176

Table 1 | Overall damages of the GEJE and Tsunami (as of 10 June 2016) | Own illustration based on Japan Reconstruction Agency, 2016a

Iwate, Miyagi and Fukushima Prefecture were most severely affected by the tsunami. The topography of Tohoku's Pacific coast is characterized by the ria Sanriku in northern Iwate Prefecture and the flat plains in and around Sendai City (Miyagi Prefecture), which constituted the largest part of the area flooded by the tsunami (see illustrations 21 and 22 on the next page). The large area of low lying land along the coast in Miyagi Prefecture, resulted in 327km^2 of the tsunami inundation area to be located in this prefecture. In addition to this, 112 km^2 of Fukushima Prefecture and 58km^2 of Iwate Prefecture were flooded. (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 27).

In Fukushima, the tsunami flooded the Fukushima Daiichi nuclear power plant, causing the failure of the reactors' cooling systems. Despite the reactors' emergency shut down, the lack of cooling resulted in nuclear meltdowns in the reactors 1, 2 and 3, which resulted in the release of radioactive material into the environment. The accident, which was – like the nuclear accident in Chernobyl in 1986 – rated with a 7 on the International Nuclear Event Scale, resulted in the immediate evacuation of a radius of 20 km around the power plant. Later, this evacuation zone was extended to react to radioactive contamination that was registered outside of this zone (Matanle, 2011, 2013). The nuclear accident put Fukushima Prefecture into an even more severe situation than Iwate and Miyagi Prefecture. The recovery process in Fukushima Prefecture was excluded from the investigation of this work because of its specific focus on the recovery after a nuclear disaster.

4.5 JAPAN'S DISASTER RISK MANAGEMENT FRAMEWORK

To deal with the multiple disaster risk Japan frequently has to face, a risk management framework was established in the 1880s and has continuously been adapted since then, usually after the occurrence of a significant disaster. Today,

Illustration 21 | Sanriku Coast in Miyako City | Photo by author, October 2015

Illustration 22 | Sendai flat plains | Photo by author, February 2015

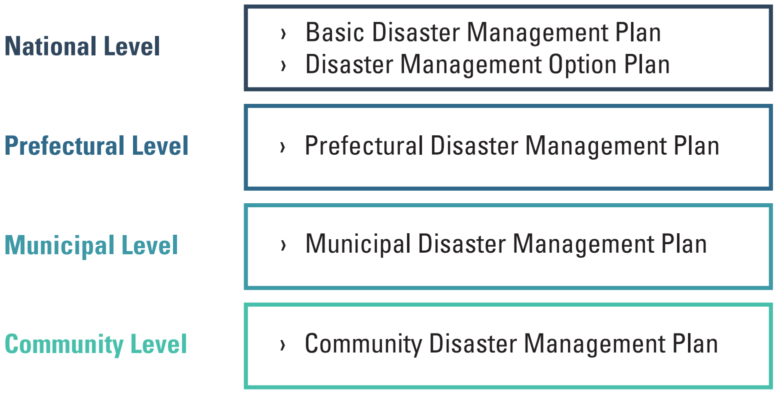


Illustration 23 | Japan's four levels of Disaster Management Plans | Own illustration adapted from Iuchi, 2016, p. 25

the legislative framework for disaster risk management consists of three main documents: The Disaster Countermeasures Basic Act organizes Japan's general disaster management while the Flood Control Act and the River Act address water related risks (Iuchi, 2016).

The Disaster Countermeasures Basic Act

The Disaster Countermeasures Basic Act (Act No. 223 of 1961) was adopted in 1961 as a reaction to the Isewan Typhoon in 1959. Since then it was revised various times. The Disaster Countermeasures Basic Act "aims to protect the lives, livelihoods and assets of citizens from natural disasters, and to safeguard social order, security and public welfare" (Iuchi, 2016, p. 23). The Act provides for four levels of disaster management plans: The Basic Disaster Management Plan and the Disaster Management Operation Plan on the national level, the Prefectural Disaster Management Plan on the prefectural level, the Municipal Disaster Management Plan on the level of the municipalities and the Community Disaster Management Plan on the community level, addressing local residents and enterprises (see illustration 23).

On the national level, the Central Disaster Management Council is required to formulate and promote the implementation of the *Basic Disaster Management Plan*. The Central Disaster Management Council is chaired by the Prime Minister and consists of all Cabinet members, the heads of major public corporations and experts. It is the Council's responsibility to plan and coordinate the national disaster management processes. The Minister of State for Disaster Management is responsible to ensure the smooth realization of these tasks (Cabinet Office, Government of Japan, 2015a). The Basic Disaster Management Plan sets the basis for Japan's disaster management and all lower scale disaster management plans have to consider its content. The plan was first developed in 1963 and has been revised continuously since then, including after the Great Hanshin-Awaji Earthquake and the GEJE and Tsunami (Iuchi, 2016, p. 24). The plan is structured based on hazard types, including natural and accident hazards (see illustration 24).

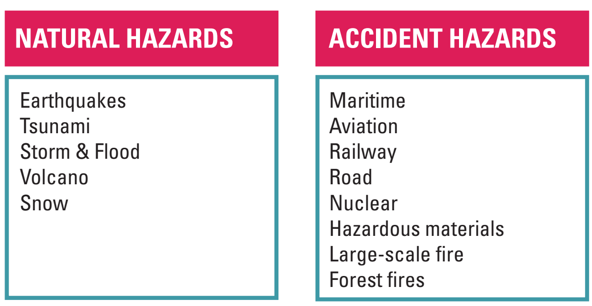


Illustration 24 | Hazards addressed in the Basic Disaster Management Plan | Own illustration based on Central Disaster Management Council, 2016

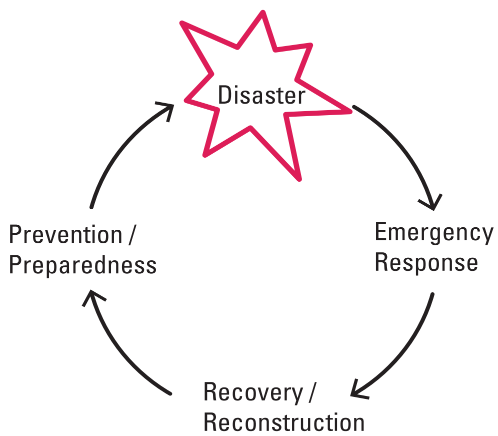


Illustration 25 | Disaster management phases of the Basic Disaster Management Plan | Own illustration based on Central Disaster Management Council, 2016

Each disaster section consists of countermeasures for each of the three phases of the disaster cycle "prevention and preparedness", "emergency response" and "recovery and reconstruction" (see illustration 25). These countermeasures are implemented on the national, prefectural and local level. In addition, the plan sets up lines of action for citizens in order to secure their safety and enable an efficient risk management (Cabinet Office, Government of Japan, 2015a, p. 9).

The Disaster Countermeasures Basic Act also requires designated government organizations (i.e., 24 ministries and agencies) and designated public corporations (i.e., 66 corporations, incl. Nippon Telegraph and Telephone (NTT), Bank of Japan, Japanese Red Cross) to formulate and implement *Disaster Management Operation Plans* based on the Basic Disaster Management Plan. These plans are also developed on the national level (Cabinet Office, Government of Japan, 2015a).

On the local level, Prefectural Disaster Management Councils and Municipal Disaster Management Councils are required to formulate *Local Disaster Management Plans* for the prefecture or municipality respectively. Local Disaster Management Plans are based on the Basic Disaster Management Plan, but consider local characteristics and need to specify the disaster countermeasures accordingly (Cabinet Office, Government of Japan, 2015a).

Community Disaster Management Plans can be established by local residents and enterprises on a voluntary basis. Such plans include disaster management activities on the community level (Cabinet Office, Government of Japan, 2015a).

The Flood Control Act and the River Act

The Flood Control Act was established in 1949 (Act No. 193 of 1949) and "addresses public safety by monitoring and protecting citizens and assets through mitigating damage from flooding, tsunamis and storm surges" (Iuchi, 2016, p. 24). The law specifies the organization of flood control and countermeasures to take. Furthermore, it states designated flood control management bodies and their cooperation with each other. The Act assigns the main responsibility for flood control to the municipalities. Nevertheless, in case that a municipality is unable to fulfill this duty on its own, it can establish a cooperation with other municipalities' governments (Kato & Cipullo, 2012, p. 55). One measure to mitigate flood risks included in the Flood Control Act, is the designation of rivers, which are subject to flood warning by the Ministry of Land, Infrastructure, Transport and Tourism (in case that the flooding of the river would cause a serious damage for the national economy) or the prefectural government (in case that the flooding of the river would cause significant damage). In these cases, the Ministry or prefectural government is also responsible for the designation of hazardous areas along the river (Kato & Cipullo, 2012, p. 58). Currently, there are 417 rivers designated as prone to flooding and 1,555 rivers hold "water-related notifications" (Cabinet Office, Government of Japan, 2015a, p. 26).

In 1964, the current version of the River Act (Act No.167 of 1964) was issued to "comprehensively manage rivers to prevent disasters from flooding, tsunamis and storm surges so that the land will be protected" (Iuchi, 2016, p. 24) and to ensure the proper utilization of the rivers to enhance the public welfare

(Infrastructure Development Institute Japan, 1999). The Act does not only focus on disaster prevention, but also on water use as well as environmental and spatial planning issues concerning rivers (Infrastructure Development Institute Japan, 1999).

The GEJE and Tsunami resulted in a stronger acknowledgment of the role that spatial planning can play to build disaster resilience. For instance, this can be recognized in the extensive designation of hazardous areas after the disaster (Iuchi, 2016). To give an understanding of the structure and instruments that Japan's spatial planners have available to address disaster risks, the following chapter gives an overview of this topic.

4.6 SPATIAL PLANNING IN JAPAN

The complexity of the Japanese spatial planning system becomes noticeable in the following quote by Professor Yorifusa Ishida, who was one of the leading experts for Japanese spatial planning after 1945 (Watanabe, 2016): "If asked to 'Describe all the different types of land use planning systems currently used in Japanese urban planning,' how many students majoring urban planning could possibly answer correctly? None. Even urban planners would argue over the 'correct' answer" (Ishida, 1994, p. 131). Accordingly, it would be presumptuous to assume that the spatial planning system could be fully explained in this work. Nevertheless, the relevance of the Japanese spatial planning regulations for this research require an overview of the basic framework conditions and the most important planning instruments for the reconstruction process after the GEJE and Tsunami.

The basic structure of Japan's spatial planning system is established in two basic Acts: The National Spatial Planning Act guides the national spatial development and the National Land-Use Planning Act established the land-use planning toolbox to enable spatial planners to reach the goals set in the spatial plans. It should be kept in mind, that Japan's traditional spatial planning (toshikeiikaku) is firmly linked to a technocratic top-down approach, which reaches back to the Meiji era (1868-1912) and has only recently been challenged through the development of the participative *machizukuri* approach in the 1970s (Hohn, 2000). Accordingly, the Japanese mentality prefers engineering solutions over social solutions (Ishinomaki City Planning Division, Employee, 2015).

The National Spatial Planning Act

The Comprehensive National Land Development Act (Act No. 205 of 1950) was established in 1950 to regulate Japan's continuous expansion and growth. In 2005, the Act was completely revised to adapt it to the changing conditions of slowed down growth and set the framework for smart land-use. Moreover, its name was changed to National Spatial Planning Act (Act No. 89 of 2005) (Bureau of Urban Development, Tokyo Metropolitan Government, 2013). Today, the purpose of this Act is to "promote the use, improvement and conservation of national land, from a comprehensive viewpoint of policies for the economy, society, culture, etc., with consideration for natural conditions of national land" (National Spatial Planning Act, 2005). It sets the framework for the development of the National Spatial Strategy (National Plan) and the Regional Plans.

The National Plan is prepared by the national government as the primary document to set strategic goals. The current version of the National Plan sets the national spatial development targets for the next decade to build "[a] country where people can feel safe and affluent", which is able to "[sustain its] economic growth" and maintains a close relationship with "the international community" (Ministry of Land, Infrastructure, Transport and Tourism, 2015, p. 10) and it specifies the course of action for the following eight fields: industry, culture and tourism, utility infrastructure, national spatial infrastructure, disaster prevention and reduction, land and water resources, environmental protection and developing a society of mutual assistance (Ministry of Land, Infrastructure, Transport and Tourism, 2015). Furthermore, the National Plan sets the outline for the development of the Regional Plans, which are prepared to specify the concept of the National Plan for the local characteristics and translate it into implementable measures. Regional Plans are developed by the Ministry of Land, Infrastructure, Transport and Tourism for each of Japan's eight regions (i.e., Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, and Kyushu-Okinawa) (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 6).

The National Land-Use Planning Act

While the National Spatial Planning Act provides for the establishment of a guiding principle for Japan's spatial development, the National Land-Use Planning Act sets the general framework for the national land-use planning (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 9). The National Land-Use Planning Act was first established in 1974 to secure the thorough and organized development of the national land-uses (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 9). In 2005, it was fully revised and changed. The National Land-Use Planning Act requires land-use planning on three different levels (Iuchi, 2016):

› The Ministry of Land, Infrastructure, Transport and Tourism is responsible to develop the *National Land-Use Plan* on the national level. The plan sets a long-term vision for land-uses on the national level. Thereby, the plan incorporates the opinions of the prefectural governors (Art. 5, National Land-Use Planning Act).

› Japan's 47 prefectures are responsible for the development of the *Prefectural Land-Use Plans*, which are based on the National Land-Use Plan and incorporate local characteristics. These plans consider the opinion of the prefecture's city mayors (Art. 7, National Land-Use Planning Act).

› *Municipal Land-Use Plans* on the local level are developed by the municipal governments. They state the basic goals for each land-use on the municipality's area. Should there be a Prefectural Land-Use Plan for the prefecture of the municipality, the Municipality Land-Use Plan needs to incorporate the content if this plan (Art. 8, National Land-Use Planning Act). Municipal Land-Use Plans are optional and their content is similar to the Urban Master Plans under the City Planning Act. Therefore, only about 40% of the municipalities in Japan have developed Municipal Land-Use Plans (M. Ubaura, personal communication, 9 October 2015).

- All Land-Use Plans can specify land-uses based on the following classification types: urban, agricultural, forestry, national parks or natural preservation. After the land-uses are designated, each land-use is controlled by another statutory basis (see illustration 26 on the next page).

After areas are designated with certain land-uses, their designation can only be changed with the agreement of the national government (Miyako City Consultant, 2015). Areas that are designated as urban can be structured more precisely with the spatial instruments of city planning.

City planning

The City Planning Act of 1968 (Act No. 100 of 1968) and the Building Standards Act (Act No. 201 of 1950) set the legal basis for the spatial development in urban areas in Japan. While the City Planning Act intends to "promote orderly spatial development by enforcing plans, regulations and projects" (Iuchi, 2016, p. 28), the Building Standards Act addresses small-scale developments and ensures the compliance of minimum building standards (Building Standards Act, 1950).

Based on the City Planning Act, areas that meet certain requirements regarding the number of population and urban facilities can be designated as city planning areas by the prefecture. The designation is optional, which is why the amount of land designated as city planning area varies from prefecture to prefecture (Iuchi, 2016). For designated city planning areas, the prefecture or municipal governments develop Urban Master Plans, which set a vision for the future development of the city. City planning offers a set of land-use regulations (e.g., the designation of urbanization promotion and urbanization controlled areas), the ability to plan urban facilities (e.g., transport facilities, public spaces) and the implementation of urban development projects (e.g., land readjustment projects) (see illustration 27). Typically, local governments are responsible for the application of city planning, e.g., by granting permission for land development or the construction of buildings, the development of proposed urban facilities or the implementation of urban development projects (Iuchi, 2016, p. 28).

Cities with 100,000 or more inhabitants are required to divide the city planning area into urbanization promotion areas (*shigaika kuiki*) and urbanization controlled areas (*shigaika chousei kuiki*). While urbanization promotion areas are designated for further urban development, the development in urbanization controlled areas is restricted. This process is referred to as senbiki and "is intended to prevent unregulated urbanization" (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 34). Smaller cities are free to decide whether they want to designate urbanization promotion and urbanization controlled areas or not. Therefore, a large amount of city planning areas does not have any land-uses applied (referred to as *hinsenbiki*). Within *hinsenbiki* areas, most local governments do not regulate the land-uses (Iuchi, 2016).

Outside of the city planning areas, municipal governments can optionally designate quasi-city planning areas (*jun toshikeikaku kuiki*). This possibility was introduced with the 2000-revision of the City Planning Act to enable the possibility to zone land located outside of city planning areas (Iuchi, 2016, p. 30).

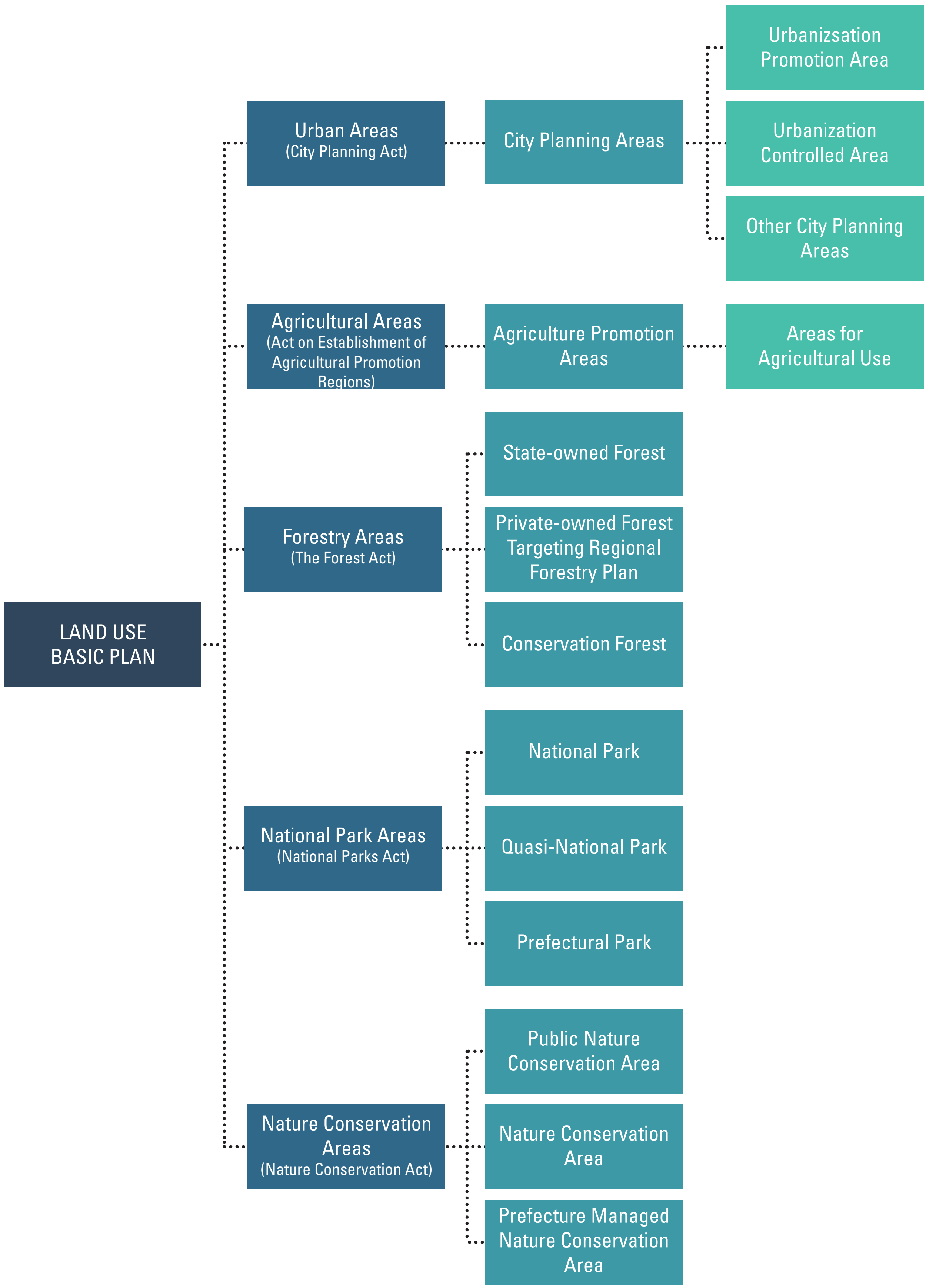


Illustration 26 | Land-uses in the National Land-Use Plan | Own illustration based on Iuchi, 2016, p 28

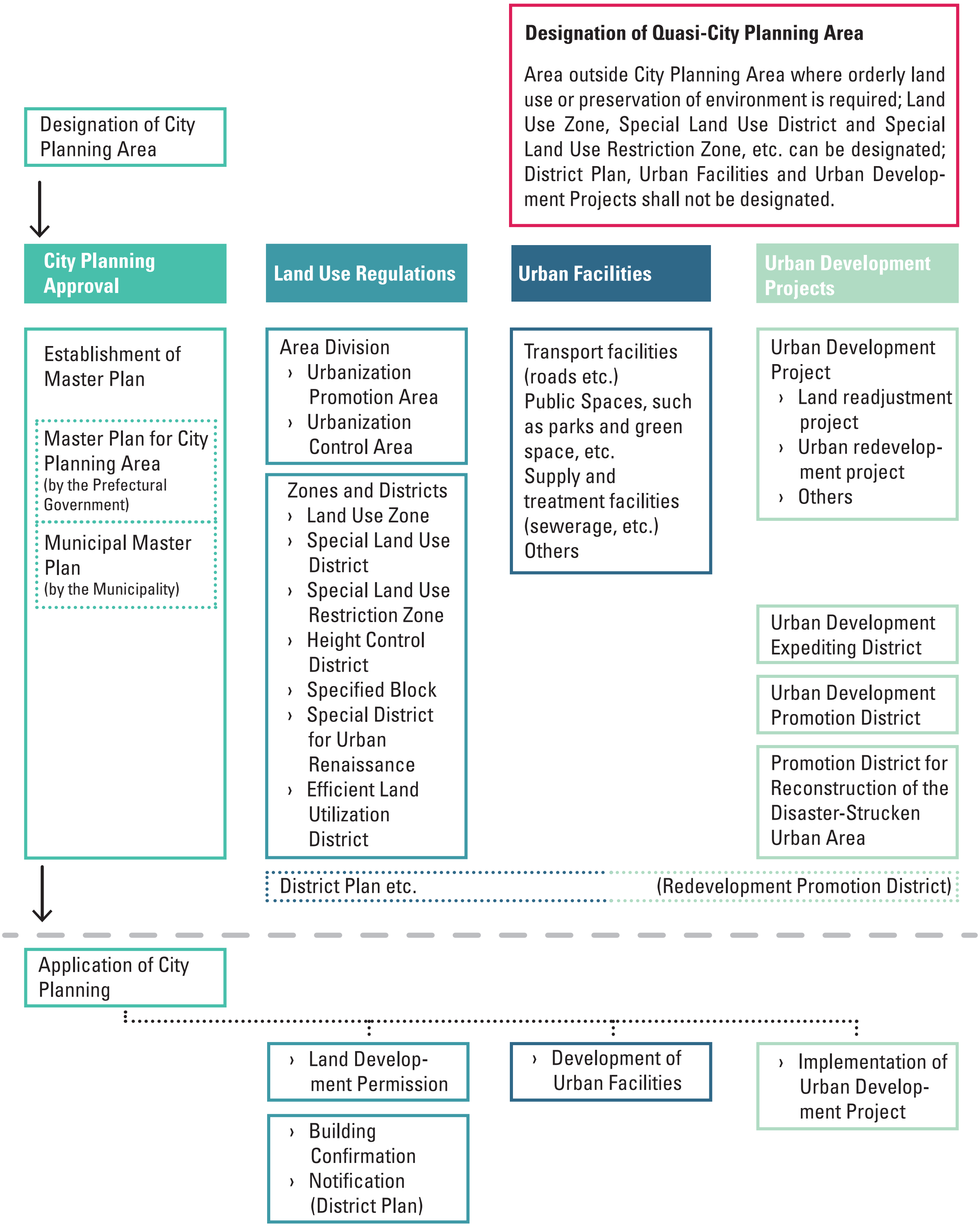


Illustration 27 | Basic structure of the city planning system | Own illustration based on Ministry of Land, Infrastructure, Transport and Tourism, 2003, p. 2

Urban promotion areas or quasi-city planning areas can be further divided into land-use zones with the intention to "ensure reasonable land use by classifying land […] and imposing certain restrictions on buildings and structures" (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 35). The City Planning Act and the Building Standards Act provide for twelve different types of residential, commercial and industrial land-uses (see illustration 29). Each land-use is associated with certain building standards, e.g., floor area ratios (FAR) or building heights (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 35).

In addition to the zoning of specific land-uses, spatial planners can also designate other zones and districts "[i]n order to promote reasonable land use according to the characteristics of the given districts" (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 35). These districts do not have to comply with the land-use zones (see illustration 28) and are intended to achieve specific purposes beyond an areas general land-use, e.g., the conservation of natural features, fire prevention or disaster prevention (Bureau of Urban Development, Tokyo Metropolitan Government, 2013).

District planning was established in 1980 to fill the gap that was left between the old City Planning Act and the old Building Standards Act (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 104). District plans are developed by the responsible municipality "to improve, develop, and conserve favorable environments that suit the qualities of each block through uniformity in building design, public facilities layout, and the layout of other facilities" (City Planning Act, 1968). The plans include propositions for the location of public facilities (e.g., local roads, local parks, footways), building control and regulations (e.g., regarding land-use, FAR, building height and design) and the preservation of green (Ministry of Land, Infrastructure, Transport and Tourism, 2003, p. 7).

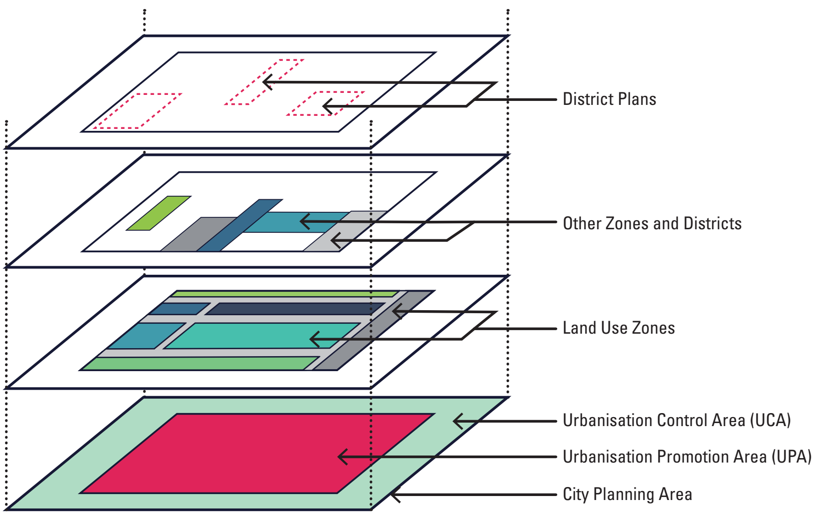
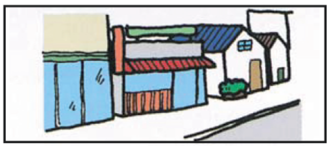


Illustration 28 | The concept of the land-use planning system in City Planning Areas | Ahlers et al., 2015, p. 91 based on Ministry of Land, Infrastructure, Transport and Tourism, 2003, p. 2

Category I exclusively low-rise residential zone

This zone is designated for low rise residential buildings. The permitted buildings include residential buildings which are also used as small shops or offices and elementary/ junior high school buildings.

Category II exclusively low-rise residential zone



This zone is mainly designated for low rise residential buildings. In addition to elementary/ junior high school buildings, certain types of shop buildings with a floor area of up to 150m^2 are permitted.

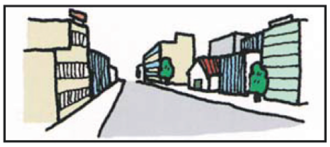
Category I mid/ high-rise oriented residential zone

This zone is designated for medium to high residential buildings. In addition to hospital and university buildings, certain types of shop buildings with a floor area of up to 500m^2 are permitted.

Category II mid/ high-rise oriented residential zone

This zone is mainly designated for medium to high rise residential buildings. In addition to hospital and university buildings, the permitted buildings include certain shops and office buildings with a floor area of up to 1,500m^2 to provide conveniences for the local community.

Category I residential zone



This zone is designated to protect the residential environment. The permitted buildings include shops, offices and hotel buildings with a floor area of up to 3,000m^2.

Category II residential zone

This zone is designated to mainly protect the residential environ-ment. The permitted buildings include shops, offices and hotel buildings as well as buildings with karaoke box.

Quasi-residential zone

This zone is designated to allow the introduction of vehicle-related facilities along roads while protecting the residential environment in harmony with such facilities.

Neighborhood commercial zone

This zone is designated to provide daily shopping facilities for the neighborhood residents. In addition to residential and shop buildings, small factory buildings are permitted.

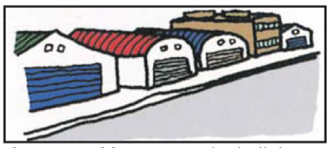
Commercial zone

Banks, cinemas, restaurants and department stores are constructed in this zone. Residential buildings and small factory buildings are also permitted.

Quasi-industrial zone

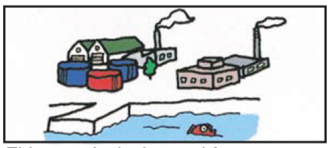
This zone is mainly occupied by light industrial facilities and service facilities. Almost all types of factories are permitted excepting those which are considered to considerably worsen the environment.

Industrial zone



Any type of factory can be built in this zone. While residential and shop buildings can be constructed, school, hospital and hotel buildings are not permitted.

Exclusively industrial zone



This zone is designated for factories. While all types of factory buildings are permitted, residential, shop, school, hospital and hotel buildings cannot be constructed.

Illustration 29 | Land-use zones in the Urban Promotion Area | Ministry of Land, Infrastructure, Transport and Tourism, 2003, p. 4 (slightly adapted)

District plans can also be used as an instrument to designate development promotion districts in order to promote the development of underdeveloped land (e.g., for the revitalization of former industrial or factory sites) or to assign disaster prevention block improvement districts (e.g., to advance the construction of evacuation roads or evacuation sites or improve the buildings' fire resistance) (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 106).

4.7 SPATIAL PLANNING AND RISK GOVERNANCE IN JAPAN

Within this spatial planning framework, planners have certain options available to manage disaster risks and increase a city's disaster resilience. Some of them were specifically established in order to handle disaster risks (e.g., the designation of hazardous areas), others are generally applicable and their use to manage disaster risks is just one of their potential applications (e.g., land readjustment projects). This chapter will introduce the most important spatial planning options that were used in the reconstruction process after the GEJE and Tsunami based on their applicability in relation to risk assessment, risk management and risk communication (see Chapter 2.4).

4.7.1 Spatial planning options for risk assessment

Spatial planners can support the assessment of risk by contributing to the development of hazard maps, e.g., by providing information about vulnerable land-uses. In addition to this, spatial planners can carry out EIAs to determine whether certain construction plans should not be carried out in order to preserve protected goods.

Hazard maps and hazard simulations

Hazard maps are an important tool to plan disaster resilient cities, since they depict areas that are exposed to certain hazards based on a scientific analysis, which includes an area's topography and the potential magnitude of hazardous events (Dzurdženík et al., 2015, 16-17). Thus, hazard maps help to determine spatial risks and serve as a basis for the designation of hazardous zones in accordance with Article 7 of the City Planning Act or Article 39 of the Building Standards Act (see Chapter 4.5). There are various hazard maps developed in order to illustrate potentially endangered areas. After the revision of the Flood Control Act in 2001, the Ministry of Land, Infrastructure, Transport and Tourism together with the prefectural governments published hazard maps for river floods, storm surges and tsunamis. The maps are publicly available on the website of the Ministry of Land, Infrastructure, Transport and Tourism (http://disaportal.gsi.go.jp/). The publication of this information did not result in the negative effects, e.g., sinking real estate prices in areas exposed to certain hazards, that had been anticipated. Sharing the information included in hazard maps, is an important aspect to enable the public to prepare for the occurrence of hazardous events, e.g., through changing building structures (Iuchi, 2016).

The tsunami hazard maps that were developed in Japan after the GEJE are based on the concept of L1- and L2-tsunamis. While L1-tsunamis have an occur-

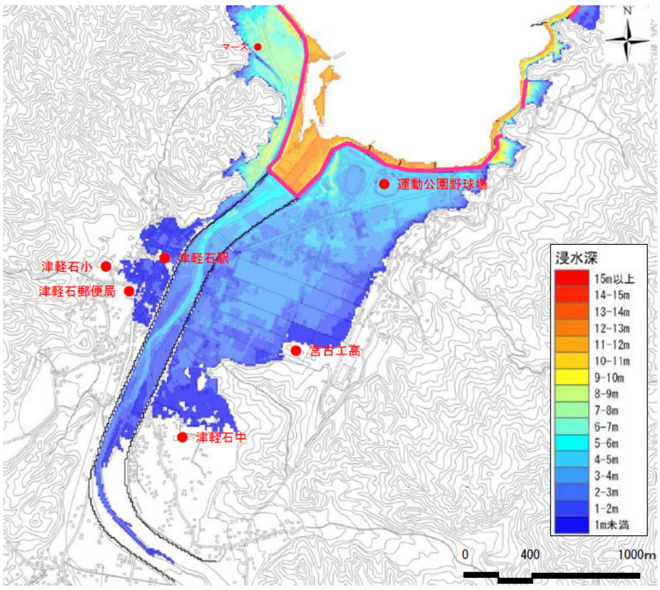


Illustration 30 | L2-tsunami simulation for Tsugaruishi District in Miyako City | Tsugaruishi District Reconstruction Town Planning Committee 2012, p. 10

rence between once every few decades to once every hundred years, they are not as high as L2-tsunamis. L2-tsunamis, on the other hand, are very high, but only occur once every couple hundred years or less frequently (Central Disaster Management Council, 2011, p. 10; Dzurdženík et al., 2015, p. 30; Iuchi, 2016, p. 25). Japan's disaster resilience concept intends the construction of a seawall along Tohoku Coast, whose height was determined based on the height of L1-tsunamis. This means, that the seawall will prospectively protect the land behind it from L1-tsunamis. Nevertheless, during the rare occurrence of a L2-tsunami, the seawall will become washed over and the low lying area behind it will become inundated. This course of events was simulated using a computer program, which considered the estimated height of the tsunami (calculated on the basis of large-scale tsunamis in the past), the intended height of the seawall, geographical and topographical characteristics as well as the local infrastructure. The simulation results were illustrated in hazard maps, which were then released to the public (see illustration 30; Dzurdženík et al., 2015, p. 18).

Based on these hazard maps and under consideration of the area's land-uses, spatial planners are able to decide which sections to exclude from future urban development and thereby increase the disaster resilience of the city.

Environmental Impact Assessment (EIA)

The EIA is an eco-political instrument which enables the forethought of the environmental impact of construction projects. This is important to ensure an optimum preservation of protective goods such as air, water, soil, flora, fauna, landscape and human beings (Ministry of the Environment, Government of Japan, n. d., p. 10). The EIA is an important instrument to include environmental aspects into spatial planning. Currently, EIAs in Japan are conducted based on the Environmental Assessment Law, which was enacted in 1997 (Environmental Impact Assessment Law, 1997). The law established a binding obligation to conduct an EIA when required. The necessity to conduct an EIA depends on the type of project and its size. Each project that is expected to have a significant impact on the environment is classified as Class-1 and generally requires an EIA.

Smaller projects are ranked as Class-2 projects (see table 2). Their requirement to conduct an EIA is determined through a case-by-case review. Projects that require the approval from the national government, receive funding from the national government or are conducted by the national government, generally require an EIA (Ministry of the Environment, Government of Japan, n. d., p. 4).

Class-2-projects have to pass through a screening to determine whether they require an EIA. The screening evaluates the requirement for an EIA on a case-by-case basis. The final decision is made by the responsible ministry (e.g., the Ministry of Land, Infrastructure, Transport and Tourism for road projects) under consideration of the prefectural governor's opinion (Ministry of the Environment, Government of Japan, n. d., p. 9).

If a project requires an EIA, the project proponent is responsible for its implementation. If spatial plans include projects that require an EIA, the level of the planning authority (e.g., municipal or prefectural government) takes on the role of the project proponent (Ministry of the Environment, Government of Japan, n. d., p. 15). The EIA includes the following steps:

1. *Scoping:* During this stage, the project proponent identifies all relevant stakeholders, defines the assessment methods and compiles everything into a scoping document. The public has the right to review the document and submit comments, before the proponent advances it, together with the received comments, to the prefectural and municipal governments. After the proponent received the opinion from the prefectural governor, which also takes into account the opinion of the municipal mayor, the proponent makes the decision about the actual assessment methods (Ministry of the Environment, Government of Japan, n. d., pp. 9–10).
2. *Identification and description of effects:* The next step requires the project proponent to implement the selected assessment methods to determine the possible impacts of the planned development on the environment. Furthermore, the step also considers the ability of appropriate measures to reduce these effects. The goal of the assessment is to identify the alternative that keeps the negative impact on the environment as small as possible (Ministry of the Environment, Government of Japan, n. d., p. 11).
3. *Environmental Impact Statement (EIS):* The results from the assessment are combined into a draft version of the Environmental Impact Statement (EIS). This document follows a similar procedure as the scoping document. The draft EIS is made open to the public. Besides the public display and the ability to write comments, additional explanation meetings are held. The public's comments and the draft EIS are then submitted to the prefectural and municipal government. Based on the prefecture's and municipal's statement, the proponent reviews the EIS and submits it to the ministry responsible for the authorization of the project (e.g., the Ministry of Land, Infrastructure, Transport and Tourism for road projects) and the Minister of the Environment. The responsible ministry prepares its statement under consideration of the Minister of

the Environment's opinion and sends it back to the project proponent. Based on this statement, the proponent prepares the final EIS, which is submitted to the authorizing ministries, the prefectural and the municipal government and made available to the public for one month (Ministry of the Environment, Government of Japan, n. d., pp. 12–13).

	Class-1 project (EIA is always required)	**Class-2 project (case-by-case review if EIA is required)**
1. Road		
national expressway	All	
metropolitan expressway	4 lanes or more	
national roads	4 lanes or more, 10 km or longer	4 lanes or more, 7.5 km-10 km
large-scale forest road	2 lanes or more, 20 km or longer	2 lanes or more, 15 km-20 km
2. River		
dam, weir	reservoir area: 100 ha or larger	reservoir area: 75 ha-100 ha
diversion channnel, lake-related development	area of land alteration: 100 ha or larger	area of land alteration: 75 ha-100 ha
3. Railway		
shinkansen (super express train)	All	
railway, track	length: 10 km or longer	length: 7.5 km-10 km
4. Airport	runway: 2,500 m or longer	runway: 1,875 m-2,500 m
5. Power plant		
hydraulic power plant	output: 30,000 kw or over	output: 22,500 kw-30,000 kw
thermal power plant	output: 150,000 kw or over	output: 112,500 kw-150,000 kw
geothermal power plant	output: 10,000 kw or over	output: 7,500 kw-10,000 kw
nuclear power plant	All	
6. Waste disposal site	area: 30 ha or larger	area: 25 ha-30 ha
7. Landfill and reclamation	area: exceeding 50 ha	area: 40 ha-50 ha
8. Land readjustment project	area: 100 ha or larger	area: 75 ha-100 ha
9. New Residential area development project	area: 100 ha or larger	area: 75 ha-100 ha
10. Industrial estate development project	area:100 ha or larger	area: 75 ha-100 ha
11. New town infrastructure development project	area: 100 ha or larger	area: 75 ha-100 ha
12. Distribution center complex development project	area: 100 ha or larger	area: 75 ha-100 ha
13. Residential or industrial land development by specific organizations	area: 100 ha or larger	area: 75 ha-100 ha
Port and harbor planning	Total reclaimed and excavated land: 300 ha or larger	

Table 2 | List of projects that are subject to the Environmental Impact Assessment Law | Own illustration based on Ministry of the Environment, Government of Japan, n. d., p. 5

4. *Integration of EIA into decision making:* After the EIS is finalized, the project can be implemented. Nevertheless, it is important for the project to follow the specific measures that are planned in the EIS document (Ministry of the Environment, Government of Japan, n. d., pp. 13–14).
5. *Monitoring:* To ensure the effectiveness of the intended measure, a monitoring can continuously evaluate the environmental conditions from the beginning of the project's construction until its operation. In reality, this option is only taken in certain cases (e.g., if the actual impacts of a project were uncertain to determine in advance) (Ministry of the Environment, Government of Japan, n. d., p. 15).

4.7.2 Spatial planning options for risk management

Spatial planning offers a variety of possibilities to manage risks. Some of them concentrate on the minimization of vulnerable land-uses at risk, either by restricting all or specific land-uses in hazardous areas, others intend to reduce the physical susceptibility of existing or planned buildings to decrease an areas overall vulnerability. Another option for risk reduction is to address the hazard, e.g., through the implementation of mitigation strategies.

4.7.2.1 Minimization of exposure of urban areas

The Japanese spatial planning system provides different possibilities to control urban development in hazardous areas: Preventing the urbanization of undeveloped areas can be achieved through the designation as urbanization control areas. This option can also be applied for hazardous areas. Another option is the designation of hazardous areas, which can be used to restrict residential land-uses on undeveloped, but also developed areas. If developed areas are designated as hazardous, the residents in this area have to be relocated to safer land. In Japan, the preparation of these relocation sites often occurs through the implementation of land-readjustment projects. Land readjustment projects are an important spatial planning instrument in Japan, which was frequently applied for the reconstruction after the GEJE and Tsunami.

Land-use control in hazardous areas

Article 7 of the City Planning Act enables the classification of the city planning area into urbanization promotion and urbanization control areas. This option was established to prevent unregulated urban development, but is also applicable to prevent unwanted development in areas that are prone to hazards. With the exclusion of areas that are exposed to hazards from urbanization promotion areas, spatial planners can prevent these areas' future urban development. One example for this is the land along river courses, which should be excluded from urbanization promotion areas unless special measures for flood control are taken. To ensure that urbanization promotion areas are safe for urban development, spatial planners are required to consider an area's hazard exposure before designating is as an urbanization promotion area (Iuchi, 2016). Although Article 7 of the City Planning Act enables the prevention of urban development in hazardous areas, in reality, this option is often left unused due to economic aspects (e.g., high land values). These aspects often pressure spatial planners to enable the urban development of areas that should rather be excluded from urbanization promotion areas (Iuchi, 2016, p. 33).

Based on *Article 39 of the Building Standards Act*, local governments are able to designate hazardous areas that are prone to landslides, tsunamis, storm surges or floods by enforcing ordinances. These ordinances permanently prohibit future residential development in these areas and also serve as a basis for the relocation of existing residents in these areas (Iuchi, 2016). The designation of hazardous areas can prevent the current and future use of exposed areas for residential purposes, even if these areas were formerly included in urbanization promotion areas and therefore available for urban development.

History shows that the proactive designation of hazardous areas was only conducted scarcely. Before the GEJE, the overall area designated as hazardous amounted to 7,060 ha. After the GEJE an additional area of 15,723 ha was designated as hazardous (Iuchi, 2016, p. 34). This shows that the intention of Article 39 of the Building Standards Act to prevent disasters through the proactive relocation of citizens from hazardous areas to safe land, was not met. The designation of hazardous areas and the associated relocation usually only happens after the occurrence of a disaster (Iuchi, 2016, p. 32).

Relocation through relocation programs or land readjustment projects

The designation of hazardous areas in accordance with Article 39 of the Building Standards Act usually addresses existing urban areas. Therefore, the designation enables the implementation of the following two relocation programs:

- The "collective relocation promotion program for disaster prevention" (*Bousai no tameno shudan iten jigyou ni kakaru kuni no zaiseijou no tokubetsu sochi tou ni kansuru horitsu*) (hereafter, group relocation program) enables communities to proactively relocate from hazardous to safe land. In the past, the program was often used to move citizens from remote, hazard-prone areas into existing urban areas to provide them with better infrastructure services (Iuchi, 2016, p. 31).
- The "relocation program for hazardous residential buildings adjacent to steep slopes" (*Gakechi rinsetsu kiken jyutaku iten jigyo*) allows the "proactive relocation of individual residents specifically living near collapsible slopes in order to prevent damage and loss from slope failure" (Iuchi, 2016, p. 31). This program focuses on the relocation of individual households rather than communities, since slope failures usually only affect small areas. The program's flexibility to relocate individual households, results in a frequent application of the steep slope relocation program (Iuchi, 2016, p. 31).

Besides these relocation programs, *relocation* of existing settlements can also be implemented through *land readjustment projects*. The importance of land readjustment in Japan is displayed in its characterization as 'The Mother of City Planning' (*Toshi Keikaku no Haha*) (Sorensen, 2000, p. 217). In the 19th century, when the disorganized development of Japanese cities called for adequate planning approaches, land readjustment was adopted from agricultural planning, where land consolidation was successfully used to boost crop yields. Land readjustment has versatile fields of application, but is most frequently applied for the restructuring of large areas and for the improvement of public infrastructure. Land readjustment projects can either be used for suburban development (*kaihatsu*) or for the renewal, redevelopment or reconstruction of urban areas (Hohn, 2000, p. 221).

This wide application of land-readjustment projects in Japanese spatial planning enables their use for the preparation of new relocation sites, the adaptation of existing urban structures (e.g., roads or parks) as well as for the readjustment of affected areas for the recovery on-site or on raised land. To prevent repetitions, the main steps of land readjustment are explained in Chapter 4.7.2.4 because the adaptation of existing urban structures is one of the advantages of land re-adjustment projects. In case that land readjustment projects are implemented to prepare a new relocation site, the city administration purchases the required land from the previous land owners and sells it to the new residents at the end of the process. Nevertheless, the basic steps remain the same (see Chapter 4.7.2.4). Relocation through land readjustment projects can also happen to implement the group relocation projects mentioned above.

4.7.2.2 Differentiated land-use decisions

In Japan, differentiated land-use decisions can be made through the designation of specific land-uses for urban promotion areas or quasi-city planning areas on the basis of the City Planning Act. For these areas, spatial planners are able to zone land-uses.

Land-use zoning

As explained in Chapter 4.6, there are twelve different types of residential, commercial and industrial land-use zones available to designate the specific land-use for a certain area. Using this option is especially useful if residential land-uses in a certain hazardous area should be prevented, while the development of commercial or industrial land-uses should be enabled.

After the GEJE and Tsunami, many cities along the ria coastline of Iwate Prefecture used differentiated land-use decisions to utilize most of the scarce plain areas by the sea, even though they are simulated to be flooded in case of the occurrence of a L2-tsunami. Illustration 31 gives an overview of a typical distribution of land-uses after the GEJE and Tsunami.

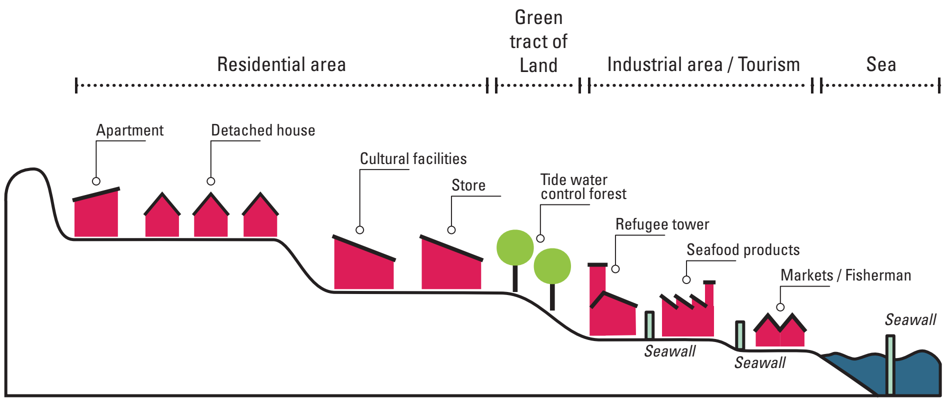


Illustration 31 | Land-uses near the ocean | Own illustration based on Ubaura, 2013, p. 7

Usually, areas directly by the sea were restricted to land-uses that require the vicinity to the ocean. These land-uses are mainly the fishing and fish processing industries as well as tourist attractions and souvenir shops. To ensure the safety of people who stay in these areas, it is important to also provide evacuation shelters. Many cities also designated green spaces along the coast. These zones can comprise memorial parks and/ or coastal forests. Areas that are located further inland, but are still prone to flooding in case of a L2-tsunami, are usually designated as commercial zones. These areas can also include cultural facilities. By excluding residential land-uses from these areas, it should be prevented that people are surprised by a tsunami while they are asleep. Residential land-uses usually are only designated in areas with an expected inundation depth of less than 2 m in case of a L2-tsunami. Nevertheless, buildings that are constructed in areas that can be inundated by a L2-tsunami usually require the implementation of certain building standards (see next chapter).

4.7.2.3 Adaptation of building structures

Reducing the susceptibility of the city's built structure is another important possibility to increase the city's disaster resilience. This can either be achieved through the implementation of legally binding building codes or additional building requirements. To ensure that also people who cannot afford to live in private housing are provided with appropriate accommodation, spatial planners should also ensure a sufficient supply with public housing.

Building codes

The Building Standards Act (Act No. 201 of 1950) is Japan's main law for the promotion of building codes. It was established in 1950 with the aim to "safeguard the life, health, and property of people by providing minimum standards concerning the site, construction, equipment, and use of buildings" (Hasegawa, 2013, p. 21) and has been continuously revised since then. Although the Building Standards Act generally applies to all buildings in Japan, regional specifics (e.g., seismic activity, snowfall) result in varying requirements for different regions (Hasegawa, 2013, p. 21). The Act sets building codes regarding the building's structural safety (e.g., regarding permanent, imposed and snow loads, wind pressure and seismic force), fire safety and hygienic safety (Hasegawa, 2013). Furthermore, the Building Standards Act includes specifications about building standards that are related to the land-use zones introduced in Chapter 4.6 (Hasegawa, 2013, pp. 22–23). These building standards depend on the land-use zone a building is constructed in and cover, e.g., requirements regarding the FAR and building heights (Bureau of Urban Development, Tokyo Metropolitan Government, 2013, p. 35). A system of building permissions and interim and final inspections throughout the construction work ensures the observance of the building code. In case that the requirements of the building code are not met, the Designated Administrative Agency can put a halt on the construction work (Hasegawa, 2013, p. 22). For more specific information of the content of the Building Standards Act, the reader is referred to Hasegawa (2013).

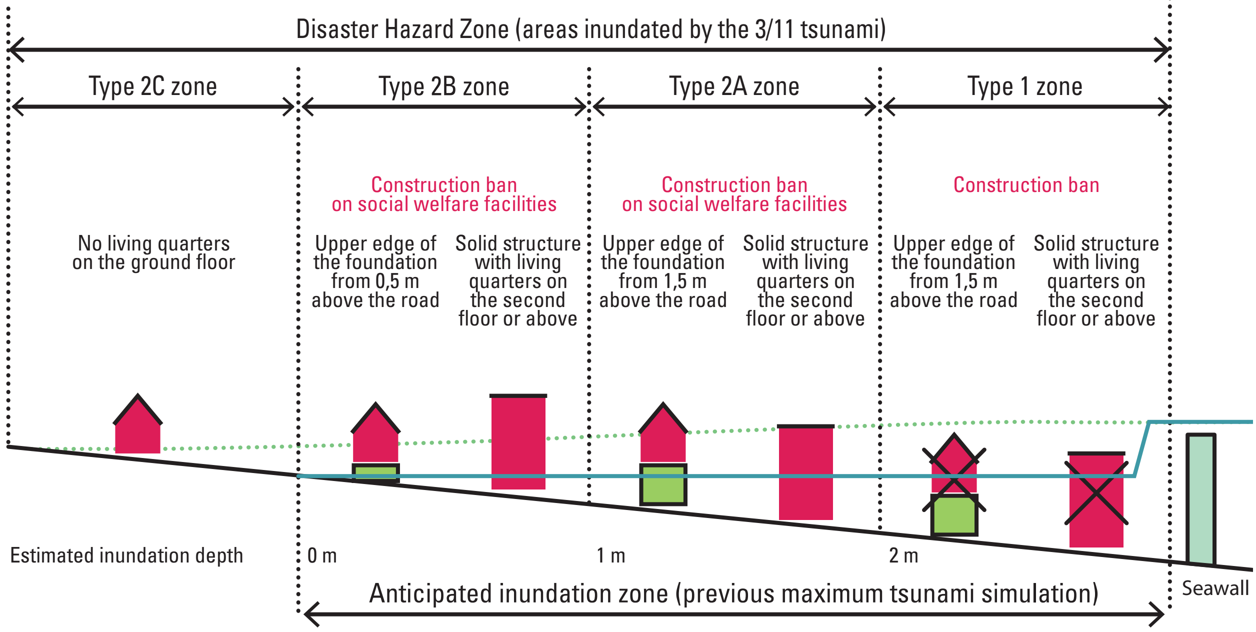


Illustration 32 | Building requirements in the hazardous area of Ofunato City | Own illustration based on Ubaura, 2016, p. 60

Additional building requirements

Besides these general requirements for the construction of buildings in Japan, it is also possible to demand additional building requirements in certain areas to reduce the buildings' vulnerability. After the GEJE and Tsunami, this option was also used in Ofunato City to enable the utilization of as much of the city's scarce flat land as possible (Ubaura, 2016, p. 60). The city administration allowed the construction of residential buildings in hazardous areas with an expected inundation depth of less than 2 m, if specific building standards that depend on the expected inundation depth in this area were met. Buildings that are constructed in type 2A zones, with an inundation depth between 1-2 m, are required to have their foundation raised by 1.5 m from the street level. In type 2B zones, with an inundation depth of less than 1 m, the buildings need to be raised by 0.5 m from the street level (see illustration 32).

Instead of officially requiring adaptations of buildings that are newly constructed, spatial planners can also try to convince the owners of existing buildings to adjust their buildings to increase their safety. This can be achieved through awareness raising campaigns or the establishment of incentives (e.g., for the installation of solar panels to increase the building's independence from the energy supply network).

Provision of public housing

Besides the above mentioned options to increase the safety of private owned houses, spatial planners are also responsible to provide a sufficient amount of safe housing for people who cannot afford privately owned homes. This requirement becomes especially relevant in the aftermath of a disaster, when a significant amount of people lost their homes and requires shelter. Borrowing from Quarantelli (1995), the following three phases of housing recovery can be identified after a disaster: (1) staying in evacuation shelters, (2) living in temporary housing, (3) returning to repaired or new constructed permanent housing. Spatial planners are able to contribute to each of these phases, e.g., by finding safe locations for evacuation shelters and temporary housing sites. Nevertheless, to increase the engineering resilience of built structures, the construction of public housing for citizens who are unable to afford private housing is most relevant.

The right to obtain adequate housing is enshrined in Article 25 of Japan's Constitution (Kobayashi, 2016, p. 19), which states: "All people shall have the right to maintain the minimum standards of wholesome and cultured living" (The Constitution of Japan, 1946, Article 25). To provide municipalities with the financial ability to comply with this goal, the Public Housing Act (Act No. 193 of 1951) was established in 1951 (Kobayashi, 2016, p. 15). Public housing is constructed, bought or rented by municipal or prefectural governments with grants received from the national government (Building Center of Japan, 2016, p. 27). It is provided for low-income renters, whose income lies below a certain threshold and who are unable to find accommodation on the private housing market (Kobayashi, 2016, p. 19). The allocation of housing units is implemented through lottery. Nevertheless, it is possible to favor particularly indigent people, e.g., elderly or single-parent households (Building Center of Japan, 2016, p. 27).

For the housing recovery after the GEJE and Tsunami, public housing plays an important role. As of January 2016, 30,000 new public housing units were planned in Tohuku Region, of which roughly 50% were already completed (Japan Reconstruction Agency, 2016b). In comparison to this, roughly 130,000 housing units are expected to be privately constructed (Japan Reconstruction Agency, 2016b).

4.7.2.4 Hazard mitigation

In contrast to the other risk management options presented in this chapter, which address the vulnerability component of risk, it is also possible to reduce risk by mitigating the hazard. One option for this is the installation of *protective infrastructure* (e.g., seawalls or river embankments). Furthermore, the raising of land and the adaptation of urban structures, which can both be implemented by means of land readjustment projects, are able to reduce risk by mitigating the hazard.

Protective infrastructure

Planning and constructing protective infrastructure usually requires the cooperation of spatial planners with the sectoral departments in charge (e.g., water authorities). One measure taken after the GEJE to increase the future disaster resilience against tsunamis, is the construction of a giant seawall along Tohoku Coast. The height of the seawall was determined based on the principle of Level1-tsunamis (L1-tsunamis) and Level2-tsunamis (L2-tsunamis), which was established by the Central Disaster Management Council (2011): L1-tsunamis "occur more frequently than the […] largest-possible tsunamis and cause major damage despite their relatively lower tsunami heights" (Central Disaster Management Council, 2011, p. 10). Nevertheless, their damage is not as severe as the damage that is caused by L2-tsunamis. L1-tsunamis occur with a frequency of once every few decades to once every hundred years (Dzurdženík et al., 2015, p. 30; Iuchi, 2016, p. 25). It was the intention of the Central Disaster Management Council that the damage from L1-tsunamis should be prevented through the construction of a seawall. For L2-tsunamis, “the frequency of […] occurrence is extremely low” (Central Disaster Management Council, 2011, p. 10), they only happen every couple hundred years or less frequently (Dzurdženík et al., 2015, p. 30). Nevertheless, if they take place, their damage is immense. The GEJE Tsunami falls into this category. The planned seawall does not intend to protect the low-lying land behind it against the extreme height of L2-tsunamis. Instead, the protection from this rare tsunami type relies on evacuation measures (Central Disaster Management Council, 2011, p. 10). This means, that the constructed seawall will be flooded should a L2-tsunami occur and the area behind it will become inundated. In order to develop the spatial plans after the GEJE and Tsunami, this process was simulated with the help of computer software.

Land readjustment and raising program

In some cases, the construction of a seawall is not sufficient to completely prevent the inundation of the area behind it. In cases where an increase of the seawall’s height is not desirable, there is another option to solve this problem. Many cities in Tohoku Region decided to implement the *land readjustment and raising program* to mitigate the hazard. According to the main intention of the Land Readjustment Act, the program is used to reorganize the existing urban structures. Specific for this program is that the land is raised before the distribution of the housing lots occurs (Iuchi et al., 2015, p. 35). The height of this artificial land raise depends on the hazard simulations. In many places, the soil to implement the land raising projects is obtained from nearby mountains that are cut to establish relocation sites. In Rikuzentakata City, an enormous conveyor system was established to transport the needed soil from the nearby mountain into the central area of the city. To transport the soil across Kesen River, the Bridge of Hope was installed (see illustration 33). The use of conveyors instead of trucks enabled a tenfold acceleration of the transportation of the soil (M. Ubaura, personal communication, 21 February 2015). This illustrates the immense amount of soil needed to implement the planned land readjustment and raising program.

Illustration 33 | The Bridge of Hope in Rikuzentakata City | Photo by author, February 2015

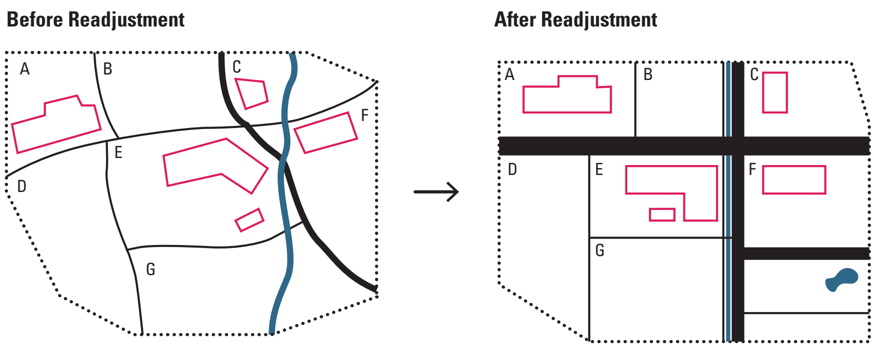


Illustration 34 | The procedure of land readjustment projects | Own illustration adapted from Hohn 2000, p. 229

Adaptation of urban structure through land readjustment projects

The implementation of land readjustment projects is also a useful option for the adaptation of urban structure (e.g., to widen roads or establish parks). In this context, the land readjustment projects can be used in accordance with their original intention to reorganize and improve existing urban infrastructure (Hohn, 2000, p. 221).

The current Land Readjustment Act (Act No. 119 of 1954) (*tochi-kukaku-seiri-ho*) was issued in 1954. It aims for an organized development of public infrastructure and the quality improvement of newly cut building lots (Hohn, 2000, p. 227). Land readjustment projects can either be conducted privately or publicly. Private readjustment projects require all land owners or tenants to agree to the project. If the private project is organized through the establishment of a land readjustment cooperative (*tochi-kukaku-sei-ri-kumiai*), its implementation still requires the agreement of three-quarter of all land owners or tenants. Furthermore, does the establishment of the cooperative require the association of at least seven parties. Public land readjustment projects, on the contrary, do not require the agreement of a certain amount of land owners or tenants to be initiated (Hohn, 2000, pp. 222–223).

Land readjustment projects after disasters are typically initiated by public authorities. The procedure of public land readjustment comprises the following steps (see illustration 34; Hohn, 2000, pp. 228–232):

- The land owners contribute their plots to the land readjustment pool.
- The land is reduced by the amount of land that is required for the development of the public infrastructure (e.g., the widening of roads or the development of parks) and an additional amount of land, which is summarized in the reserve area pool. This land is sold after the completion of the land readjustment project to balance the expenses for the entire project.
- Public land readjustment projects are accompanied by readjustment councils which consist of 10 to 50 members (e.g., land owners, land tenants or experts).
- Before the construction work starts, a Replotting Design Proposal is developed. This document gives an overview of the intended redistribution of the lots.

- After the construction work is finished, each land owner receives a lot that has a smaller size, but – in most cases – a higher value than the old one. The value increase results in the provision of an improved infrastructure. It is intended to provide each owner with a lot that is equivalent to the former one in relation to its location, area, potential land-uses and surrounding conditions.
- To conclude the land readjustment project, the new lots are registered and the land owners are either reimbursed, if the value of their property decreased, or have to pay a countervailing charge, if the value of the land increased. This step is necessary because the values of the new lots usually vary from the values of the former lots.

While the calculation of the land which is required for the construction of adequate infrastructure usually is easy to accomplish, the amount of land that is required as reserve area (*horyuchi*) to break even at the end of the project, is complicated. To reduce the financial risk for the project and allow expenses before the reserve area is sold at the end of the project, the public sector is able to grant interest-free loans that correspond with the predicted value of the reserve area. Furthermore, the construction of public infrastructure is subsidized by the national or local government (e.g., the national government subsidizes the construction of roads that are wider than 12 m with three-quarter of the expenses) (Hohn, 2000, pp. 228–230).

4.7.3 Spatial planning options for risk communication

Throughout the entire risk governance process, spatial planners should ensure a comprehensive participation process for all relevant stakeholders (incl. the public). This includes the continuous information about ongoing processes and upcoming decisions and the integration into the decision-making process. Nevertheless, the exact organization of the participation process should be determined situation-related.

Citizen Participation in Japan

In Japan, the public participation process for spatial planning was established with the 1992 revision of the Land-Use Planning Act. The Land-Use Planning Act requires a two-stage participation process for the development of master and district plans: The first step includes the information of the public about the intended goals of the plan in form of public hearings or another form of information event. The second participation step includes the public display of the plan's draft version and the opportunity for the public to comment on it (Mägdefrau & Sprague, 2016). Based on the forms of participation introduced in Chapter 2.4, the legal requirements for public participation in Japan include public information about the intention of the plan and consultation regarding the content of the plan. After the GEJE and Tsunami, citizen participation conformed to these legal requirements, but mostly did not go beyond them. Reasons for this might have been the restricted time frame and damaged administrative structures after the disaster (Mägdefrau & Sprague, 2016). Nevertheless, there are occasional examples for public participation processes that went beyond the legal requirements (see Chapter 8).

In Japan, citizen participation is linked to the *machizukuri*, which can either be translated with "community development", "neighborhood building" or "town making" (Sorensen et al., 2009, p. 33). *Machizukuri* emerged in the 1970s as a counter-movement to the traditional highly centralized and technocratic spatial planning approach (*toshikeikaku*). Instead of focusing on economic growth, the *machizukuri* approach intended to improve the environment and living quality of people in their neighborhood (Sorensen et al., 2009, p. 35). Over the years, *machizukuri* developed into an integrative and participative bottom-up approach on the community level (Hohn, 2000, p. 100; Kadomatsu, 2007, p. 6; Sorensen et al., 2009, p. 35). *Machizukuri* can be established by local governments through the enactment of ordinances. These ordinances "are legally binding insofar they do not run counter to the statutory law" (Kadomatsu, 2007, p. 6).

Current *machizukuri* movements usually have the following characteristics in common: First, they operate on the small scale level of single neighborhoods. Second, their main intention is to establish or manage common spaces (e.g., local parks or indoor meeting places). Third, they highlight the importance of community participation for the decision-making process and therefore foster comprehensive communication processes on the community level (Sorensen et al., 2009, p. 40). The last aspect highlights the *machizukuri*'s relevance for citizen participation in Japan. Nevertheless, it should be considered that even though *machizukuri* are officially established by the local governments, they are not integrated into the legal spatial planning system. Accordingly, *machizukuri* are mostly run by community members on a voluntary basis. In order to have their concerns and needs integrated into official plans, *machizukuri* have to rely on their ability to convince local governments to conform to them (Sorensen et al., 2009, p. 47). Local governments are, however, generally able to collaborate with *machizukuri* on the participation level of active involvement or shared decision-making in order to produce legally binding documents that include the requirements of the local population (Sorensen et al., 2009, p. 47).

4.8 SPATIAL PLANNING FOR RECONSTRUCTION AFTER THE GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI

The Reconstruction Process of Tohoku Region is guided by the B*asic Act on Reconstruction from the Great East Japan Earthquake* (Act No. 76, 2011) (hereafter, Basic Act on Reconstruction), which was enacted by the Diet in June 2011. The Act "set the policy for reconstruction, enabled the government to issue reconstruction bonds and establish special zones for reconstruction" (The Law Library of Congress, 2013, p. 37). Furthermore, the Act prepared the establishment of the Reconstruction Headquarter Response Office and the Reconstruction Agency. On 29 July 2011, the Reconstruction Headquarter Response Office published the *Basic Guidelines for Reconstruction in response to the Great East Japan Earthquake* (hereafter, *Basic Guidelines for Reconstruction*). The guidelines base on the *Basic Act on Reconstruction* and set the overall vision for the reconstruction process, which were then specified by setting specific policies and measures for implementation (The Law Library of Congress, 2013, p. 37).

According to the Basic Act on Reconstruction and the Basic Guidelines for Reconstruction, the main goal of the reconstruction process is to not only rebuild destroyed urban structures but use the reconstruction process as a chance to improve and revitalize Japan. In this context, the reconstruction process should also be used to address existing challenges Japan has to face: "Innovative measures shall be implemented to contribute to the resolution of challenges that Japan is facing, such as declining birthrate and aging population […], global warming and other issues" (Basic Act on Reconstruction in response to the Great East Japan Earthquake, 2011).

Reconstruction measures should correspond to the following three objectives (Basic Act on Reconstruction in response to the Great East Japan Earthquake, 2011):

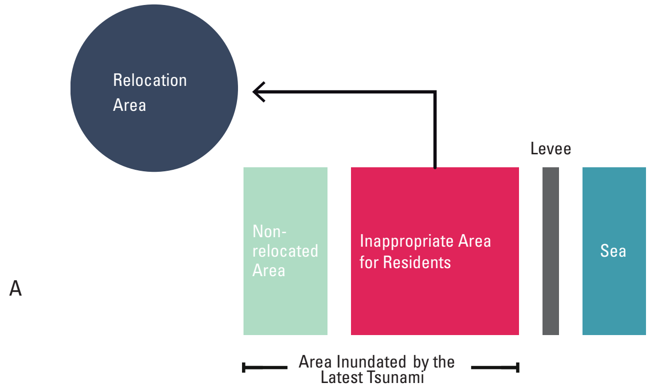
1. Creating safe communities
2. Revitalizing the local economy and create employment opportunities
3. Strengthening community cohesion

In accordance with the Basic Guidelines for Reconstruction, the main responsibility for the reconstruction process after the GEJE and Tsunami, rests with the municipalities. This is the reason, why the applied approaches vary from place to place (Ubaura, 2016, p. 57). Ubaura (2016) distinguishes between two basic principles that frame the local reconstruction processes after the GEJE and Tsunami. The first approach intends to create safe communities in order to prevent future destruction through similar events to the GEJE. The second approach is related to the structural problems that many of the affected villages, towns and cities already had to face before the disaster: the decline and aging of population and tight financial budgets. These problems intensified even more after the GEJE. In response to these challenges, communities should be reconstructed based on the compact city principle in order to reduce the maintenance costs for utility and social infrastructure and enable people to run their errands by foot (Ubaura, 2016, pp. 57–58). Although the selection of both of these principles is reasonable, there are problems in implementation. Focusing on the future safety of communities, the intention to build compact cities often takes a backseat. One example for this is the relocation of residential land-uses from low-lying areas onto hills, while industrial and commercial land-uses are permitted to remain in these areas (see Chapter 4.7). In some places, this resulted in the separation of residential land-uses from commercial and recreational land-uses, which cannot be considered to correspond with the aim to shorten the distances within the city (Iuchi, 2016, p. 38).

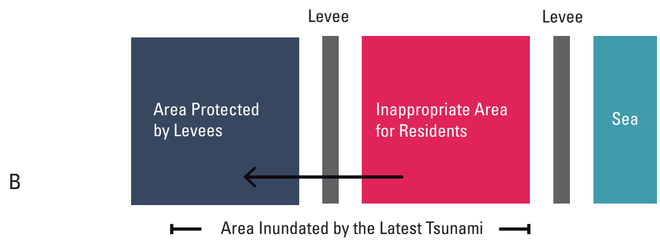
Based on the simulated inundation height (see Chapter 4.7), the most suitable reconstruction pattern for an area was selected. In most municipalities an inundation height of more than 2 m resulted in the area's designation as hazardous. Hazardous areas are restricted from future urban development (Ubaura, 2016, p. 59). In this case, reconstruction usually involved relocation, land raise or the combination of the two options. The reason for the 2-meter threshold lies in the disproportionately higher degree of destruction that Japanese traditional wooden houses suffer, when they are flooded with an inundation depth of more than 2 m (Ubaura, 2016, p. 59). For areas with a lower simulated inundation depth, onsite aggregation or on-site reconstruction were available reconstruction options.

All in all, the Ministry of Land, Infrastructure, Transport and Tourism provides for five reconstruction patterns to deal with the low-lying area that was affected by the GEJE tsunami in order to build safe communities (see illustration 35 A-E below; Ministry of Land, Infrastructure, Transport and Tourism, 2012; Ubaura, 2015):

A. *Relocation:* In case that an area is designated as hazardous, it is restricted from future residential development. This means that the former households inhabiting this area have to be relocated to safer areas, usually inland or on a hill.

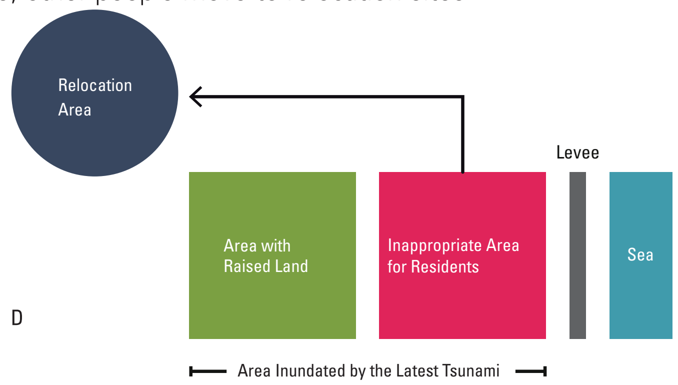


B. *On-site aggregation:* If the construction of a first and secondary levee ensures the future safety of the area behind the secondary levee, the aggregation in this area is the preferred type of reconstruction. This option is especially reasonable if a community's demographic development resulted in vacancies.



C. *Land raising:* In some places, instead of relocating the affected citizens to other places, part of the affected land is raised and people are moved to this artificially created higher land. The height of the land raise depends on the expected inundation height of L2-tsunamis.

D. *Relocation and land raising:* In some cases, the relocation and land raising approaches are combined. This means, some people stay in their former location, which is converted to safe land by the means of land raise, other people move to relocation sites.



E. *On-site reconstruction with defense facilities:* If the construction of protective measures ensures sufficient safety, the citizens are required to rebuild their houses on-site. Usually, an area is considered to be safe if the inundation depth in case of a L2-tsunami is less than 2 m. Nevertheless, on-site reconstruction does not always involve the reconstruction of houses on the exact same spot. In many cases, the reconstruction process is used to improve the community's living environment, e.g., by widening roads or adding parks. For this purpose, the land is restructured by the means of land readjustment projects (see Chapter 4.7; Ubaura, 2016, p. 60). On-site reconstruction can lead to problems because even though the government considers an area as safe, the perception of the local population can be different. This can result in the citizens' desire to relocate instead of returning to their former location. Nevertheless, because there are no incentives for the relocation from "safe areas", these citizens are required to stay if they cannot afford moving away on their own.

Illustration 35 | A-E: Reconstruction patterns after the GEJE and Tsunami | Ahlers et al., 2015, p. 60 based on Ministry of Land Infrastructure, Transport and Tourism, 2012, p. 4-3

The application of these reconstruction patterns in reality is illustrated in context of the two case study sites, Miyako City and Ishinomaki City, in Chapter 8 and 9. The relocation in Miyako City's Taro District, for example, follows Option D: Relocation and land raising: Some citizens rebuild their houses on raised land in their former location, while most people move onto nearby Otobe Hill.

4.9 INTERIM CONCLUSION

Japan has a long history with disasters, which is based on the country's geographic location. This history results in a well-developed disaster risk management framework, which was introduced in this chapter.

Accordingly, Japan's spatial planning system offers various options to address disaster risks. These options can be assigned to the risk governance phases risk assessment, risk management and risk communication: To *assess the risk*, spatial planners can prepare hazard and risk maps or use EIAs to determine the influence that a planned development might have on the environment or other goods worth protecting. *Risk management* options include the minimization of exposure of urban areas. In Japan, this can be achieved through land-use control based on Article 7 of the City Planning Act or Article 39 of the Building Standards Act. In case that this control affects existing residential areas, group relocation programs are a commonly used option to develop newly designated relocation sites. After the GEJE and Tsunami the development of new settlements was also implemented through land readjustment projects. Furthermore, differentiated land-use decisions can help to restrict specific land-uses in certain areas (e.g., restrict residential land-uses, but admit industrial land-uses). Japan's Building Standards Act enables the enforcement of strict building codes when new buildings are constructed. In this way it is possible to increase the building's engineering resilience. One final risk management option is the mitigation of the hazard, e.g., through the construction of protective infrastructure. In the context of spatial planning, *risk communication* includes the involvement of citizens in all important decisions. In Japan, this means the continuous information and consultation of all relevant stakeholder, including the public.

It must be kept in mind, that the complexity of the reconstruction process after a disaster makes it complicated for spatial planners to decide which of these options would result in the best solution. In some cases, planners are compelled to select one out of two options, which are equally desirable but incompatible (e.g., safety versus compactness, deliberation versus time). In these cases, all relevant pros and cons need to be balanced to come to the best conclusion.

5. OPERATIONALIZATION OF RESILIENCE

To determine how spatial planning can build urban resilience, it is important to specify how resilience can be operationalized. Over the past years, many frameworks to measure resilience have been developed.

To decide which resilience measurement framework should be used for this research, Schipper and Langstons working paper "A comparative overview of resilience measurement framework" (2015) served as a basis. All of the 16 considered resilience measurement frameworks in the paper were considered for their usefulness for this research. Some of the resilience measurement frameworks only address certain types of resilience: The ACCCRN framework (Tyler et al., 2014), the AIACC framework (Osman Elasha, Elhassan, Ahmed, & Zakieldin, 2005), the BRACED framework (DFID, 2014) and the TAMD framework (International Institute for Environment and Development, 2014) focus on climate resilience, while the Constas and Barrett Resilience Measurement for Food Security (Constas & Barrett, 2013), the framework of the Feinstein International Center (Vaitla, Tesfay, Rounseville, & Maxwell, 2012), the framework of the International Institute for Sustainable Development (Tyler et al., 2013) and the SHARP framework (Choptiany, Graub, Phillips, Colozza, & Dixon, 2015) focus on agricultural and/ or food aspects. The ARCAB framework (ARCAB, 2012), the CoBRA framework (UNDP, 2013), the Characteristics of a Disaster Resilient Community (Twigg, 2009) and the USAID framework for community resilience (USAID, 2013) specifically address resilience on the community level. The USAID coastal resilience framework (U.S. Indian Ocean Tsunami Warning System Program, 2007) emphasizes coastal resilience and the framework of Mayunga (Mayunga, 2007) has a capital-based approach.

Because it was intended to use a holistic resilience approach for this research, resilience measurement frameworks with a focus on the specific aspects mentioned above were excluded from further consideration. The two remaining frameworks were the City Resilience Index and the UNISDR Disaster Resilience Scorecard for Cities:

- The City Resilience Index (da Silva, 2014) was developed by Arup Group Limited with the support of the Rockefeller Foundation to help cities assess their strengths and weaknesses regarding four dimensions of resilience (i.e., health and well-being, economy and society, infrastructure and environment, leadership and strategy). Each of these dimensions are further divided into three goals and each goal includes three to five indicators. The document defines city resilience as "the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter" (da Silva, 2014, p. 3).
- The UNISDR Disaster Resilience Scorecard for Cities (UNISDR, 2015d) is part of the Making Cities Resilient campaign and its ten essentials. It was compiled by the companies IBM and AECOM, which are both members of UNISDR's Private Sector Advisory Group, and understands disaster resilience as "the ability of a city to understand the disaster risks it may face; to mitigate those risks; and to respond to disasters that

may occur, in such a way as to minimize loss of or damage to life, livelihoods, property, infrastructure, economic activity and the environment" (UNISDR, 2015d, p. 2).

Both of these frameworks offer a variety of indicators to assess urban resilience and could have been used in the context of this research. Eventually, the Disaster Resilience Scorecard for Cities (hereafter, Disaster Resilience Scorecard) was selected because it was published by the UNISDR and builds on the content of the Sendai Framework for Disaster Risk Reduction, a document which was adopted by all UN member states, including Japan. Accordingly, the content of the Disaster Resilience Scorecard can be considered to have a certain importance for the UN member states.

The Disaster Resilience Scorecard was first published in 2014 to supply cities around the world with a toolkit to assess their level of resilience and "to guide cities towards optimal disaster resilience, and to challenge complacency" (UNISDR, 2014, p. 3). In 2015, the document was revised and updated to incorporate the content of the Sendai Framework for Disaster Risk Reduction. Currently, the document consists of the following 10 essentials:

01	**Organize for disaster resilience**
02	**Identify, understand and use current future risk scenarios**
03	**Strengthen financial capacity for resilience**
04	**Pursue resilient urban development and design**
05	**Safeguard natural buffers to enhance the protective functions offered by natural ecosystems**
06	**Strengthen institutional capacity for resilience**
07	**Understand and strengthen societal capacity for resilience**
08	**Increase infrastructure resilience**
09	**Ensure effective disaster response**
10	**Expedite recovery and build back better**

Table 3 | Essentials from the Disaster Resilience Scorecard for Cities | Own illustration based on UNISDR, 2015d, p. 3

Essentials 1-3 basically cover political-institutional resilience and are focused on governmental and financial issues. Essentials 4-8 follow an integrative approach and are most important from a spatial planner's point of view. For instance, these essentials acknowledge the relevance of land-use planning, building codes and the provision of disaster resilient infrastructure to build disaster resilience. Finally, essentials 9-10 deal with disaster response and the recovery process after a disaster (UNISDR, 2015d, p. 2). Each essential is composed of various subjects; subjects are further specified with different resilience items. To "measure" these resilience items, the scorecard provides specific indicators, e.g., the percentage of buildings where building codes were implemented as an indicator for the application of building codes. Even though the Disaster Resilience Scorecard intends the measurement of resilience based on numeric values, this possibility is not used for this research. The reason for this lies in the fact that measuring the results in numbers would require a naturalist world-view that considers disaster risk and resilience to be quantifiable and a quantitative research approach. This research supposes that not all aspects are quantifiable and the understanding of reality bases on people's perceptions. Accordingly, a qualitative research approach was selected, which also requires a qualitative assessment of the resilience items introduced in this chapter.

This chapter gives an overview of each of the ten resilience essentials, the resilience subjects and the resilience items that constitute it. To enable the reader to find each resilience item in the Disaster Resilience Scorecard, even though some of their names have been slightly adjusted to suit the research framework of this research better, each item is provided with its own code based on its number in the Disaster Resilience Scorecard (e.g., UN-4.3.2 refers to item 4.3.2 Sustainable building design standards).

In accordance with the spheres of resilience introduced in Chapter 3.2, each essential is linked to the type of resilience that it can most effectively address (engineering, political-institutional, socio-economic and environmental). To connect the various resilience items with the reconstruction process after the GEJE and Tsunami, the Basic Guidelines for Reconstruction (2011) were analyzed to provide information about this topic. Each subchapter concludes with an evaluation of the influence that spatial planners have in the context of this topic. If spatial planners can be considered to be the main actor to address a topic, their influence on this topic is rated as high (e.g., land-use changes). Certain subjects require the consideration through spatial planners, but are also important for other actors. These subjects usually require a close collaboration of all actors involved. In these cases, spatial planners are not the main actor, but can still be considered to be important. For these topics, the influence of spatial planners was rated as medium. If spatial planners are one of various actors to address a certain topic, the planners influence on this topic was regarded as low. Finally, there are topics that spatial planners can either only influence insignificantly or not at all. Examples for this are the determination of the city's budget for resilience building or the development of business continuity plans. For these cases, the influence of spatial planning was rated with none.

5.1 ESSENTIAL 1: ORGANIZE FOR DISASTER RESILIENCE

Essential 1 [UN-1] aims at the underlying governance structure that enables the building of resilience. Organizing and coordinating all relevant processes in advance of a disaster is a crucial part for the stakeholders' understanding or their role and duties before, during and after a disaster. Therefore, a lead entity (e.g., the Mayor) should be established in the city's administration, which helps to develop a collaborative strategy that is available to the various emergency entities in case of a disaster. It is important that all relevant topics – i.e., environmental, economic, infrastructure, health, disaster, education, social/cultural – are considered in a holistic way that acknowledges their relevance for disaster resilience. This means that the administrative departments of a city must not only discuss these topics with each other, but also with relevant businesses, NGOs, academia and citizens to incorporate the stakeholders' opinions and determine their skills and physical resources. Furthermore, the lead entity should ensure that the city also cooperates with neighboring municipalities and national and international partners that might be able to assist with their knowledge (UNISDR, 2015d). Since the items and indicators of essential 1 are mainly concerned with the coordination and organization of political and administrative processes, they can be considered as relevant to build political-institutional resilience.

Organization & Coordination	Co-ordination of all relevant pre-event planning/ preparation activities, all event-response activities and all post-event activities for the city's area, with clarity of roles and accountability across all relevant organizations [UN-1.1.1, UN-1.1.2, UN-1.1.5]
	Participation and coordination of all relevant organizations in the structure(s) defined [UN-1.1.3]
	Co-option of physical contributions by both public and private sectors [UN-1.1.4]
Integration of disaster resilience with other initiatives	Extent to which any proposal in government is also evaluated for disaster resilience benefits or impairments [UN-1.2.1]
Capture, publication and sharing of data	Extent to which data on the city's resilience position is shared with other organizations involved with the city's resilience, community organizations and the public [UN-1.3.1, UN-1.3.2]

Table 4 | Subjects and items from essential 1 | Own illustration based on UNISDR, 2015d

Organization & Coordination

To organize and coordinate pre-disaster planning, response activities and post-disaster efforts, the roles of all actors in these fields should be clarified in advance. In this way it can be ensured that each organization is aware of its role in case of an emergency (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 17). In addition to this, necessary laws and policies should be put into place. It is important to decide on a generally accepted authority to coordinate these processes and to establish a strong entity who takes over the leadership in case of a disaster [UN-1.1.1, UN-1.1.2, UN-1.1.5]. In this context, the Basic Guidelines for Reconstruction aim to analyze the situation after the GEJE to enable the sufficient coordination of the recovery process. To achieve this goal, it is necessary that all relevant governmental entities collaborate and share their information with each other as well as with the affected municipalities (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 13). In particular, the importance of cross-scale incorporation of emergency responses is stressed (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 34–35).

The organization and coordination of disaster risk reduction should include the participation of all relevant stakeholders [UN-1.1.3]. Participation is not only a crucial aspect for pre-disaster planning processes, but also for the reconstruction planning after a disaster. To reach the best results, public and private organizations, including their abilities and knowledge, must be managed as efficiently as possible. In some cases, the establishment of new collaboration forms (e.g., New Public Commons), can enhance these processes (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 14). To optimize the cooperation with different stakeholder and know the local sources that can be obtained in case of a disaster, it is important to determine the physical resources that public and private stakeholders are able and willing to contribute [UN-1.1.4]. These resources can be material, workforce, data, computer equipment or, as mentioned in the Basic Guidelines for Reconstruction, accommodation for reconstruction workers (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 13).

Integration of disaster resilience with other initiatives

It is a crucial aspect of resilience building to continuously consider the relevance of disaster resilience in context with other aspects. Accordingly, each governmental entity should evaluate possible influences of its policies or programs on disaster resilience. This requires that each entity understands and acknowledges the existing correlations that its work has for urban disaster resilience [UN-1.2.1].

Capture, publication and sharing of data

To optimize a city's resilience building, all of the gathered information must be shared with the public and relevant organizations. In order to achieve this goal, policies that enable stakeholders to share their data should be established. This includes the exchange with other cities or initiatives (e.g., climate change or resilience initiatives) [UN-1.3.1, UN-1.3.2]. The Basic Guidelines for Reconstruction intend the international cooperation with neighboring countries, such as China and South Korea, but also the rest of the world. To promote this exchange, Japan hosted the Third UN World Conference on Disaster Risk Reduction in Sendai in March 2015. In addition to this, the exchange with foreign students and researchers is an intended goal of the reconstruction process (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 31).

The influence of spatial planning on essential 1

The role of spatial planning to "Organize for resilience" is to participate in the planning process and interact with the other actors involved. Accordingly, spatial planners are one of many actors to participate in this step. Like any other administrative entity in their area of responsibility, spatial planners should check current land-use planning and building code regulations to identify possible constraints and opportunities to build urban disaster resilience (for the relevance of land-use planning and building codes to create disaster resilience, the reader is referred to Chapter 5.4). The leading role for essential 1 rests with the city administration's lead entity for disaster risk reduction. The lead entity might consider to assign certain responsibilities to the city's spatial planning department because spatial planners usually have a vast knowledge about the spatial relations in the city and are experienced with holistic coordination processes. Nevertheless, spatial planners usually are just one of many actors to address essential 1 and their influence can be considered as low.

5.2 ESSENTIAL 2: IDENTIFY, UNDERSTAND AND USE CURRENT AND FUTURE RISK SCENARIOS

To minimize potential risks (mitigation), prepare for the possible occurrence of a disaster (preparedness) and gain the ability to cope with disasters (response), it is important to identify and understand the nature of risks (risk assessment) (Dzurdženík et al., 2015, p. 11). Accordingly, risk assessment is the main aspect of the Disaster Resilience Scorecard's essential 2 [UN-02]. The essential requests cities to conduct a risk assessment in order to increase their disaster resilience and to update the assessment data frequently. To achieve the best results, the risk assessment should incorporate all relevant stakeholders (see Chapter 2.3) and the results of the assessment should be included into the stakeholders' work. The scorecard suggests to conduct the risk assessment on the basis of at least two scenarios: one for the most probable and one for the worst case (UNISDR, 2015d, p. 13). The risk assessment should include all relevant aspects of resilience. Nevertheless, the implementation of the assessment mostly embraces political and administrative decisions and the assessment results help to enhance political-institutional processes. The items of essential 2 are therefore considered as mainly relevant to build political-institutional resilience.

Risk assessment	Knowledge of hazards (also called perils) that the city faces, and their likelihood [UN-2.1.1]
	Knowledge of exposure and vulnerability [UN-2.1.2]
	Understanding of critical assets and the linkages between these [UN-2.1.3]
	Hazard maps [UN-2.1.4]
Update process	Process ensuring frequent and complete updates of scenarios [UN-2.2.1]

Table 5 | Subjects and items from essential 2 | Own illustration based on UNISDR, 2015d

Risk assessment

Risk assessment includes the determination of the risk components as introduced in Chapter 2.2: hazard [UN-2.1.1] and vulnerability (incl. exposure and, even though not specifically mentioned in the scorecard, physical susceptibility and fragility) [UN-2.1.2]. For the identification of the hazard component, it is important to consider, how it might change over time or through the influence of certain factors (e.g., climate change can influence the occurrence of typhoons). Furthermore, the combination of multiple hazards can increase the extent of a disaster (e.g., the impact of the GEJE and Tsunami was larger than the impact of the earthquake alone would have been). As explained in Chapter 2.2.2, exposure refers to the spatial factor of vulnerability, which can be illustrated in hazard maps for various hazards (e.g., flood hazard maps) [UN-2.1.4]. Vulnerability assessment should also include the consideration of the fragility of different population groups and their assets (of course the capacities of these groups should also be considered). Special attention should be paid to the susceptibility of critical assets, so that the structures can either be adapted or emergency plans can be prepared to minimize cascading failures [UN-2.1.3]. The risk assessment should be based on a comprehensive participation process that incorporates the stakeholders' various perceptions and understandings of risk. Accordingly, the results of risk assessment should be widely distributed and used in future decision-making processes and response and recovery plans (UNISDR, 2015d, p. 13).

To prepare for future disasters, particularly the risk of an earthquake striking Tokyo, the Basic Guidelines for Reconstruction envisage to "[a]ssess the risk of earthquake and tsunami disaster" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 33). This assessment should not only look ahead, but also appraise the response to the GEJE with the intention to improve processes and technologies wherever necessary (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 36). The Basic Guidelines for Reconstruction also acknowledge the importance of hazard maps for risk reduction and require their development (UNISDR, 2015d, p. 10).

Update process

Understandably, risk assessment scenarios are only useful if they are up to date. Accordingly, all relevant data has to be updated frequently [UN-2.2.1]. The Basic Guidelines for Reconstruction consider this importance when they require the revision of the existing Basic Disaster Prevention Plan and the policy of land development on the basis of the experiences from the GEJE in order to improve their effectiveness for future disasters (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 33–36).

The influence of spatial planning on essential 2

As explained in Chapter 2.4.1, spatial planners can make valuable contributions for the assessment of risk. For instance, can they provide their knowledge about vulnerable land-uses and their exposure to certain hazards. For the illustration of these spatial connections, hazard maps are helpful tools. The type of hazard included in these maps can vary from river flooding, storm surges, and tsunamis over volcanic eruptions to earthquakes (Dzurdženík et al., 2015, pp. 15–16). If hazard maps are developed in detail, they can also indicate evacuation routes and how these routes can be disrupted by hazardous events. Hazard maps are developed on the basis of spatial information, which is why spatial planners should be involved in their development. Albeit, the input of other stakeholders (e.g., emergency responders, traffic planners, and the public) for hazard mapping and the remaining risk assessment process is equally important. Hence, spatial planners can be understood as valuable contributors for this essential, even though they are not primarily responsible. Spatial planners' influence for this essential therefore is determined as medium.

5.3 ESSENTIAL 3: STRENGTHEN FINANCIAL CAPACITY FOR RESILIENCE

Essential 3 [UN-03] addresses the importance of financial capacity to build resilience. Without having adequate funding, it is impossible to create a disaster resilient city. The essential states several aspects that have to be considered in this context: First, it is important to understand the necessity to invest in resilient city structures before a disaster occurs. For this purpose, a certain budget must be defined. Building resilience can help to reduce possible negative monetary effects that a disaster can cause, e.g., by relocating businesses from hazardous areas to safe land. Second, the impact that a disaster can cause for a city's economy has to be determined and funding for the recovery process after a disaster has to be allocated. An additional way to enhance a city's resilience is to incentivize citizens and businesses to increase the engineering resilience of existing private buildings. To enable all of the required measures, the government should consider various ways of funding (UNISDR, 2015d, p. 20). For essential 3, the spheres of resilience vary for the different items. The assignment therefore is conducted in the paragraphs below.

Financial plan & budget	Adequacy of financial planning for all actions necessary for disaster resilience [UN-3.1.1]
	Capital funding for long run engineering and other works that address scenarios in essential 2 and essential 8 [UN-3.1.2]
	Operating funding to meet all operating costs of disaster resilience activities [UN-3.1.3]
Contingency funds	Contingency fund for post disaster recovery (may be referred to as a "rainy-day fund") [UN-3.2.1]
Financing of resilience expenditures	Pursuit of all possible methods of financing and funding, as required [UN-3.4.1]
Incentives & financing for businesses, community organizations and citizens	Affordability of, and help with achieving safe housing [UN-3.3.1]
	Domestic and non-domestic insurance coverage [UN-3.3.2, UN-3.3.5]
	Incentives to businesses and non-profit organizations to improve disaster resilience – disaster plans, premises etc. [UN-3.3.3, UN-3.3.4]

Table 6 | Subjects and items from essential 3 | Own illustration based on UNISDR, 2015d

Financial plan & budget, contingency funds and financing of resilience expenditure

It is important that the budget appointed to build disaster resilience is adequate to perform the required actions [UN-3.1.1]. Accordingly, the direct and indirect costs for each action need to be assessed first. This task is usually carried out based the experiences from similar disasters in the past. When assessing the costs, the trade-off between pre-disaster investments that decrease the recovery costs after a disaster should be considered thoroughly. It is useful to assign ring-fenced budgets, e.g., for the development of the risk scenarios in essential 2, to ensure that all relevant measures can be implemented [UN-3.1.2]. To maintain disaster resilience once it is built, operating costs to perform required activities should also be allocated [UN-3.1.3]. To stay able to act after a disaster occurred and advance the recovery process as fast as possible, it is important to have a sufficient budget allocated for this purpose ("rainy-day fund") [UN-3.1.3] (UNISDR, 2015d, p. 20). The measures that are required to create resilience, are expensive and have to be financed in some way. This demands the government to be aware of various established financing options, but also consider new and innovative ways of financing [UN-3.4.1] (UNISDR, 2015, p. 20). Setting up the financial frame increases the political-institutional resilience to act before, during and after a disaster.

The dimension of the GEJE and Tsunami together with the nuclear accident in the Fukushima Daiichi nuclear power plant was so extreme, that it by far exceeded the national reverse fund. In addition to using a total of 67.8 billion JPY from the reverse fund for the fiscal year 2010 (running from 1 April 2010 until 31 March 2011). 5.03 billion JPY from the reserve fund for the fiscal year 2011 were used to address direct emergency needs (The Law Library of Congress, 2013, p. 39). Nevertheless, the reconstruction process required the provision of additional funding. The Basic Guidelines for Reconstruction include basic information about the budget provided by the Japanese government (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 6–7). It was intended that the financial resources "shall basically be borne by the entire current generation" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 6). Indeed, the supplementary budgets that were approved in the fiscal year 2011 were mostly covered through adaptations of the national budget: The first supplementary budget of 4 trillion JPY was financed through the reduction of the national child benefits and maintaining the highway tolling system and the second supplementary budget of 2 trillion JPY was covered by the excess budget from 2010. The 12 trillion JPY for the third supplementary budget had to be enabled by reducing other planned expenses for the fiscal year 2011 and allocating non-tax revenues. Nevertheless, 11.55 trillion JPY had to be financed through the issue of reconstruction bonds (The Law Library of Congress, 2013, pp. 39–40). This example shows that even if an emergency budget is set aside, large scale disasters can quickly exceed the directly available funding. Accordingly, decision-makers should consider additional funding sources in preparation for a disaster.

Incentives & financing for businesses, community organizations and citizens

To improve the position of private homeowners, local businesses and non-profit organizations when a disaster strikes, incentives that promote disaster resilience should be created [UN-3.3.3, UN-3.3.4]. This includes the development of business continuity plans, the creation of redundancy to prevent failure in case of a hazardous event and the improvement of building structures (UNISDR, 2015d, p. 20). Furthermore, constructional measures can decrease the susceptibility of a city's built structure. These measures directly increase the availability of affordable housing after the event because stronger buildings are less likely to break down in case of a disaster [UN-3.3.1]. To improve the financial situation of people, businesses and organizations after a disaster, appropriate domestic and non-domestic insurances that cover lives and/ or common or private assets should be concluded [UN-3.3.2, UN-3.3.5] (UNISDR, 2015d, p. 20). Even though the allocation of funding for the public also addresses socio-economic resilience (e.g., by increasing the number of affordable housing or the continuation of business proceedings after a disaster), the main purpose of this subject is to ensure a possibly smooth continuation of the city's routine business. Therefore, this subject is considered to primarily build political-institutional resilience.

As a post-disaster document, the Basic Guidelines for Reconstruction do not include any incentives to promote the structural resilience of private buildings. Nevertheless, the guidelines emphasize the importance to promote affordable housing for affected people. This is especially important because many people who lost their houses did not have insurance coverage against tsunamis. This means they depend on special measures, such as the modification of mortgage rates, that help them to deal with their persisting housing loan after their house is completely or partially destructed (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 12–13). In addition to this, short-term financial support is needed to ensure an ongoing supply with essential goods such as shelter (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 36–37). The government's assistance can also be required to solve possible legal disputes caused by the disaster, e.g., with insurance companies (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 27).

The influence of spatial planning on essential 3

As the title suggests, essential 3 basically deals with the financial background to build urban disaster resilience. Even though the outcomes from these efforts also influence areas concerning the responsibility of spatial planners (e.g., the provision of affordable housing), the planners influence on financing decisions can be considered to be low at the most. Spatial planners are able to submit their funding needs, but the final decisions are made by the government.

5.4 ESSENTIAL 4: PURSUE RESILIENT URBAN DEVELOPMENT

Essential 4 [UN-04] deals with the city's built structure and therefore is focused on strengthening engineering resilience. Building on risk maps and scenarios (see essential 2), this essential intends to improve disaster resilience through land-use planning, the application of building codes and innovative design solutions on the small and larger scale. These spatial planning options are highly relevant to build disaster resilience because they are able to address the vulnerability and hazard component of risk. Planning agricultural, economic and residential land-uses can reduce these land-uses' exposure to hazards. The existence and application of contemporary building codes can lower the susceptibility of the city's built structure. In addition to this, the implementation of new designing solutions, such as sustainable urban design solutions and building designs can mitigate certain hazards (e.g., greenways or green architecture can mitigate heatwaves). Of course these processes all require the participation of all relevant stakeholders, including the public. To take full effect, all regulations that are used should continuously be revised and updated accordingly (UNISDR, 2015d, p. 27). Points that directly address the physical infrastructure (e.g., transportation or electricity network) are covered by essential 8.

Land-use effectiveness	Vulnerable land at risk (incl. agriculture, economic activity and residential) [UN-4.1.1, UN-4.1.2, UN-4.1.3]
Building codes	Existence, application and update of building codes designed to address risks identified in risk assessment [UN-4.2.1, UN-4.2.2, UN-4.2.3]
New development	Urban design solutions that increase resilience [UN-4.3.1]
	Sustainable building design standards [UN-4.3.2]

Table 7 | Subjects and items from essential 4 | Own illustration based on UNISDR, 2015d

Land-use effectiveness

As explained in Chapter 2.2, the exposure of vulnerable land-uses to hazards creates risk. Preventing the new settlement of vulnerable land-uses in hazardous areas or relocating existing vulnerable land-uses from hazardous to safe areas, can increase a city's resilience and simultaneously reduce disaster risk. Hazard or risk maps can help spatial planners to determine areas at risk and the need for action. If the relocation of land-uses in a certain area is considered to be necessary, hazard maps can also be used to find suitable relocation sites. To ensure the compliance with land-use decisions, it is important that land-use plans have a legally binding effect (UNISDR, 2015d). In Japan, the reduction of vulnerable land-uses at risk can be achieved through the application of Article 7 of the City Planning Act or Article 39 of the Building Standards Act or by designating specific land-uses to certain areas (see Chapter 4.7).

The Resilience Scorecard specifically mentions the following types of vulnerable land-uses: agricultural land-uses [UN-4.1.1], economic activity [UN-4.1.2] and residential land-use [UN-4.1.3].

Keeping agricultural land-uses out of hazardous areas, is important to ensure an ongoing supply with food, if a disaster occurs. In Tohoku Region, the inundation of farming land through the tsunami, resulted in salty soil, which had to be removed before agriculture could return to its normal business (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 22). The relocation of agricultural land to safe areas, could solve this problem for the future. Nevertheless, when different land-uses (e.g., agricultural and residential) compete with each other, spatial planners must consider which land-use should take priority for the relocation to safer land. This decision can vary from country to country and from case to case. In Japan, the recovery process after the GEJE is used to revise the existing land-uses. This includes the "conversion from residential to agricultural zones" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 12) and the "accumulation of farmland" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 23) to decrease cultivation costs. This means, that the relocation of residential areas to safe land usually takes the highest priority for the reconstruction process in Tohoku Region.

The destruction of important industries or other businesses through a disaster can not only result in short-termed economic damages, but deeply cut into a city's or region's economic potential. Especially industrial establishments can cause mayor environmental problems, when they are hit by a hazardous event, and massively harm people's health. One example for this is the accident in the Fukushima Daiichi nuclear power plant caused by the GEJE and Tsunami. Therefore, spatial planners should consider an industry's exposure and physical susceptibility to certain hazards when zoning land-uses. Generally speaking, the smaller a city's amount of economic activity at risk, the stronger is its resilience [UN-4.1.2] (UNISDR, 2015d). Of course, trade-off effects between economic and other vulnerable land-uses also have to be considered in this context. In Tohoku Region, the economy already had its problems before the GEJE and Tsunami. Accordingly, the revitalization of the local economy is one mayor interest in the Basic Guidelines for Reconstruction. Nevertheless, the measures that the guidelines state in this context focus on revitalizing the economy rather than increasing the industry's engineering resilience through the relocation to safer land. The guidelines do not state anything regarding the future land-use planning for economic activity.

Residential land-uses can be considered to be especially vulnerable because citizens spend a significant amount of their time in these areas, many hours of this time asleep . While people are able to evacuate on time when they are awake during the day, they are in greater danger if a hazard occurs during the night. Accordingly, the relocation of residential land-uses to safe land is an important aspect to build resilience. The Disaster Resilience Scorecard quantifies this aspect with the potential population displacement [UN-4.1.3], which means the amount of people that live in areas that are exposed to hazards. Since many residential buildings are destroyed after a disaster, the reconstruction process enables spatial planners to reconsider a city's preexisting land-uses and relocate residents to safer ground. The Basic Guidelines for Reconstruction also take this opportunity into account. They request the development of "urban areas and mass relocation [to advance the] recovery of central functions of disaster-afflicted cities" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 10–11). To forward the relocation process, municipal governments should consider to buy up hazardous land from private owners (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 11). Transformations from one land-use to another, should ensure the ongoing utilization of hazardous land (e.g., through the conversion from residential land-uses to farmland) (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 12).

Building codes

To decrease the susceptibility of buildings to hazardous events, the existence and application of contemporary building codes is a useful measure. In this way, specific building standards are assured and the buildings' engineering resilience is increased. Due to the frequent occurrence of earthquakes in Japan, the Japanese Building Standards Act is strictly applied. The Act specifies standards for the structural, fire and hygienic safety of buildings (incl. the necessity to withstand seismic forces) (see Chapter 4.7). Nevertheless, the large scale destruction from the GEJE Tsunami revealed that the existing buildings were not constructed to withstand the destructive force of a tsunami. The importance of effective building codes for engineering resilience can be observed when disasters occur in counties with poorly constructed buildings, which often results in the destruction of a significant amount of houses and the loss of many lives. One example for this is the Gorkha Earthquake, which occurred in Nepal in April 2015 and severely damages 800,000 buildings (Sharma, Deng, & Cruz Noguez, 2016). Accordingly, the Disaster Resilience Scorecard requires resilient cities to have a building code established that appropriately addresses disaster risks. This code should constantly be implemented and frequently updated to the current standard [UN-4.2.1, UN-4.2.2, UN-4.2.3].

The Basic Guidelines for Reconstruction also stress the importance of building codes to build resilience. The guidelines specifically demand the promotion of earthquake-resistant buildings. This applies to residential buildings (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 34) as well as to medical and educational institutions or technical infrastructure (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 35–36). Furthermore, the future tsunami risks should be considered for the construction of public housing by restricting wooden buildings to zones that are not exposed to tsunamis and including evacuation options for buildings that are constructed in low-lying areas (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 13).

New development

In addition to improving the city's layout (through land-use planning) and built structure (through building codes), a city's resilience can also be improved through the application of new urban design solutions [UN-4.3.1] and sustainable building design standards [UN-4.3.2]. These aspects have especially gained popularity over the recent years. Urban design solutions are linked with the aspiration to create sustainable cities and encourage the development of urban green spaces, water retention areas or greenways. These measures can improve the profit from ecosystem services, e.g., by cooling the city or enhancing the percolation of heavy rainfall, and thereby contribute to hazard mitigation. In addition to this, urban design solutions can also decrease the city's dependency on traditional technical infrastructure (e.g., sewage systems). The sustainability approach can also be applied on the smaller scale of single buildings, e.g., by applying green building standards such as BREEAM, LEED, or Greenstar, that seek to decrease a buildings energy demand or enable it to stay comparably cool during heat waves (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 27).

The application of sustainable building concepts is also a concern of the Basic Guidelines for Reconstruction. For instance, the reconstruction process should be carried out based on the compact city concept and take into account new options for the use of renewable energy and the improvement of people's relationship to the environment (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 9). One option to build resilience, is the development of "smart communities" or "smart villages" to improve the region's energy sufficiency, e.g., by introducing solar or wind energy (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 28–29). In addition to this, the creation of "eco-towns" should restore the "linkages between the ecosystems of forest, [...] countryside [...] and sea" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 29).

The influence of spatial planning on essential 4

Spatial planners can be considered as the key player to achieve a resilient urban development. They are able to prepare land-use plans under consideration of disaster risks and designate hazardous areas in order to transfer the content of hazard maps into legally binding documents. Furthermore, they are responsible for land-use zoning, which influences the building code requirements. Like any work spatial planners have to execute, the planning of resilient city structures also requires the collaboration with various stakeholder, including sectoral planning departments. Nevertheless, the influence of spatial planners on essential 4 is high.

5.5 ESSENTIAL 5: SAFEGUARD NATURAL BUFFERS TO ENHANCE THE PROTECTIVE FUNCTIONS OFFERED BY NATURAL ECOSYSTEMS

As introduced in Chapter 3.2, the proper functionality of the ecosystem is an important aspect of environmental resilience. In the past, this connection was often neglected and people assumed that engineering solutions could overcome any dependencies from the environment. Recent times, in contrast, are characterized by a change of thinking away from the sole dependency on technical solution to a more sustainable understanding that incorporates people's relationship with nature. This relationship is especially evident in the context of ecosystem services [UN-05]. Ecosystem services are functions that are provided by nature and used by people, e.g., the purification of air and water or the provision of food and energy resources. If nature is out of balance, the provision of these services can become restricted which can result in negative effects for the people who rely on them (Millennium Ecosystem Assessment).

Ecosystem services	Awareness of the role that ecosystem services may play in the city's disaster resilience [UN-5.1.1]
	Ecosystem health [UN-5.1.2]
	Impact of land-use and other policies on ecosystem services [UN-5.1.3]

Table 8 | Subjects and items from essential 5 | Own illustration based on UNISDR, 2015d

Ecosystem services

To keep ecosystem services intact, it is mandatory to understand the role that they play for a city's disaster resilience [UN-5.1.1]. Ecosystem services that are of special importance to support a city's resilience "include, but are not limited to: water retention or water infiltration; afforestation; urban vegetation; floodplains; sand dunes; mangrove and other coastal vegetation; and pollination" (UNISDR, 2015d, p. 33). Since the natural resources that supply these ecosystem services are not necessarily located on the city's territory (e.g., vegetation on a mountain might reduce the water rundown), it can be difficult to grasp all relevant relationships. Still, the effort should be made in order to understand the coherencies between city and nature and the relevance that they have for disaster prevention. In a second step, measures to preserve relevant ecosystem services should be taken [UN-5.1.2]. The type and scope of these measures varies from case to case. Finally, it must be considered that changing land-uses can impact the health of ecosystem services, e.g., when a forest is logged off to construct new buildings. This impact should always be sufficiently considered in land-use planning (see essential 4). Optimally, land-use changes should not have negative impacts on ecosystem services [UN-5.1.3] (UNISDR, 2015d, p. 33).

The Basic Guidelines of Reconstruction especially focus on the preservation and recovery of the disaster-preventing functions of forests along the coastline (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 11). Furthermore, the relationships between the forests, countryside and ocean should be considered throughout the reconstruction process, including the integration of renewable energies, such as solar or wind power or biomass (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 28–29). Thereby, logging should always occur in a sustainable way, so that the forest's ecological functions remain (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 24).

The influence of spatial planning on essential 5

For the retention of ecosystem services, spatial planners play an important role, especially in regards to land-use planning. The relationship between humans and nature is very complex. Therefore, a variety of professionals (e.g., environmental scientists, water engineers) is needed to define and understand a city's relevant ecosystem services. Spatial planners can be considered as one of many actors with influence on the awareness of ecosystem services for disaster resilience and ecosystem health, which is why their influence on these items can be considered to be medium. Spatial planners influence for the consideration of land-use planning's impact on ecosystem services, however, can be considered as high.

5.6 ESSENTIAL 6: STRENGTHEN INSTITUTIONAL CAPACITY FOR RESILIENCE

While essential 1 focuses on the collection of information about the responsibility of different institutions (e.g., governmental or private organizations, providers of public services, NGOs) before, during and after a disaster, essential 6 [UN-06] focuses on strengthening the soft skills of these institutions to enable them to cope with disasters if they occur. Improving the institutions skills and experiences and enabling the learning from other's experiences increases the political-institutional resilience. In addition to this, the education and training of the public – optimally provided in various languages – can help to build socio-economic resilience, by enabling the citizens to react optimally in case of a disaster. The Disaster Resilience Scorecard suggests that institutional capacity should be developed based on the disaster risk reduction phases "understanding, prevention, mitigation, response and recovery planning" (UNISDR, 2015d, p. 37). In Japan, the Basic Disaster Management Plan follows a similar structure, by specifying countermeasures for the phases prevention and preparedness, emergency response and recovery and reconstruction (see Chapter 4.5).

Skills and experience	Availability of skills and experience in disaster resilience – risk identification, mitigation, planning, response and post event response [UN-6.1.1]
Public education and awareness	Exposure of public to education and awareness materials/ messaging [UN-6.2.1]
	Validation of effectiveness of education [UN-6.2.2]
Training Delivery	Availability, take-up of training [UN-6.3.1]
Languages	Accessibility of education and training to all linguistic groups in the city [UN-6.4.1]
Learning from others	Effort taken to learn from what other cities, states and countries (and companies) do to increase resilience [UN-6.5.1]

Table 9 | Subjects and items from essential 6 | Own illustration based on UNISDR, 2015d

Skills and experience

To consider the impact of risks in their work, employees of different institutions need a certain knowledge about risks. They need to know how to assess risks for their fields of work (e.g., land-use planning, water engineering or healthcare sector), and how these risks can be mitigated. Furthermore, they should be prepared and know how to respond to a disaster if it occurs. In many cases, this knowledge does not exist, which necessitates an appropriate training of the employees to enable them to incorporate risk reduction into their daily work [UN-6.1.1]. Some of the knowledge needed can be contributed by external experts, as it was the case during the reconstruction process in Tohoku Region, where the institutional capacity to recover from the GEJE was enhanced through the allocation of reconstruction professionals to Tohoku Region (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 13–14). Other measures to enhance the region's institutional capacity after the disaster were the collaboration of various governmental offices and ministries and their cooperation with the private sector, e.g., through public-private partnerships (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 13–14).

Public education and awareness

Understanding risks and the threat that they pose is also of great importance for the public. To increase resilience, it is therefore required to teach the population awareness and prepare them for possible threats in the future. The first step in this context is to prepare appropriate information and distribute it over various media channels (e.g., print, teaching material for schools, TV, radio, internet/ social media, posters). Of course, it is important to ensure that the provided information actually reaches the intended recipient. Therefore, it should be considered that the most appropriate form of distribution varies with the population's demographics (young people can be reached via Twitter or Facebook, while older people can be reached via newspapers) [UN-6.2.1]. To ensure that the provided information is effective to educate the public and increase the general awareness, the information campaigns should be evaluated regularly (e.g., through telephone surveys) [UN-6.2.2]. While the Basic Guidelines for Reconstruction focus on the public's information about the reconstruction process (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 12), there are also measures intended to improve the education of the public in preparation of a future disaster, e.g., by promoting the idea to escape (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 35).

Training Delivery

In addition to supplying the public with information about disaster risks, it is also important to train the citizens to prepare them for the occurrence of a disaster [UN-6.3.1]. Ideally, this training is based on case studies that determine the best way of behavior for disaster risk reduction (UNISDR, 2015d, p. 37). In Tohoku Region the future training should especially promote the idea to escape rather than stay in exposed areas (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 35). The Basic Guidelines for Reconstruction do not further specify the scale and frequency of this future training.

Languages

In countries and cities with a diverse ethnic structure it is especially important to provide information material on disaster risk reduction in each relevant language [UN-6.4.1]. This is the only way to ensure that every single citizen is able to react sufficiently in case of a disaster. In Japan, this point might not seem as important as in countries with a more diverse ethical structure because of the small amount of foreigners who live in the country (1,7% in 2014) (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2016b). Nonetheless, just because the number of foreigners is small, does not mean that they do not have to be addressed: Especially because the Japanese language is complicated to understand by foreigners, it should be considered to at least supply an English version of all important documents – a requirement that is often not met at the moment. The Basic Guidelines for Reconstruction, however, do not address this topic.

Learning from others

To increase a city's resilience, it can be helpful to incorporate the knowledge that other cities, regions or countries collected. This enables to consider steps that were useful and correct shortcomings in advance [UN-6.5.1]. Japan's long history with disasters emphasized the importance to learn from the past and fostered the exchange of knowledge between regions. Accordingly, disasters in other cities are frequently used to improve the handling of hazardous events in the future. This includes the importance to keep communities together in the aftermath of a disaster. In Japan, this importance became apparent during the reconstruction process in Kobe after the Great Hanshin-Awaji Earthquake in 1995 (Kadoya, 2005). Therefore, it is also mentioned in the Basic Guidelines for Reconstruction (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 33). Furthermore, the Basic Guidelines for Reconstruction intend the exchange of information with other Asian countries (e.g., China, Korea) and an ongoing exchange with international scientists and students to enable countries all over the world to learn from Japan's experiences (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 31). In this context, Japan also hosted the Third UN World Conference on Disaster Risk Reduction in Sendai in March 2015.

The influence of spatial planning on essential 6

The influence of spatial planning for essential 6 is only determined to be low. The reason for this is that spatial planners are only one of many actors that are included in the education measures of this essential. This means, spatial planners should attend the trainings offered for them and help with the preparation of the information material for the public (e.g., designating evacuation routes, providing maps).

5.7 ESSENTIAL 7: INCREASE SOCIETAL AND CULTURAL RESILIENCE

As explained in Chapter 3.2, resilience does not only consist of physical aspects but also includes a socio-economic sphere. Building societal and cultural resilience [UN-07], is directly linked with the work of grassroots organizations and the inclusion of vulnerable population segments in participation processes. Grassroots organizations and the involvement of citizens into the planning process can also help to increase the social cohesion of communities, which helps to build socio-economic resilience. In addition to this, businesses can help to build socio-economic resilience by providing their employees with relevant information. Furthermore, the preparation of business continuity plans can help businesses to continue their work after a disaster. One final aspect of this essential is the importance to enable citizens to communicate with each other before and after a disaster.

Grassroots organizations	Coverage of grassroots organization(s) throughout the city and effectiveness of grassroots networks [UN-7.1.1, UN-7.1.2]
	Social connectedness and neighborhood cohesion [UN-7.1.3]
	Engagement of vulnerable segments of the population [UN-7.1.4]

Private sector/ employers	Extent to which employers act as a channel with employees [UN-7.2.1]
	Business continuity planning [UN-7.2.2]
"Systems of Engagement"	Use of mobile and e-mail "systems of engagement" to enable citizens to receive and give updates before and after a disaster [UN-7.3.1]

Table 10 | Subjects and items from essential 7 | Own illustration based on UNISDR, 2015d

Grassroots organizations

Grassroots organizations can play an important role for the increase of societal and cultural resilience. The orientation of the grassroots organization thereby determines if it directly improves a community's ability to respond to disaster risks (e.g., emergency responders) or if it improves the community's social connectedness, which can also increase resilience (e.g., churches, youth organizations, food kitchens) (UNISDR, 2015d, p. 45). To increase socio-economic resilience, it is important that these organizations reach certain population groups on a frequent basis and that they consider and address the topic of resilience in their daily work [UN-7.1.1, UN-7.1.2]. Therefore, grassroots organizations should be engaged in emergency response planning and training and be provided with all relevant information and data needed (UNISDR, 2015d, p. 44). The work of grassroots organizations can increase a community's social connectedness [UN-7.1.3], which in turn increases the chance that community members are directly approached after a disaster to assure their safety and that help is provided if they need it. Furthermore, social cohesion reduces the risk of crime in the aftermath of a disaster. To optimally utilize these advantages of grassroots organizations to increase resilience, it is important to engage vulnerable citizen groups into their work [UN-7.1.4]. Vulnerable population groups can be the poor, the elderly, physically or mentally disabled, children, non-native speakers, or women.

The Basic Guidelines for Reconstruction recognize the importance of community cohesion and social inclusion to build resilience. They therefore mention this topic in several passages of the text (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 14 and 32). To reach the aim of community building, the Basic Guidelines for Reconstruction intend the introduction of "New Public Commons" that enable the government to work together with various organizations (e.g., NPOs, NGOs and local organizations) (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 32). The importance to engage vulnerable groups of population into the reconstruction process is continuously mentioned in the guidelines. Based on Japan's demographic structure (see Chapter 4.2), special emphasis is put on the elderly, but also women, children, the youth, disabled people and foreigners should specifically be addressed (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 14).

Private sector/ employers

Private organizations can operate as multipliers for resilience. One way to do this is the introduction and discussion of the topic with the business's employees

[UN-7.2.1]. Another way is the development and implementation of business continuity plans that contain information how the company's affairs can be handled in case of a disaster [UN-7.2.2]. These plans cannot only improve the company's resilience, but also improve the community's ability to recover its economy as fast as possible. In this way, the private sector can directly contribute to the community's overall resilience. To prepare for future disasters, the Basic Guidelines for Reconstruction intend to support the companies' intention to continue their business after a disaster (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 33–34). In case of the stable supply and food industry, the guidelines specifically mention that business continuity plans should be developed to assure the continuous supply with these essential goods in case of a disaster (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 36).

"Systems of Engagement"

Especially directly before and after a disaster, it is important for people to receive current information. With the wide distribution of mobile phones and the internet, these ways of communication are an easy and affordable option to keep the citizen's up to date [UN-7.3.1]. Information should be distributed over various channels like social media, e-mail or mobile phone apps (e.g., the Japanese earthquake early warning app "Yurekuru Call"). Nevertheless, the GEJE showed that these new ways of communication are not always reliable in case of a disaster. For instance, the full restoration of the mobile phone network in Miyako City after the GEJE took about one month (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 36). Accordingly, the Basic Guidelines for Reconstruction stress the importance to have a radio to get information in case of a disaster (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 11). This emphasizes the importance to spread information over various platforms, so that as many people as possible can be reached.

The influence of spatial planning on essential 7

As explained in Chapter 2.4.3, communication is an important aspect for disaster risk reduction. Especially the requirements of vulnerable population groups need to be included in the decision-making processes. In this context grassroots organizations can serve as a contact to reach certain population groups and build community resilience. In case that grassroots organizations specifically address spatially relevant topics (like some *machizukuri* in Japan), spatial planners should involve them into the decision-making process. Grassroots organizations, strengthening community cohesion and the integration of vulnerable population groups therefore are of medium relevance for spatial planners. The preparation of information in the private sector and the development of business continuity plans, on the other hand, is not relevant for spatial planners. Regarding the provision of information, spatial planners might be able to provide information (e.g., about evacuation routes) or take care of the engineering resilience of communication networks (this point is addressed in essential 8), but their main influence for this subject is low.

5.8 ESSENTIAL 8: INCREASE INFRASTRUCTURE RESILIENCE

Essential 8 addresses the resilience of a city's critical infrastructure [UN-08]. Meeting the aspects of this essential therefore builds engineering resilience, which is directly linked with its physical structure. The essential's first component is the existence and maintenance of protective infrastructure, which is of major importance to keep the impact of a hazardous event as low as possible. In addition to this, a resilient utility infrastructure can increase the probability that a city's basic functions are not or only slightly disrupted by a hazardous event. In case that the utility infrastructure still becomes disrupted, a resilient system structure helps to recover the important services as fast as possible. This extends to other functions like the maintenance of law and order and first responders, educational and healthcare services and administrative functions. To ensure a continuous supply with the above mentioned services in case of a disaster, it is important that the computer systems that store all relevant data continue to work. To increase infrastructure resilience, all relevant infrastructure should be included in the risk assessment and scenario development addressed in essential 2. The risk assessment should consider possible linkages or cascading effects between different systems, e.g., the consequence of electricity failure for hospitals (UNISDR, 2015d, p. 51). Simultaneously, the operator of critical infrastructure should include risk scenarios for the planning of their systems. To achieve a resilient infrastructure, it is helpful if the operators and the city administration agree on elementary system standards (UNISDR, 2015d, p. 51).

Protective infrastructure	Adequacy of protective infrastructure and effectiveness of maintenance [UN-8.1.1, UN-8.1.2]
Utility infrastructure	Disaster resilience of the following services: communication, electricity, water/sanitation, gas, transportation [UN-8.2.1, UN-8.2.2, UN-8.2.3, UN-8.3.1, UN-8.3.2, UN-8.3.3, UN-8.4.1, UN-8.4.2, UN-8.4.3, UN-8.5.1, UN-8.5.2, UN-8.5.3, UN-8.5.4, UN-8.6.1, UN-8.6.2, UN-8.6.3, UN-8.6.4, UN-8.6.5, UN-8.6.6]
Social infrastructure	Disaster resilience and structural safety of law and order & first responders, education facilities, healthcare providers and administrative services [UN-8.7.1, UN-8.7.2, UN-8.8.1, UN-8.8.2, UN-8.8.3, UN-8.9.1, UN-8.9.2, UN-8.9.3, UN-8.10.1]
Computer systems and data	Assurance of continuity of computer systems and data critical to government continuity [UN-8.11.1]
	Assurance of continuity of computer systems and data critical to any of the above infrastructure [UN-8.11.2]

Table 11 | Subjects and items from essential 8 | Own illustration based on UNISDR, 2015d

Protective infrastructure

Protective infrastructure can decrease a city's exposure, if it adequately matches a disaster's magnitude. Examples for such infrastructure are "levees and flood barriers", "flood basins", "sea walls" "tornado/hurricane shelters", "storm drains" or "shock absorption capabilities fitted to infrastructure to deal with earthquakes" (UNISDR, 2015d, p. 53). To increase a city's resilience, protective infrastructure that matches the type and scale of predictable hazardous events should be installed [UN-8.1.1] and maintained frequently [UN-8.1.2]. Nevertheless, it must be considered that protective infrastructure can never safeguard a city from any possible disaster of any scale. The inundation of Taro District in Miyako City through the GEJE Tsunami shows that a seawall can be run over if the height of the tsunami wave is big enough. Accordingly, protective infrastructure should never result in a false feeling of safety and can never be the only measure to build resilience.

The Japanese government intends to "restore and build coastal and river dikes and strengthen the functions of disaster-prevention/ drainage facilities such as floodgates and water shoot pipes" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 10), a plan that is currently executed. In addition to this, the Basic Guidelines for Reconstruction also provide for the development of evacuation buildings, the raise of roads and railroads to create setback levees and the restoration of disaster-prevention forests along the coastline (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 10–11).

Utility infrastructure

According to the Disaster Resilience Scorecard, the resilience of utility infrastructure depends on three aspects. First, the amount of services lost through a disaster should be as small as possible. Second, the number of service days lost through the failure of critical infrastructure should be as small as possible. Critical infrastructure includes operations of special importance for the city's emergency response, e.g., basic communication systems for police and emergency services, basic water and energy systems and the persistence of evacuation routes (UNISDR, 2015d, p. 51). Third, the costs for the restoration of the utility networks should be as low as possible. These three points apply to the following types of utility infrastructure: communication [UN-8.2.1, UN-8.2.2, UN-8.2.3], electricity [UN-8.3.1, UN-8.3.2, UN-8.3.3], water and sanitation [UN-8.4.1, UN-8.4.2, UN-8.4.3]. The resilience of the gas network is measured slightly different through its safety and integrity [UN-8.5.1], the amount of customer service days at risk [UN-8.5.2], the critical assets service days at risk [UN-8.5.3] and the costs for restoration [UN-8.5.4]. The resilience of the transportation network is divided into the resilience of the different modes of transportation. The aim is to keep the loss of service days for the road network [UN-8.6.1], the railroad network [UN-8.6.3], airports [UN-8.6.4], river and/ or seaports [UN-8.6.5] and other public transportation networks [UN-8.6.6] as low as possible. Furthermore, it is important to keep a city's evacuation routes intact if a disaster occurs [UN-8.6.2].

The Basic Guidelines for Reconstruction demand that risk assessments are based on the largest disasters possible. Based on this assessment, solutions for the above mentioned utility networks should be developed to ensure that all evacuation and emergency activities can proceed without constraints in order to secure people's life, health and assets and minimize the disruption of socio-economic activities (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 33–34).

The special importance of a working communication network to build disaster resilience is evident because a functioning communication system permits to warn the citizens about hazardous events and enables them to evacuate. The Basic Guidelines for Reconstruction intend the promotion of new solutions to improve the overall communication system in case of a disaster. Some of these solutions are the launch of a cloud service (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 28) and the improvement of the reliability of the information system before and during large scale disasters, e.g., through the use of satellite systems (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 36). Of course the recovery of the existing communication network (e.g., internet access) or the supply with information from the government is an additional important point (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 28).

The Basic Guidelines for Reconstruction also intend to launch new and independent "smart energy systems" that rely on renewable energy sources (e.g., solar and wind power) and store energy in batteries which can stabilize the power supply and provide evacuation centers with energy in case of a disaster (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 28–30). In this way, the dependency on the electricity network and the overall gas and/ or oil supply can be reduced. In addition to this, the guidelines intend to re-engineer the water and sewage system to improve its earthquake resistance. Furthermore, the network structure for oil and gas supply should be designed to be more resilient (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 35–36).

Reconstructing the transportation network to improve its resilience, is another goal of the Basic Guidelines for Reconstruction. This includes the widening of arterial roads to prevent congestion from too much traffic (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 10) and the prevention of traffic light failure in case of a disaster (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 28). Furthermore, the redundancy of the transportation network should be build (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 28). To provide easy access to Tohoku Region in order to advance the reconstruction process, the fast construction of the basic logistics network is prioritized. This also includes the speedy completion of the Sanriku Longitudinal Expressway (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 27). The reconstruction of the railroad network should occur based on the local characteristics of each community (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 27). In reality, this resulted in the replacement of the former railway lines Kesennuma Line and part of Ofunato Line with a Bus Rapid Transit system because the demand for public transportation in the smaller towns and cities along the coast is not large enough to justify the reconstruction of the railway tracks after they were destroyed by the GEJE and Tsunami (JR Japan, 2016).

Social infrastructure

In addition to a working utility infrastructure, it is also important that basic social services are continuously provided if a disaster occurs. This includes law and order and first responders and the provision of education, healthcare and administrative services. In order to ensure the persistence of social services in case of a disaster, it is also important that all relevant data is stored safely in robust computer systems.

In times of a disaster, it is especially important that law and order and first response are secured. Accordingly, first responders and police officers should be able to work sufficiently and not be restricted in any way [UN-8.7.1]. This can be achieved by providing needed equipment such as additional vehicles, pumps or generators (UNISDR, 2015d, p. 52). The Basic Guidelines for Reconstruction consider this point and intend to "[s]ecure extensive and large-scale swift evacuation, relief, emergency and rescue activities conducted by police officers, fire fighters, coast guard officers and Self Defense Force members" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 33–34). Furthermore, it is also important that a city's prison system does not get disrupted by a disaster. This includes the safety of the prisoners as well as the maintenance of custody [UN-8.7.2].

The resilience of education facilities is split into three factors. First, it is important to enhance the structural safety of school building and other educational facilities [UN-8.8.1]. Second, the teaching time that is lost after a disaster should be kept to a minimum [UN-8.8.2]. This point is influenced by the availability of temporary teaching facilities if the original facilities are inaccessible and the ability of teaching staff to continue their work. Third, the safety of educational data should be ensured [UN-8.8.3], this can be achieved by frequently backing up all important data. The Basic Guidelines for Reconstruction aim to strengthen the resilience of school facilities, through the application of structural measures (incl. possible relocation) as well as the social resilience of staff members, through special training measures. The continuity of classes after the GEJE should be secured through the allocation of additional teaching staff as well as school counselors to ensure the psychological and physical health of affected children. To enable children, whose families' were severely financially affected by the disaster, to attend school, the guidelines intend monetary assistance (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 17–18).

Because a disaster results in a large amount of casualties, the continuation of healthcare services is another important point to build resilience. Disaster resilience of the healthcare system is composed of the structural safety of healthcare facilities [UN-8.9.1], the protection of health records and data (e.g., through frequent backups) [UN-8.9.2] and the ability to deal with all acute needs that occur in connection with the disaster [UN-8.9.3]. The Basic Guidelines for Reconstruction intend to provide disaster-affected people with sufficient healthcare

(Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 15) and to increase the structural safety of healthcare facilities (e.g., earthquake-resistance) to ensure "that medical care can be continuously provided even at time of a large-scale disaster" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 35). In addition to this, the efficiency of the healthcare sector should be increased, e.g., by reducing the length of hospital stays (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 15).

A disaster can significantly disrupt a city's administration, either by destroying governmental buildings or by affecting staff members. Still, the basic administrative functions, that directly affect the citizen's wellbeing after a disaster, should be secured [UN-8.10.1]. Depending on the extent of the disaster, these services might be the distribution of food stamps, the allocation of temporary housing or the record of damages (UNISDR, 2015d, p. 69). The Basic Guidelines for Reconstruction stress the importance to recover a city's main governmental building, so that a headquarter for the further reconstruction process is secured (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 14). Measures to increase the structural safety of administrative buildings in preparation for future disasters are also planned (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 33).

Computer systems and data

The progressive distribution of computer systems increased the importance to secure IT structures and the data connected with them. The disaster's effect on IT infrastructure and data that is crucial for the continuation of basic administrative, educational and healthcare services should be kept to a minimum [UN-8.11.1]. In addition to this, the stability of computer systems that are relevant for the proper provision of the utility infrastructure services should also be ensured [UN-8.11.2]. The Basic Guidelines for Reconstruction do not state any specific measures for this topic.

The influence of spatial planning on essential 8

To ensure the continuous work of a city's protective, utility and social infrastructure, the structural safety of these services must be secured. Spatial planning options to build infrastructure resilience include the location of newly planned infrastructure (e.g., transmitting or receiving towers) in zones that are not exposed to hazards or the relocation of existing critical infrastructure from hazardous areas to safer grounds. Another option to build resilience is the establishment of redundant or alternative infrastructure (Jha et al., 2013, 141ff.). Furthermore, the enforcement of building codes can help to adapt building structures according to essential requirements (e.g., creating earthquake-resistant buildings) and by this means increase a building's structural resilience (see Chapter 2.4.2). To obtain the best results, the selected measures should be based on the risk assessment (see essential 2). The various options that spatial planners have on hand to build infrastructure resilience illustrate the important role that they play in the context of essential 8. Of course, the competence of various sectoral planning departments for the supply of utility and social services necessitates the collaboration of spatial planners with the responsible departments. Nevertheless, the influence of spatial planners in this context can be considered as high. As explained above, the continuous supply with social services does also depend on the ability of people to continue their work (e.g., teachers, doctors, administrative staff) and the reliability of computer systems in order to continuously provide relevant data. Spatial planners have no influence on these aspects. Therefore, they are not further considered for this research.

5.9 ESSENTIAL 9: ENSURE EFFECTIVE DISASTER RESPONSE

Essential 9 [UN-09] asks a city to establish an effective disaster response system. This response should be based on risk assessments and scenarios, which require a frequent update (see essential 2). Furthermore, all relevant stakeholders identified in essential 1 should be included into the preparation of preparedness and contingency plans to secure a continuous supply of law and order, food, basic healthcare and shelter. Disaster preparation involves the installation of an early warning system, the existence of emergency response plans and the ability of emergency staff members to react properly.

Early warning	Existence and effectiveness of early warning systems [UN-9.1.1]
Event management plans	Existence of emergency response plans that integrate professional responders and grassroots organizations [UN-9.2.1]
Staffing/ responder needs	“Surge” capacity of police also to support first responder duties [UN-9.3.1]
	Definition of other first responder and other staffing needs, availability – including fire, ambulance, healthcare, neighborhood support etc. [UN-9.3.2]
Equipment & relief supply needs	Definition of equipment and supply needs, and availability of equipment [UN-9.4.1]
Food, shelter, staple goods & fuel supply	Likely ability to continue to feed population [UN-9.5.1]
	Likely ability to meet needs for shelter/ safe places [UN-9.5.2]
	Ability to meet likely needs for staple goods [UN-9.5.3]
	Likely availability of fuel [UN-9.5.4]
Interoperability & inter-agency compatibility	Interoperability with neighboring cities/ states and other levels of government of critical systems and procedures [UN-9.6.1]
	Emergency operations center [UN-9.6.2]
Drills	Practices and rehearsals – involving both the public and professionals [UN-9.7.1]
	Effectiveness of drills and training [UN-9.7.2]

Table 12 | Subjects and items from essential 9 | Own illustration based on UNISDR, 2015d

This includes the availability of all the equipment that they require and their ability to provide this equipment for affected people. In addition to this, each city should collaborate with neighboring towns and city and train its disaster response with regularly performed drills. The resilience spheres that essential 9 addresses, differ for the specific items: While many of the subjects (early warning systems, event management plans, knowledge about staffing and responder needs, equipment and relief supply needs and the interoperability and inter-agency compatibility) help to build political-institutional resilience, other aspects help to build socio-economic resilience (availability of food, shelter, staple goods and fuel supply).

Early warning

To maximize the time for evacuation, it is important to have an efficient early warning system in place and that the citizens receive the warnings on time [UN-9.1.1]. In case of a disaster, this can safe many people's lives and enable emergency responders to get prepared. Early warning systems are frequently improved and therefore should be updated on a regular basis. The Basic Guidelines for Reconstruction intend to put an alert and evacuation system into place (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 10) and especially mention the improvement of tsunami early warning systems (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 33).

Event management plans

To be sufficiently prepared for a disaster, it is important to have disaster management plans established [UN-9.2.1]. These plans should integrate all relevant actors (e.g., first responders, grassroots organizations) and cover the following aspects: coordination, evacuation, continuity of basic infrastructure (e.g., communication, healthcare, law and order (see essential 8)), contribution from grassroots organizations and the public (UNISDR, 2015d, pp. 73–74). The Basic Guidelines for Reconstruction (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011) do not specifically address this topic, however, it can be assumed that the development of event management plans will be part of the improvement of the "response capability" mentioned on page 34.

Staffing/ responder needs

A disaster multiplies the number of first responders needed. To enable an effective response, a plan of the surge capacity of the police [UN-9.3.1] and other emergency staff [UN-9.3.2] in case of a disaster should be prepared. The capacity of the regular staff can also be assisted by the army or civil defense forces. This point is also included in the Basic Guidelines for Reconstruction, where an extended "partnership among police, fire department, Coast Guard and Self Defense Forces" is demanded (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 34).

Equipment & relied supply needs

To respond to the disaster, emergency staff will need certain equipment which should also be secured. Equipment might include vehicles, helicopters, rescue or medical equipment (UNISDR, 2015d, p. 76). The Basic Guidelines for Reconstruction do not specifically address this topic. Nevertheless, the improvement of the response capacity to future disasters should also incorporate this factor (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 34).

Food, shelter, staple goods & fuel supply

People that are affected by a disaster have certain needs that have to be satisfied. Building the ability to meet these needs, increases disaster resilience. One of the most important aspects is the citizens' consistent access to food and water [UN-9.5.1]. Another important point is the availability of shelter [UN-9.5.2], which can be roughly differentiated between emergency shelter, temporary shelter/ housing and permanent housing (Quarantelli, 1995). There should be enough space to accommodate every displaced person and the shelter's location should be safe. Furthermore, the supply with critical staple goods should be secured [UN-9.5.3]. Staple goods vary from place to place, but usually include "sanitation; [p]ersonal sanitary supplies and diapers; [m]edication and first aid supplies; [b]atteries; [c]lothing; [b]edding, [b]ottled gas for cooking [and] heating [as well as] material for immediate repairs or weather-proofing of housing" (UNISDR, 2015d, p. 79). Finally, the supply with fuel for emergency and other important vehicles should be secured [UN-9.5.4].

Because of the publication a few months after the disaster, the Basic Guidelines for Reconstruction do not address the supply with basic goods immediately after the disaster. Nevertheless, the guidelines stress certain points that are of major importance when dealing with the citizen's basic needs. These points include the creation of a healthy living environment in evacuation shelters (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 37) and temporary houses (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 13). This aspect is of special importance when people have to stay in this environment for a longer period of time and also includes to help affected citizens to rebuild their lives, e.g., by providing financial support (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 36–37) or organizing cultural or sports events (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 19). To secure a community's supply with basic necessities, the guidelines aim to support the restoration and maintenance of "barbers, hairdressers and cleaners, architect engineers such as carpenters and plasterers and store managers such as restaurants and retailers" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 26).

Interoperability & inter-agency compatibility

Because disasters disregard man-made borders, it is important to address risks in a holistic way. This can optimally be achieved when neighboring cities and countries collaborate with each other [UN-9.6.1]. This interoperability increases a city's response capacity and therefore its resilience. Possible fields for collaboration that should be assessed in preparation for a disaster could be: "[c]ommunication systems; [d]ata [and] [e]mergency management applications" (UNISDR, 2015d, pp. 80–81). In addition to this, each city should own a highly disaster resilient emergency operations center [UN-9.6.2]. This center should be able to control all activities that are necessary in case of a disaster and carry out the communication between different actors.

The Basic Guidelines for Reconstruction intend the collaboration of local governments, relevant organizations and the Self Defense Forces to improve the benefits from disaster drills and increase the overall disaster response capacity (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 34). To ensure a continuous work in case of an emergency, the engineering resilience of local government buildings should be improved (see essential 8) (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 35–36).

Drills

Finally, the planned out disaster response should be trained on a regular basis. This can be achieved through drills that are held for first responders, volunteers and the public [UN-9.7.1]. To ensure their effectiveness, the drills and trainings should also be evaluated after they are completed [UN-9.7.2].

After the GEJE, the Basic Guidelines for Reconstruction intend to use experiences to improve the existing disaster training. This includes the promotion of "escape" as the preferred action and the availability of evacuation guidance in case of a tsunami (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 35) as well as the enhancement of schools for disaster prevention purposes (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 17).

The influence of spatial planning on essential 9

Beyond the general participation in preparing the disaster response plans and delivering information that is needed to prepare them, spatial planners are not further involved in the aspects of essential 9. The influence of spatial planning can therefore be regarded as low, with one exception: The provision of safe shelter after a disaster (including evacuation shelters, temporary housing sites and permanent housing) falls within the scope of spatial planners. Their influence for this aspect therefore is considered as medium.

5.10 ESSENTIAL 10: EXPEDITE RECOVERY AND BUILD BACK BETTER

The time after a disaster opens a window of opportunity for improvement (see Chapter 3.3). To use this window as effectively as possible, planning the recovery process in advance of a disaster, is a helpful step. Thereby, it is important to incorporate the needs of the citizens and their communities into the planning process to ensure "that the recovery programmes are consistent and in line with the long-term priorities" (UNISDR, 2015d, p. 85).

Post event recovery planning – pre-event	Planning for post event recovery and economic reboot [UN-10.1.1]
	Shadow financial arrangements for processing incoming aid and disbursing funds [UN-10.1.2]
	Learning loops [UN-10.1.3]

Table 13 | Subjects and items from essential 10 | Own illustration based on UNISDR, 2015d

Post event recovery planning – pre-event

Post event recovery plans ideally should be developed before a disaster strikes [UN-10.1.1]. In this way, it can be ensured that all important points are considered and the plan matches a city's long term development goals. The plan should be comprehensive and include the following points (UNISDR, 2015d, pp. 85–86):

- Location of emergency shelters and temporary housing
- Intended procedure to remove debris and start repairs
- Psychological support
- Economic recovery (e.g., interim taxes, incentives)
- Intended adjustment of city layout (e.g., relocation to safer places)
- Measures to provide social equality

Furthermore, the financial frame for the recovery plan should be planned out in a realistic way [UN-10.1.2]. This is necessary to ensure that it is actionable. In addition to this, procedures should be established that enable the review of the processes after a disaster in order to learn from mistakes and improve the established approaches for future disasters [UN-10.1.3].

The Basic Guidelines for Reconstruction basically represent the recovery plan for Tohoku Region, although they were not developed before the disaster. Therefore, they include many specifications regarding the points mentioned above. They make a point to improve the living environment in emergency shelters (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 37) and temporary housing (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 13), state that the debris from the GEJE should be recycled wherever possible (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 29), demand the provision of psychological support for disaster affected people (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 15), give information about the financial blueprint of the recovery process (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 4–8) and provide measures to increase social equality, e.g., by promoting the participation of women (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 4). However, the guidelines do not give any specifications about intended city layouts beyond the scope of discussing mass relocation as an option to increase a city's resilience (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 10), since these decisions are made by each municipality individually. In addition to this, the guidelines emphasize the importance to use the experiences from the GEJE to prepare for future disasters and dedicate an entire subchapter to this topic (see "Preparing for future disaster" in Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, pp. 32–37). One example for this is the analysis of people's actual behavior when they were supposed to evacuate. Understanding the citizens behavior can be used to improve the evacuation process for future disasters (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011, p. 36). The adjustments of the Disaster Countermeasures Basic Act and the Basic Disaster Management Plan after the Great Hanshin-Awaji Earthquake in Kobe in 1995 (Iuchi, 2016, pp. 23–24) illustrate that the Japanese government knows about the importance to learn from past events.

The influence of spatial planning on essential 10

The preparation of a pre-event recovery plan should also include spatial details, such as the location of emergency shelters, temporary housing sites or adjustments of the city's layout. Ideally, these plans should incorporate the city's long-term vision and include the proper participation of relevant stakeholders, including the public. In this way, the communication and implementation of these plans after a disaster can be simplified. The influence of spatial planners for the development of such post disaster land-use plans is high. When it comes to the determination of available budgets for the reconstruction process, the influence of spatial planners is only low. Nevertheless, spatial planners can play an important role for the development of recovery plans in advance of a disaster by coordinating the planning process.

5.11 INTERIM CONCLUSION

Taking the information in this chapter together, it can be stated that the two essentials with the largest influence of spatial planners (essentials 4 and 8), mainly address engineering resilience. The large scale destruction of a city's physical structure after a disaster offers the opportunity to build back better and improve the city's engineering resilience (see Chapter 3.3). The toolbox that spatial planners have available offers a variety of options to address essentials 4 and 8. Some examples are the minimization of exposure of urban areas through relocation or differentiated land-use decisions to prevent certain land-uses in specific areas (see Chapter 4.7.2).

When it comes to the improvement of political-institutional, socio-economic and environmental resilience, the planner's role is not as noticeable, but still important. Especially when dealing with spatially relevant topics, like the development of hazard maps (to build political-institutional resilience), the provision of safe shelter (to build socio-economic resilience) or securing ecosystem health (to build environmental resilience), spatial planners can provide useful contributions.

All resilience items introduced in this chapter were sorted by their ability to influence them through spatial planning. Furthermore, the type of resilience that each specific resilience item can influence most effectively was indicated. For instance, a low amount of vulnerable land-uses in hazardous areas is associated with a high engineering resilience. The possible improvement of socio-economic resilience in case of the relocation of economic activity (as one vulnerable land-use), is considered to be secondary in this context and therefore not indicated in the table. The table for this analysis can be found in the annex.

Resilience items	Codes
Engineering Resilience	
› Vulnerable land-uses at risk	[UN-4.1.1, UN-4.1.2, UN-4.1.3]
› Building Codes	[UN-4.2.1, UN-4.2.2, UN-4.2.3]
› Urban Design Solutions	[UN-4.3.1]
› Sustainable building design standards	[UN-4.3.2]
› Protective infrastructure	[UN-8.1.1, UN-8.1.2]
› Disaster resilience of utility infrastructure	[UN-8.2.1, UN-8.2.2, UN-8.2.3, UN-8.3.1, UN-8.3.2, UN-8.3.3, UN-8.4.1, UN-8.4.2, UN-8.4.3, UN-8.5.1, UN-8.5.2, UN-8.5.3, UN-8.5.4, UN-8.6.1, UN-8.6.2, UN-8.6.3, UN-8.6.4, UN-8.6.5, UN-8.6.6]
› Disaster resilience of social infrastructure	[UN-8.7.1, UN-8.7.2, UN-8.8.1, UN-8.9.1, UN-8.10.1]
Political-institutional resilience	
› Proposal evaluation for disaster resilience	[UN-1.2.1]
› Risk assessment	[UN-2.1.1, UN-2.1.2, UN-2.1.3, UN-2.1.4, UN-2.2.1]
› Pre-event planning for disaster recovery	[UN-10.1.1]
› Learning loops	[UN-10.1.3]
Socio-economic resilience	
› Consideration of the citizen's needs	[UN-7.1.1, UN-7.1.2, UN-7.1.4]
› Social connectedness and neighborhood cohesion	[UN-7.1.3]
› Provision of safe shelter	[UN-9.5.2]
Environmental resilience	
› Ecosystem health	[UN-5.1.1, UN-5.1.2, UN-5.1.3]

Table 14 | List of resilience items considered for this research | Own illustration

Because the main focus of this research is on spatial planning's ability to build resilience, only items where spatial planners possess a high or medium degree of influence will be further considered. Items where spatial planners can only contribute in a minor way or not at all will be left out because these items can be more effectively addressed by other actors. To provide an efficient analysis framework for Part B of this work, similar resilience items were clustered and renamed. The final items to assess engineering, political-institutional, socio-economic and environmental resilience are presented in table 14.

6. INTERIM CONCLUSION OF PART A

Part A elaborated the theoretical background of this research by introducing the complex topics of disaster risk and resilience. Furthermore, the framework characteristics of the area under investigation were introduced and the concept of resilience was further specified to answer the main research questions:

› How can spatial planning help to build a city's resilience after a disaster?

› How can spatial planning use the window of opportunity effectively to improve a city's resilience after a disaster?

To answer these research questions, it is especially important to specifically operationalize the independent variable (spatial planning) and dependent variable (a city's resilience). A task that was achieved in Part A of this work. The time frame after the disaster and the window of opportunity are considered as background characteristics and therefore do not require an equally profound definition. For them the definitions introduced in Chapter 1 are maintained for the further research process. The operationalization of spatial planning and resilience as the independent and dependent variable is summarized in the following paragraphs to clarify the background for the case study analysis in Part B of this work.

Spatial Planning

There are several spatial planning options available, that are relevant for building resilience in the aftermath of the GEJE and Tsunami. Chapter 4 introduced and discussed them in-depth based on their association with the risk governance phases assessment, management and communication. Table 15 on the next page gives an overview of all of these options.

	Spatial planning options
Assessment	› Hazard maps and hazard simulations
	› Environmental Impact Assessment (EIA)
Management	**Minimization of exposure of urban areas**
	› Land-use control in hazardous areas
	› Relocation through relocation programs or land readjustment projects
	Differentiated land-use decisions
	› Land-use zoning
	Adaptation of building structures
	› Building code
	› Additional building requirements
	› Provision of public housing
	Hazard Mitigation
	› Protective infrastructure
	› Land readjustment and raising program
	› Adaptation of urban structure through land readjustment projects
Communication	› Citizen participation

Table 15 | Spatial planning options considered in the case study analysis | Own illustration

Resilience

Resilience can be assessed through the items introduced in Chapter 5. For each of the four resilience spheres – engineering, political-institutional, socio-economic and environmental – specific items were identified that can be used to assess this type of resilience (see table 16).

Resilience items
Engineering Resilience
› Vulnerable land-uses at risk
› Building Codes
› Urban Design Solutions
› Sustainable building design standards
› Protective infrastructure
› Disaster resilience of utility infrastructure
› Disaster resilience of social infrastructure
Political-institutional resilience
› Proposal evaluation for disaster resilience
› Risk assessment
› Pre-event planning for disaster recovery
› Learning loops
Socio-economic resilience
› Consideration of the citizen's needs
› Social connectedness and neighborhood cohesion
› Provision of safe shelter
Environmental resilience
› Ecosystem health

Table 16 | Resilience items considered in the case study analysis | Own illustration

In Part B of this work, all of these elements will be brought together. For each resilience item the spatial planning options used to address this item are analyzed and their ability to build resilience are assessed. This is done separately for the two case study sites Miyako City and Ishinomaki City, before the cross-case synthesis analyses general findings and draws the conclusion which spatial planning option is able to address which kind or resilience.

Based on the elaboration of the topic of resilience in Chapter 5, it can be assumed that spatial planning is especially useful to build engineering resilience. This assumption bases on the observation that the resilience essentials with a high influence of spatial planning (namely essentials 4 and 8) mainly address engineering resilience, while essentials that address the other three spheres of resilience are characterized by a smaller influence of spatial planning. The analysis in Part B will show if this impression can be proven to be true.

PART B

7. CASE STUDY APPROACH

This chapter gives an overview of the application of the case study approach introduced in Chapter 1 on the two case study sites Miyako City and Ishinomaki City. The chapter explains the procedure for the case study selection and the methodology that was used for the collection and analysis of the case study data.

7.1 CASE STUDY SELECTION

The cases were selected based on the information that was gathered during the "soaking and poking" phase that lasted from the URBIPROOF Kick-Off-Meeting in May 2013 and the three research stays in November-December 2013, July-September 2014 and February-March 2015. During each of the stays, information was collected via literature review, site visits and conversations with local experts. Various cities and towns in Iwate and Miyagi Prefecture were visited and considered as possible case study sites. This process was important to ensure a careful selection of the most qualified cases.

The decision to choose two case study sites was based on the following considerations (Yin, 2014, pp. 63–64):

- Multiple-case designs enable to replicate or contrast the results from the first case study
- Multiple-case designs can eliminate the assumption that the findings from the first case study do not apply to any other case
- Multiple-case designs strengthen the research results and increase the quality of research
- Limiting the number of case studies to two keeps the amount of work still manageable, without losing the advantages of multiple-case designs

Finally, one city in each of the two prefectures was selected: Miyako City in Iwate Prefecture and Ishinomaki City in Miyagi Prefecture (see illustration 36 on the next page). Both cities suffered severely from the GEJE and Tsunami and implemented multiple approaches to recover from their damages.

The selection of these case study sites follows the logic of replication. This means, the researcher can either intend to literally replicate the findings from one case study in one or multiple other cases or vary certain variables in a controlled manner (theoretical replication) (Yin, 2014, p. 57). Theoretical replication can either follow a most or least similar case research design. Most similar cases "which, ideally, are cases that are comparable in all respects except for the independent variable, whose variance may account for the cases having different outcomes on the dependent variable" (George & Bennett, 2005, p. 81). Least similar cases, on the other hand, "are similar in outcome but differ in all but one independent variable, and the inference might be made that this variable contributes to the invariant outcome" (George & Bennett, 2005, p. 82).

The selected cases were expected to allow both literal as well as theoretical replication. Literal replication happened in regard to the legally defined spatial

Illustration 36 | The location of Miyako City and Ishinomaki City in Japan | Own illustration based on D-maps, 2016a

planning options that were used in both cases. These options include the legally defined framework for the development of hazard maps and simulations, the implementation of EIA, the minimization of exposure of urban areas, differentiated land-use decisions, adaptation of buildings structures, hazard mitigation and citizen participation as they are enshrined in the Japanese law (see Chapter 4). Both selected cases are located in Japan and are therefore bound to the same spatial planning framework. Furthermore, both cities experienced the same disaster and suffered from similar effects. Their reconstruction work is based on the Basic Guidelines for Reconstruction, which set the basic framework for the reconstruction process in Tohoku Region. This means, that both cases possess the same background conditions. Accordingly, it can be expected that the literal replication of the legally defined spatial planning options and the background conditions of both cases will deliver similar results regarding the dependent variable (the effect on resilience) (see illustration 37).

Beyond the legally binding spatial planning options, each case study city put an emphasis on specific aspects throughout the reconstruction process. These emphases are the preservation or creation of community cohesion in Miyako City and the economic revitalization of the city center in Ishinomaki City. Trying to reach these specific goals included the use of optional spatial planning options that were not required or specified by law (this especially refers to participation

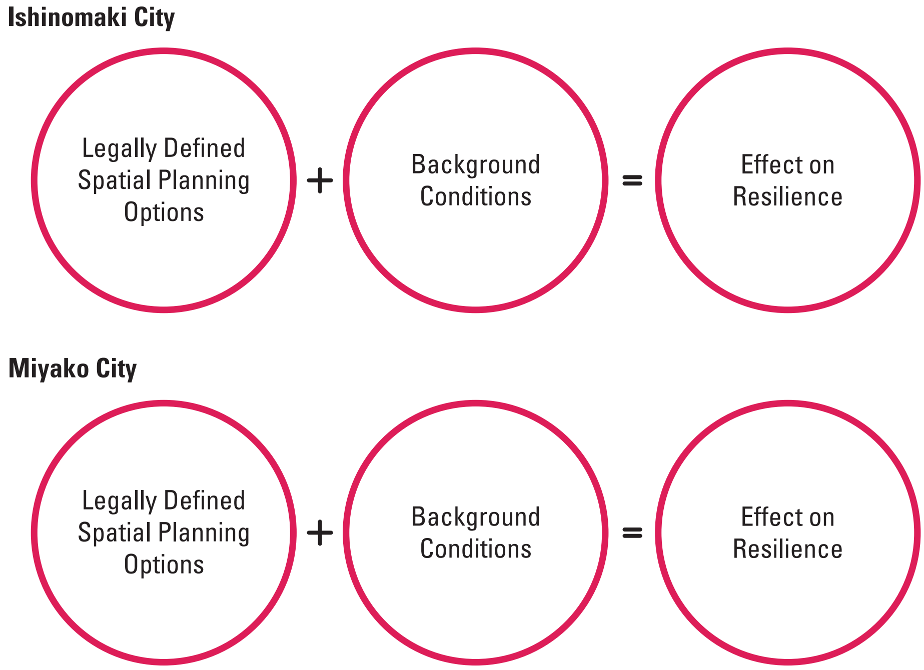


Illustration 37 | Literal replication | Own illustration

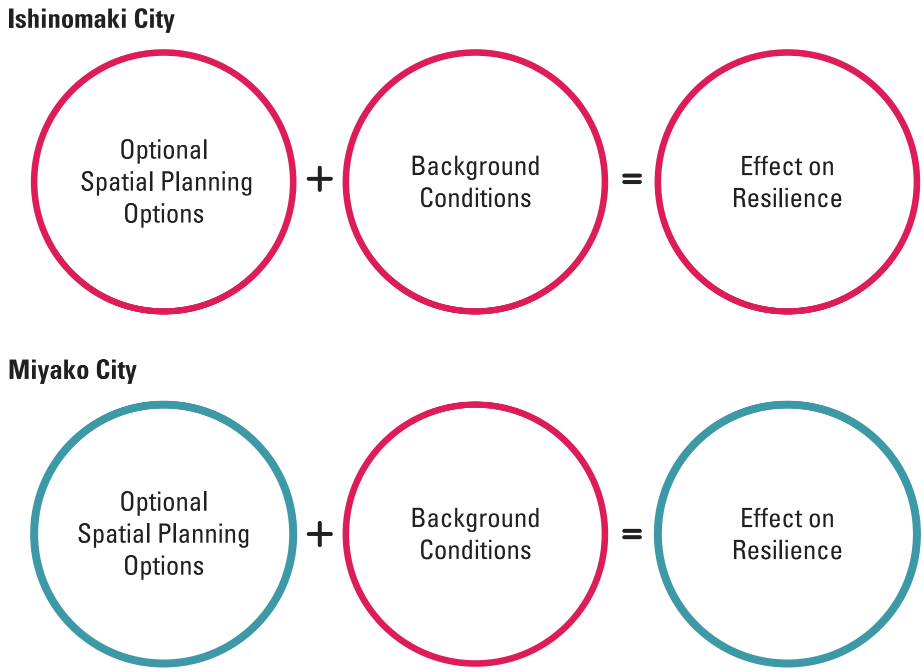


Illustration 38 | Theoretical replication (most similar cases research approach) | Own illustration

approaches). In this context, the case study selection follows a most similar cases research approach: The background conditions for the case study sites remain the same, while the independent variable (the optional spatial planning options used) varies. This approach is expected to result in different outcomes for the dependent variable (the effect on resilience) for the two case study sites (see illustration 38).

Finally, it should be mentioned that one reason for the selection of the two case study sites was the access to the field that was initialized by Professor Dr. Michio Ubaura. Without his personal connection to the spatial planners on-site it would have been very difficult if not impossible to collect all the information that was necessary for this research.

7.2 METHODOLOGY OF DATA COLLECTION AND ANALYSIS

After the case study sites were selected, the phase of structured data collection started. Due to the nature of case study research, some of the data had already been collected during earlier research stays.

As mentioned above, the first phase of "soaking and poking" occurred during the Kick-Off-Meeting of the URBIPROOF research project in May 2013 and during the three 6- to 8-week research stays in Tohoku Region which were conducted in November-December 2013, July-September 2014 and February-April 2015. During each of these stays, Professor Dr. Ubaura supplied a workplace at the Urban and Regional Planning System Lab at the Department of Architecture and Building Science at Tohoku University to enable an efficient work throughout these stays abroad. The final data collection, including the conduction of the interviews used for the case study analysis, was conducted between 27 September and 17 October 2015. During this time, the data collection for the case studies took top priority.

Although the research stays were lead by the guiding questions, it was attempted to stay adaptive and open for unexpected possibilities to learn more about the reconstruction process in Tohoku Region or Japanese traditions in general. This included to listen and watch things carefully and unbiased whenever possible. Of course this intention could not always be met due to human constraints. Nevertheless, the note taking and recording of the information given in the interviews enabled a later analysis and revision of first impressions.

Gaining access to the field was a complex procedure which was characterized by language restrictions, the limited time of local experts due to their ongoing efforts to manage the reconstruction process and the high amount of interview requests that they get from international researchers. It was only possible to gain this access through the personal connections from Professor Dr. Michio Ubaura who also was involved in the reconstruction process and collaborated with many of the local experts.

To collect the data for the case study analysis, a variety of scientific methods were used. To gather the basic information and get an understanding for the theoretical background, a literature review was conducted. This review included scientific literature as well as internet websites of Japanese authorities (e.g., Recovery Agency, Miyako City, Ishinomaki City). Furthermore, statistical data was collected. The research's key part, however, are the various field trips to Tohoku Region. During these stays, on-site visits and interviews with local experts were conducted. It was carefully paid attention to meet the four principles of data collection to ensure the continuous quality of the empirical work. This quality is determined by the criteria "construct validity", "internal validity", "external validity" and "reliability" (Yin, 2014, pp. 45–46).

Construct validity refers to the use of the correct research design in order to measure the intended phenomena (Yin, 2014, p. 46). This is of special importance for case study research because the research design depends on the subjective decisions of the researcher. Therefore, the operationalization that serves as the research basis and the research itself should be carried out with careful consideration. To increase the construct validity of this research, the research results are based on multiple sources of evidence that were evaluated based on the principle of real data triangulation whenever possible. This means that the needed data was collected from different sources with the aim to receive consistent results. The data was then evaluated jointly before the final conclusions were drawn. The procedure to use various sources of evidence emphasizes the particular strength of case study research and increases the research's quality (Yin, 2014, p. 119).

Internal validity means "[t]he degree to which descriptive or causal inferences from a given set of cases are correct for those cases" (Seawright & Collier, 2010, p. 334). Internal validity can be achieved easier when only a small number of cases is analyzed. Case study research can therefore reach internal validity more easily than statistical surveys. To increase the internal validity of conclusions, it is helpful if the selected cases possess homogeneous framework conditions (Blatter et al., 2007, pp. 137–138), as it is the case with the two selected case study sites.

External validity refers to "[t]he degree to which descriptive or causal inferences for a given set of cases can be generalized to other cases. It is also called generalizability" (Seawright & Collier, 2010, p. 330). As discussed above, case study research focuses on its strength in internal validity rather than on the generalization of research results. This means that any generalization can only happen on the analytical level. Analytical generalization enables the researcher to "extend [case study findings] to situations outside of the original case study, based on the relevance of similar theoretical concepts of principles" (Yin, 2014, p. 237). This means, the research results might also be true for other cases with similar background characteristics. They can, however, not be generalized in a way that representative statistical studies permit it. Nevertheless, it should not be forgotten that external validity is not the first priority of case study research and, to borrow from Small (2009), a ship does not have to fly (p. 28). To prevent the mistake of overgeneralization, the results from this case study research are not applied to places with different characteristics, even though the selection of two case study sites instead of one contributes to an increase of the research's external validity.

Reliability defines the reproducibility of the results by other researchers. This can be ensured by operationalizing the subject of research as clear as possible (Przyborski & Wohlrab-Sahr, 2014, p. 24). In this research, the operational set was developed based on the literature review in Part A. It includes all important terms from the research questions: spatial planning, resilience, disaster, window of opportunity (see Chapter 6). Of course, an operationalization can never completely describe the complexity of the real world, which means operationalizations are always abstractions from reality that are determined by a specific researcher. To make the operationalization as comprehensible as possible, they were carefully explained. To ensure that future researchers, who investigate the same cases, can come to the same conclusion, the needed data for each case was planned out on the basis of guiding questions (see Chapter 1.4). The collected data was precisely documented in a case study database. Moreover, the research work was conducted and documented as accurate as possible to make it replicable for other researchers.

The analysis for the case studies for this research bases on multiple forms of documentation (e.g., administrative documents and plans, scientific evaluations and news articles), archival records (e.g., maps and statistics), interview transcriptions and direct observations from on field site visits. The collection of this data required multiple scientific methods, which will be introduced in the following chapters.

7.2.1 Systematic literature review

The data collection for the case study analysis was supported by a systematic literature review. Different from the literature review that was conducted to compile the state of research in Part A, this literature review – or document review – focused on documents and archival records about the selected case studies rather than scientific literature. Documents that were of interest were agendas or presentations from meetings, administrative documents (e.g., reports, planning documents) or articles from newspapers. In addition to this, archival records such as Census data, maps and charts that provide information about the geographical characteristics of the case study sites were also collected. These literature reviews were mainly conducted via systematic internet searches, especially on the websites of governmental institutions (e.g., Statistics Japan, Reconstruction Agency, Miyako City, Ishinomaki City). Additional material was collected during the research stays. The majority of the documents and archival records were written in Japanese. To still make use of these documents, the researcher translated them with the help of the software Google Translate. By this means it was possible to obtain a general understanding of the Japanese data. Nevertheless, a detailed analysis of these documents was unfeasible. To keep an overview of the large amount of data, the collected data was compiled in a case study database.

7.2.2 Interviews

"Interviews are an essential source of case study evidence because most case studies are about human affairs or actions" (Yin, 2014, p. 113). Principally, there are two basic forms of interviews: Interviews that aim for a quantitative data analysis and interviews that focus on the qualitative aspects. Quantitative interviews or surveys usually are strongly structured, which means the questions are pre-formulated and their order cannot be changed (Bortz & Döring, 2006, p. 238). To enable a quantitative evaluation of the collected data, surveys usually are conducted with a representative group. Their aim is to measure certain predetermined effects (Atteslander, 2010, p. 133). Quantitative interviews can either be conducted orally (e.g., individual survey, telephone survey) or in written form (e.g., postal survey, internet survey).

Qualitative interviews, on the other hand, are usually partially or slightly structured and aim at the interpretation of the compiled data (Atteslander, 2010, p. 133). Partially structured interview forms (e.g., guided interview, expert interview) are based on an orientation guideline that includes the interviews general topics and questions. Nevertheless, the interviewer is free to adjust this guideline to the actual content of the conversation and the interviewee is free to answer in his or her own words (Misoch, 2015, p. 13). Interviews that are only slightly structured (e.g., narrative interviews) completely refrain from the use of an interview guideline or questionnaire. This form of interview strongly depends on the researcher's ability to encourage the interviewee's flow of speech (Misoch, 2015, p. 14). Qualitative interviews are mostly conducted orally because of their length (Bortz & Döring, 2006, p. 308). The strength of open interview questions is their ability to reveal a person's knowledge about connections that were previously unknown to the researcher. This means, the researcher is able to gain new information without the need to specifically ask for it.

7.2.2.1 Expert interview

For the purpose of this research, the specific interview form of expert interviews was selected. Expert interviews are characterized by a focus on the interviewee's specific knowledge about his or her field of expertise that is not part of general knowledge (Misoch, 2015, p. 120). In this context, an expert can be defined as a person who possesses specific knowledge about a certain topic. In many cases this status is associated with a person's profession (Przyborski & Wohlrab-Sahr, 2014, p. 119). The reason to use expert interviews in the context of this research, is that the specific knowledge of local spatial planners was essential for the analysis of the reconstruction process. Therefore, experts who work in this field were selected for the interviews. It was aimed to speak to experts who work for different institutions for each case study site. It was intended to speak to a representative of the city administration, a member of a NGO and a consultant in Miyako City and Ishinomaki City. Table 17 on the next page gives and overview about these interviews that served as a basis for the case study analysis of this research.

When conducting interviews with experts, it is especially important to carefully prepare and gain a basic knowledge about the interviewee's work. The reason for this is the verifiable influence of the interviewer's knowledge on the expert's willingness to share his or her expertise (Misoch, 2015, p. 122). The interviews were conducted at the end of a two-year "soaking and poking" phase, during which an ongoing engagement with the topic occurred. Accordingly, the interviewer had some general knowledge about the local conditions as well as the state of the local reconstruction efforts. This knowledge helped to follow the conversation with the experts. Nevertheless, the fact that the research was conducted in a foreign country with existing language barriers resulted in a certain imbalance between the interviewer and the experts that could not be prevented. The influence of this fact on the interviews had to be accepted, and was considered for the analysis of the data.

City	Expert's occupation	Date of interview	Language of interview/ Translation	Location of interview	Notes
Miyako City	Employee A of City Planning Division	2 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Miyako City, Planning Division	
Miyako City	Consultant	3 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Miyako City, Taro District, Community Restaurant	This interview included talking to the Consultant, Citizen A and Citizen B
Miyako City	Citizen A	3 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Miyako City, Taro District, Community Restaurant	This interview included talking to the Consultant, Citizen A and Citizen B
Miyako City	Citizen B	3 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Miyako City, Taro District, Community Restaurant	This interview included talking to the Consultant, Citizen A and Citizen B
Ishinomaki City	Member of Downtown Creative Reconstruction Committee	7 October 2015	English	Ishinomaki City, Machi Café	
Ishinomaki City	Employee of Machizukuri	7 October 2015	Japanese translated by Tomoko Otsuka	Ishinomaki City, Machi Café	
Ishinomaki City	Employee of City Planning Division	14 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Ishinomaki City, City Hall	
Ishinomaki City	Consultant	14 October 2015	Japanese translated by Tomoko Otsuka	Sendai City, Central Station, Starbucks Café	

Table 17 | Interviews conducted in Miyako City and Ishinomaki City | Own illustration

Interview Guidelines

Expert interviews are a specific form of guided interviews and therefore follow equal rules (Przyborski & Wohlrab-Sahr, 2014, p. 120). This means expert interviews are based on guidelines, which are developed based on the research interest and which contain all relevant subjects of interest. During the interview, the researcher uses guidelines to structure the interview and focus on the relevant aspects. If more than one interview is conducted, guidelines enable a certain comparability between these interviews. Depending on the research, interview guidelines can vary in their level of detail. If the conversation requires it, the interviewer is free to vary the order of questions or topics (Misoch, 2015, pp. 65–66).

In this way, the general focus on the main research interest can be maintained, while an adjustment of the conversation is possible if a new topic emerges.

The interview guidelines were structured in four phases, based on the standards for qualitative interviews (Misoch, 2015, p. 68): The information phase, the introduction phase, the main interview phase and the conclusion phase. Although the basic structure of the interviews was similar, they varied in accordance with the interviewee. The actual interview guidelines used can be found in the annex.

In the information phase at the beginning of the interview, the interviewees were informed about the topic of research and the value of their knowledge for the research process. Moreover, the interviewees were assured that their personal data would be treated confidentially and asked if they would permit the recording of the interview (see illustration 39 on the next page).

The aim of the introduction phase was to ease the beginning of the interview and help the interviewee to arrive in the unusual communication situation. For this purpose, questions that can be answered without hesitation should be used (Misoch, 2015, p. 68). Within the scope of this research, the interviewees were asked to introduce themselves and explain their position in the reconstruction process (1)[6]. This also enabled the acknowledgment of their expert status (Przyborski & Wohlrab-Sahr, 2014, pp. 122–123). The second question served as a stimulus for the interviewees narration (2). The question was intentionally formulated to enable the expert to outline the situation with his or her own words.

After the flow of speech stopped, the researcher built on what was said by asking the interviewee to specify certain points and asking questions from the guideline that tied in with the previous content of the conversation. Only after this phase of immanent questions was finished, the remaining interview questions from the guideline were asked (Przyborski & Wohlrab-Sahr, 2014, pp. 123–124). Accordingly, the order of the questions asked differed from interview to interview according to the conversation.

The main part of the interview guidelines consisted of questions that where of special relevance for the research. To increase the orientation, the questions were summarized thematically to cover the topics "engineering resilience", "socio-ecological resilience"[7], "additional challenges" and "window of opportunity".

The questions regarding engineering resilience, aimed for the identification of spatial planning options that were used to increase this type of resilience (3) and an evaluation for their usefulness (4). The second block of questions addressed socio-ecological resilience and queried spatial planning options that were used to increase socio-ecological resilience (5). This question was formulated to explain the meaning of socio-ecological resilience by giving examples for items that address socio-ecological resilience (community connectedness, involvement of vulnerable population groups). Similarly to the preceding thematic block, the interviewees were also asked to evaluate the usefulness of the available spatial planning options to reach socio-ecological resilience (6). The third block of questions ad-

[6] The numbers in brackets refer to the respective question in the interview guidelines in illustration 39.

[7] The decision to use the term "evolutionary resilience" instead of "socio-ecological resilience" for this research was made after the interviews were conducted. Accordingly, the interview guidelines use the term "socio-ecological resilience" instead of "evolutionary resilience". Nevertheless, they both refer to the same (see Chapter 3).

Interview Guideline for Spatial Planners

Information phase

Thank you for the opportunity to interview you to learn more about the reconstruction process in [your city]. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis. To make the analysis of the interview easier, it would be very helpful to record it. Would this be OK for you?

Introduction phase

(1) First, I would like to ask you to please introduce yourself and tell me what your position in the reconstruction process of [your city] is?

(2) Could you please tell me about the reconstruction process after 3-11? Feel free to begin wherever you find it appropriate and explain the steps that were most important for you. Take your time; I will not interrupt you until you are finished.

Main phase

Engineering resilience

(3) The basic goals for the reconstruction process in response to the Great East Japan Earthquake include building infrastructural resilience – what has been done to approach this goal?

(4) Do you think that the available tools and approaches of spatial planning were sufficient to build up infrastructural resilience? What do you think could be improved?

Socio-ecological resilience

(5) Besides the sufficient infrastructure, resilience is also increased by socio-ecological factors such as community connectedness or participation of vulnerable segments of the population (e.g., the elderly). What tools and approaches did spatial planners in [your city] use to increase some of the things I just mentioned, like community connectedness or participation of vulnerable segments of the population or anything else related to this (socio-ecological resilience)?

(6) Do you think these things were helpful? What would you like to be different?

Additional challenges

(7) The Basic Act on Reconstruction and Response to the Great East Japan Earthquake states that the changing needs of an aging society or global warming (e.g., sea level rise or rising possibility of heat waves) should be considered throughout the reconstruction process. Do you feel like this is happening? If yes, how? If no, what would help to improve the current situation?

(8) Do you see the uncertainty of future as a challenge? For example, the fact that you do not know about the height of a possible sea level rise or changes in weather. How are these uncertainties considered?

(9) Were special measures to fulfill the changing needs of an aging society taken into account throughout the reconstruction process? Was global warming (e.g., sea level rise or changing temperatures) considered?

Window of opportunity

(10) Do you think there is a window of opportunity after a disaster? If yes, did this opportunity help plans to be implemented faster?

(11) Before 3-11, did the administration of [your city] already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

Conclusion phase

(12) Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done.

Illustration 39 | Interview guidelines for spatial planners | Own illustration

dressed the additional challenges that the Basic Act on Reconstruction mentions (e.g., demographic change, climate change), if they were addressed in the local reconstruction process (7) and how this was achieved (9). Furthermore, the topic of uncertainty was addressed to understand if spatial planners did anything to address this topic (8). Because it was necessary to streamline the research process after the interviews were conducted, the information regarding these additional challenges were later excluded from the case study analysis. It is planned to use this information in another context (e.g., for the preparation of a scientific article). The final block of the main interview phase addressed the window of opportunity that, according to theory, opens after a disaster and enables planners to build a city back better (see Chapter 3.3). To test this assumption in the field, the interviewees were asked if they believed in the existence of a window of opportunity and how its influence on the implementation of the reconstruction plans was evaluated (10). The topic was concluded with a question regarding the city's pre-disaster preparation of the reconstruction process. The intention was to find out if a reconstruction plan existed before the disaster and if the experts considered such a plan to be helpful in order to use the window of opportunity more effectively (11).

The interview closed with the final phase that offered the opportunity to add so far undiscussed information that the interviewee considered important. The final phase also has the aim to conclude the interview situation (Misoch, 2015, p. 69).

During the entire interview, the researcher carefully paid attention to what was said to enable an adaptation of the interview structure if the conversation required it. In this way, spontaneously mentioned topics that were intended to be raised later in the interview, could be discussed earlier and the natural flow of conversation could be optimally obtained.

When conducting interviews, the researcher should be aware of the basic principles of social communication. To put it simply, models of communication understand a conversation as a message that is send out by one person (source) to another (receiver). To enable a communication without misunderstandings, it is essential that source and receiver use the same "code" for the message, which means they are both talking about the same content (Kromrey, 2002, pp. 315–318). This means, if the communication process gets disrupted, misconceptions between source and receiver can occur. This problem is of special relevance when interviews are conducted in a foreign language and are translated by a third person, as it was the case for this research. The author's verbal abilities in Japanese are very restrictive and communication with Japanese could only be performed in English, if the conversational partner was proficient in this language, or with the help of a translator. This certainly led to the loss of atticism or information between the lines. Even though these circumstances restrict the collected data, there was no feasible way to prevent this as it is a general problem of research conducted in counties that do not speak the researcher's native language. The author kept these difficulties in mind while conducting the case study analysis. Another difficulty when carrying out interviews is a possible inaccuracy of information based on an interviewee's bias. This can also occur if the interviews are conducted with experts (Yin, 2014, p. 113). To deal with this problem, it was intended to base conclusions on information from more than one resource whenever possible.

The limited number of potential interviewees enabled a careful qualitative analysis of the collected data. For this purpose, the recordings from the interviews were completely transcribed following standard orthography. This procedure was selected to ensure that no important information was lost as it can be the case if only selected party of an interview are transcribed (Misoch, 2015, p. 257). The transcribed interviews were then added to the case study database and analyzed in the next step (see Chapter 7.2.4).

7.2.3 Direct observations: Site visits

The complex framework conditions in the field are of particular importance for planning as a spatial science. Site visits allow the researcher an active involvement with the area of research and enable a better understanding of the local conditions as well as the localization of the collected data. During site visits, the researcher can vary the level of detail and make use of various scientific methods (e.g., direct observation, mapping or surveys) (Althaus, Grunwald, & Kreuzer, 2009, p. 2). Site visits can be useful for the collection of historic developments, natural conditions, landscape structures, transportation infrastructure, pattern of use (e.g., social infrastructure), existing developments, public space, population structure, local actors or existing land-use planning (Althaus et al., 2009, pp. 15–23).

Generally speaking, site visits are a specific form of observations because the researcher observes his or her surroundings to collect the needed data in observations as well as in site visits. Direct observations are especially useful for case study research because "the phenomena of interest have not been purely historical, some relevant social or environmental conditions will be available for observation" (Yin, 2014, p. 113). In the context of spatial planning, these relevant conditions are often locatable. Compared to other forms of data collection, observations or site visits are characterized by the fact that the object of interest continuously changes. This means that once missed observations cannot be caught up (Kromrey, 2002, p. 337). This results in the fact that the researcher who conducts observations is forced to decide which information is going to be recorded for later considerations and which information is not. This increases the subjectivity of observations as a tool for data collection. The researcher should be aware of this constraint and attempt to lower the subjectivity of the collected material by recording what he or she observes with the help of a camera (Kromrey, 2002, p. 338). The difference between site visits and conventional direct observations is that site visits focus on the spatial conditions while other observations often focus on the people who inhabit this space. This does not mean that site visits never intend to collect data about a place's residents, but site visits try to link the social component with the area under investigation.

There are two different types of site visits that vary in their degree of preparation. Site explorations are useful to gather first impressions and observe specific characteristics of the area of research. They can be conducted accompanied with local experts or alone. Site explorations are characterized by a more or less unstructured approach that allows the researcher to intuitively follow his or her own perception of the surrounding area. Despite their formless nature, site explorations should still be documented carefully, to enable the later use of the collected data. This documentation can take place, e.g., by taking photographs or writing down relevant information or ideas for further research (Althaus et al., 2009, pp. 24–25). Site inspections, on the other hand, are suitable to systematically collect data from the field. This requires a careful preparation and the knowledge which data from the field is required. The researcher should consider in advance which aspects should be recorded and how this recording should occur. Useful methods of documentation are photographs, mapping or taking notes. The researcher should ensure to have all needed tools available when conducting a site inspection (Althaus et al., 2009, pp. 26–29).

The location of this research's case study sites in a foreign country – from the researcher's point of view – increased the relevance to conduct site visits to receive an impression of the local conditions. Accordingly, each stay in Tohoku Region was accompanied by a site visit of various cities and villages along the coast that were affected by the disaster. During all of these stays, the site visits were documented with photographs and by taking notes of important information that was supplied. For some of the field trips additional material (e.g., handouts) were supplied.

During the URBIPROOF project's Kick-Off-Meeting from 12 May till 16 May 2013, the group of researchers visited Iwanuma City, Natori City, Ishinomaki City, Minamisanriku Town, Kesennuma City and Rikuzentakata City. The field trip was accompanied by Professor Dr. Ubaura who also prepared a brochure with information about the visited area and answered questions about the reconstruction process.

During the first research stay in Sendai, which lasted from 2 November till 24 December 2013, a second site visit of the affected area along Tohoku Coast took place (from 14-15 December 2013). This time, the researcher visited Iwanuma City, Natori City, Ishinomaki City, Onagawa Town, Minamisanriku Town and Kesennuma City.

The second research stay from 28 July till 6 September 2014 was also used to make several site visits. On 18 August 2014 the researcher visited Natori City, on 29 August 2014 she went to Ishinomaki City and from 31 August till 1 September 2014 a trip to Miyako City, Otsuchi Town, Kamaishi City, Ofunato City Rikuzentakata City and Kesennuma City was undertaken.

During two weeks of her third research stay (18 February till 4 March 2015), the researcher was accompanied by 14 students from TU Dortmund University. Together with Prof. Dr. Michio Ubaura and Prof. Dr. Christian Dimmer the group undertook a field trip to Iwanuma City, Natori City, Ishinomaki City and Rikuzentakata City (20-21 February 2015). Afterwards, the group stayed in Ishinomaki City from 21-27 February 2015 to conduct additional field work. During this time, an additional field trip to Onagawa Town was conducted. During the Third UN World Conference on Disaster Risk Reduction, that took place in Sendai from 14-18 March 2015, the researcher took the chance for additional field trips and visited Arahama Ward in Sendai City (15 March 2015), Kesennuma City, Minamisanriku Town, Ishinomaki City, Onagawa Town and Sendai City (17 March 2015) and Ibasho Café in Ofunato City (19 March 2015).

All of the above mentioned site visits were characterized by a high degree of spontaneity in regard of the data collection. Everything that seemed important was photographed and documented, so that it was available for further use in the future.

Finally, during the last research stay from 27 September till 17 October 2015, more organized site inspections of the case study sites were conducted. The purpose of these inspections was to document the current status of the reconstruction process at specific locations. Despite the former site visits, this more focused approach to data collection in the field was helpful to locate the reconstruction projects on a map and understand the spatial connections between them. These site inspections were conducted between 30 September till 3 October 2015, when the researcher visited Ishinomaki City, Minamisanriku Town, Kesennuma City, Rikuzentakata City, Ofunato City, Kamaishi City, Otsuchi Town and Miyako City. Further site inspections were conducted in Ishinomaki City (7 and 14 October 2015) and Higashi-Matsushima (13 October 2015). All important information as well as the researcher's personal impressions were documented in a field diary and with photographs even more carefully than during the former research stays. Furthermore, various expert interviews (see above) were conducted during this time. In addition to these interviews, two of the site visits in Miyako City were also accompanied by an employee of the city's Planning Division, who answered several questions about the ongoing reconstruction process in Taro District and Kuwagasaki District. These interviews did not follow a specific guideline. Nevertheless, the content was carefully noted to enable its consideration for the case study analysis (see table 18).

City	Expert's occupation	Date of interview	Language of interview/ Translation	Location of interview
Miyako City	Employee B of City Planning Division	3 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Miyako City, Taro District
Miyako City	Employee B of City Planning Division	3 October 2015	Japanese translated by Prof. Dr. Michio Ubaura	Miyako City, Kuwagasaki District

Table 18 | Interviews during the site visits in Miyako City | Own illustration

7.2.4 Data Analysis

After the data collection phase, the researcher had an extensive amount of information available. Although interesting, substantial parts of this information were redundant for answering the research and guiding questions. It was important to set aside this information in order to keep the focus on the main research topic. The preparation of the collected data for analysis included the write up of field notes and the transcription of the interviews. The aim of this step was to edit the data to make it understandable for the reader. To better understand the processes in the case study cities, the collected data was rehashed into chronological order before it was analyzed.

The data was analyzed based on the principles of qualitative data analysis and occurred in two coding cycles. "Codes are labels that assign symbolic meaning to the descriptive or inferential information compiled during a study" (Miles, Huberman, & Saldaña, 2014, p. 71). They can be used to structure large amounts of data and enable the detection of patterns. For the coding of the data, the data analysis software MAXQDA 12 was used. For the analysis of the data, it is important for the researcher to maintain an adequate distance. This aspect is especially relevant for case study research because the "soaking and poking" phase inevitably leads to a certain closeness to the subject under investigation. This important aspect was also considered for this research by challenging the decisions made throughout the data analysis phase.

The first coding cycle used the resilience items developed in Chapter 5 as provisional codes. In addition to the resilience items, the additional topics with relevance for the research were also added to the coding list: demographic change, climate change, window of opportunity and uncertainty. The first coding cycle enabled to structure the large amount of data and to match relevant information with the specific aspects of the research (Miles et al., 2014, p. 72). The codes that were used during this phase are listed on the next page in table 19.

Resilience Codes
› Engineering Resilience
› Vulnerable land-uses at risk
› Building Codes
› Urban Design Solutions
› Sustainable building design standards
› Protective infrastructure
› Disaster resilience of utility infrastructure
› Disaster resilience of social infrastructure
› Political-institutional resilience
› Proposal evaluation for disaster resilience
› Risk assessment
› Pre-event planning for disaster recovery
› Learning loops
› Socio-economic resilience
› Citizen participation
› Social connectedness and neighborhood cohesion
› Provision of safe shelter
› Environmental resilience
› Ecosystem health
Additional Codes
› Demographic change
› Climate change
› Window of opportunity
› Uncertainty

Table 19 | Codes used for the first coding cycle | Own illustration

The second coding cycle applied descriptive and in vivo codes which were consecutively developed. These codes were used to label the processes that were undertaken to address the resilience and additional challenges coded during the first coding cycle. This approach lead to a versatile list of codes, which is illustrated in table 20 based on the frequency of application (excluding codes that were only applied once or twice).

Because of their consecutive development, these codes do not directly correspond to the spatial planning options identified in Chapter 4. Nevertheless, it can be noticed that most of these spatial planning options are included in the list of codes. This is the result of the iterative research process, which based the compilation of the spatial planning options in Chapter 4 on the experts' statements about the most relevant spatial planning options for the reconstruction process.

After the second coding cycle, each resilience item and additional challenge was matched with the spatial planning options (and other relevant aspects) that were mentioned in their context. The table with the matching patterns was compiled with MAXQDA and then further processed in Microsoft Excel.

Codes
› Sectoral Planning
› Participation
› Land-use planning
› Relocation
› Reconstruction Committee
› Financing
› Protective Infrastructure
› Temporary Housing
› Aim
› Beyond legal requirements
› Reconstruction Plan
› Information
› "It's difficult"
› Public housing
› Evacuation facilities
› Restoration of community infrastructure
› Community Association
› Permanent houses
› Time
› Land readjustment
› Compact city
› Revitalization
› Building Codes
› Public and private sector
› Private reconstruction projects
› Population
› General reconstruction
› Flexibility
› Land raise
› Education
› Hazard maps/ Hazard simulation
› Happiness
› Reconstruction projects
› Prioritization
› Analysis
› Cross-border coordination

Table 20 | Codes developed during the second coding cycle | Own illustration

For each data chunk the relevant information was summarized and used for the analysis of each aspect presented in Chapter 8 for Miyako City and Chapter 9 for Ishinomaki City. To conclude the research, a cross-case analysis based on the relevant spatial planning options was conducted. The results of this analysis are presented in Chapter 10, before the final conclusion for this research is drawn in Chapter 11.

8. CASE STUDY A: MIYAKO CITY

This chapter provides the results from the case study analysis of Miyako City. After an introduction of the city's geographic and demographic structure and the impacts of the GEJE and Tsunami on the local structures, the main goals of the recovery process in Miyako City are introduced. Based on this general information, the following guiding questions introduced in Chapter 1.4 are answered:

› Which spatial planning options were used to build engineering resilience?

› Which spatial planning options were used to build evolutionary resilience?

› Which spatial planning options were able to build resilience? Which additional spatial planning options would have been useful to build resilience?

› How was the window of opportunity constituted in Miyako City?

› Did Miyako City have any spatial plans for reconstruction prepared before the disaster?

› How can the preparation of spatial plans for reconstruction before a disaster help to use the window of opportunity more effectively?

8.1 INTRODUCTION OF MIYAKO CITY

Miyako City is located in northern Japan's Iwate prefecture (see illustration 41 on the next page). The city's current area was established through the great Heisei amalgamation which merged the formerly independent parts of Miyako City with Taro Town and Niisato Village in 2005 and Kawai Village in 2010 (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2014, Table No. 62). Today, the city spans an area of 1,259.15 km^2 and borders the Pacific Ocean in the east, Morioka City in the west, Iwaizumi Town in the north and Tono City in the south (Miyako City, 2015a, p. 15).

The city had a population of 59,430 people in 2010, before the disaster occurred. In 2015, 56,569 people were left (Miyako City, 2015a). One important reason for this decrease are the casualties of the GEJE and the migration of people in the aftermath of the disaster. Another reason takes effect in the longer term: Like many smaller cities in Japan, Miyako City has to deal with a demographic change which is characterized by a shrinking and aging population (see illustration 40). This leads to a growing number of elderly people while the number of children remains low.

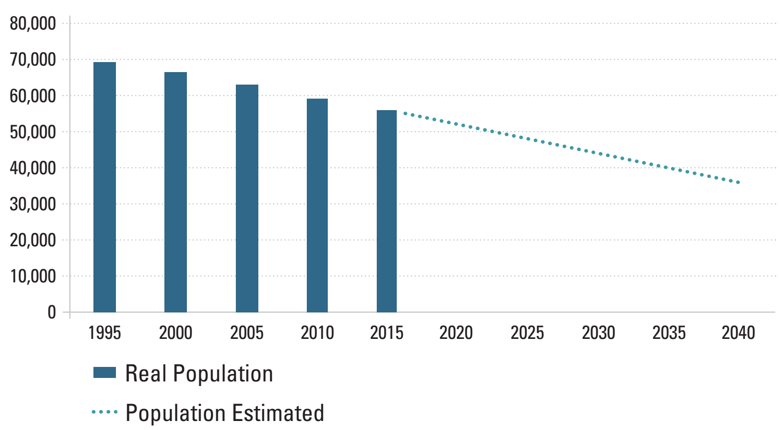


Illustration 40 | Population development of Miyako City | Own illustration based on Brinkhoff, 2016a (population 1995-2015); National Institute of Population and Social Security Research, 2013 (estimates for 2015-2040)

Illustration 41 | Location of Miyako City | Own illustration based on D-maps, 2016b

Employment in Miyako City differs between districts. The urban district of Miyako area is characterized by manufacturing and the tertiary industry (especially wholesale, medical care and welfare). Many of the more rural neighborhoods intensely rely on the fishing industry (Kuwagasaki District, Taro District) or agriculture (Niisato District and Kawai District) (Miyako City, 2015a).

8.2 THE GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI IN MIYAKO CITY

In Miyako City, at about 14:46 the GEJE was felt with an intensity of 4.9. The first wave of the tsunami arrived at 15:01, the highest wave, with a height of more than 8.5 m, was measured at 15:26. Nevertheless, this data might be erroneous due to the destruction of Hitachibama Beach tidal station through the tsunami (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015). The tsunami inundated an area of 10 km^2 and left 467 citizens dead and 94 missing. Additional 33 citizens were injured (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 27). A look at the age structure of the victims shows that more than 65% of the people who died in the disaster were 60 years or older (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 38). When compared with the amount of residents aged 60 and above in 2010 (~40%) (Miyako City, 2015a), the high number of elderly victims indicates a special vulnerability for this age group.

The tsunami completely destroyed 5,968 houses and partially damaged about 3,120 (see table 21). Of all buildings damaged, 4,449 were dwellings, while 4,639 were non-dwellings. Considering the number of houses in Miyako City before the GEJE (39,907), about 23% of houses were affected and about 15% of houses were completely destroyed (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 27).

Number of completely damaged houses	5,968
Number of houses with large-scale destruction	1,335
Number of partially destroyed houses	1,174
Number of damaged houses	611
Total number of damaged houses	9,088

Table 21 | Damaged houses after the GEJE and Tsunami in Miyako City | Own illustration based on Miyako City Planning Division, 2015, p. 27

8.3 POST-DISASTER RECONSTRUCTION PLANNING IN MIYAKO CITY

After the disaster, the city administration developed a "Post-Disaster Reconstruction Plan". The plan sets the main goals to rebuild the city of Miyako. The plan incorporates the aim of the city's Comprehensive Plan, a city wide plan that was adopted before the disaster and included objectives for the period from 2011-2019. The Comprehensive Plan intended to create "an oasis where 'forests, rivers and the ocean' and people can coexist" (Miyako City, 2012a, p. 1 cit-

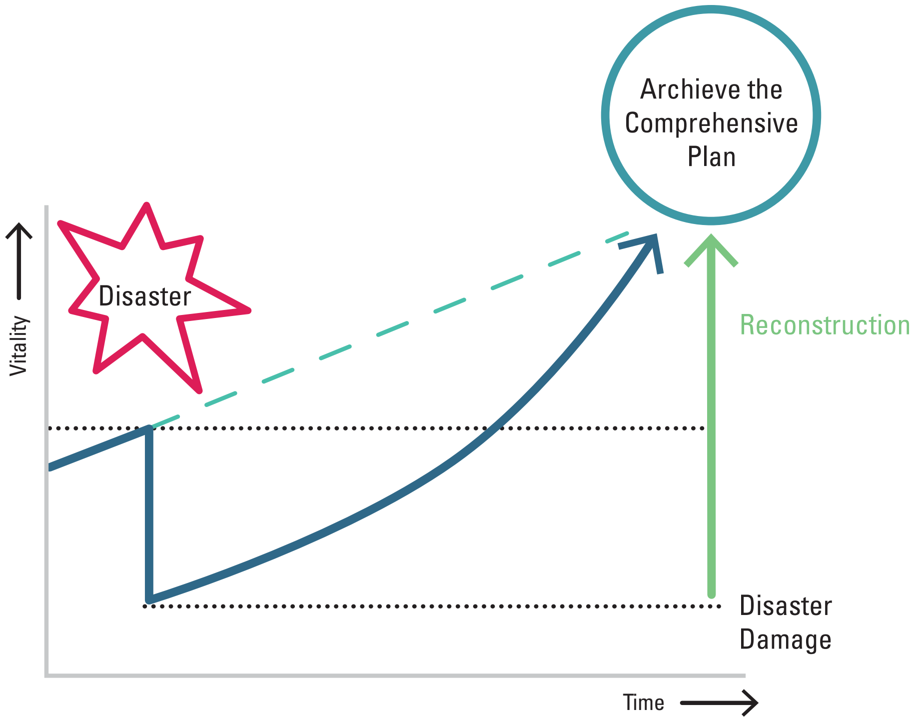


Illustration 42 | Reconstruction leading the way to achieve the aim of the Comprehensive Plan | Own illustration based on Miyako City, 2012a, p. 1

ing the Comprehensive Plan; Miyako City, 2015b). The Post-Disaster Reconstruction Plan intends a speedy recovery after the disaster. In this way, the goals that were set by the Comprehensive Plan are expected to be reached by 2019, even though the GEJE and Tsunami caused obstacles (see illustration 42).

The Post-Disaster Reconstruction Plan's time frame lasts from 2011 till 2019, whereas the first three years are called the "recovery period", the second three years are called the "revival period" and the last three years are called the "development period" (see illustration 43).

The plan builds on three pillars and develops the intended measures accordingly. Thereby, each pillar can be assigned to one of the types of resilience introduced in chapter 3.2.

Restoring people's houses and living

This point focuses on the social aspects of the reconstruction and includes the recovery of daily life of affected people by rebuilding their communities in a compact way. This enables the citizens to run their daily errands by foot. Community functions to be recovered include education, employment, healthcare and welfare. Thereby the reconstruction process should put an emphasis on elderly people and their special needs (Miyako City, 2012a, p. 2). Measures for this pillar include help to find new employment possibilities where needed, the provision of healthcare and education services, financial support and the strengthening of community cohesion (Miyako City, 2012, p. 4). These measures mainly address the social aspects of socio-economic resilience because they put the people and their communities in the center.

Illustration 43 | Time frame of the reconstruction process in Miyako City | Own illustration based on Miyako City, 2012a

Reconstructing industry and the economy

To recover the city's economy, the plan intends to revitalize the agricultural, forestry, fishing and tourist industries wherever they were affected by the disaster. Furthermore, the city center should be revitalized and the city's manufacturing industry should be strengthened. To resume economic activities as fast as possible, the reconstruction and revitalization of the city's port was another target (Miyako City, 2012, pp. 4-5). This pillar mainly focuses on the economic aspects of socio-economic resilience, especially on the revitalization of the local industry.

Rebuild safer communities

To minimize the potential damages in case of another tsunami, the plan intends the revision of the city's land-use plans, the possible relocation of residential land-uses and public facilities and the installation of protective infrastructure (e.g., tide barriers) and evacuation sites. Furthermore, disaster-resilient transportation networks (incl. road and railways) should be build and the disaster-resistance of the energy (e.g., through the promotion of renewable energy), water/sanitation and communication networks should be improved. All of these measures aim at the improvement of the city's engineering resilience. In addition to these structural changes, the city's disaster prevention and risk management system should be reviewed and improved wherever possible to ensure an optimal disaster preparedness (Miyako City, 2012a, p. 5). These aspects mainly focus on the improvement of administrative processes and therefore address political-institutional resilience.

The plan emphasizes the importance to include the citizen's view in the planning process (Miyako City, 2012a, p. 8). This was achieved by holding meetings for town reconstruction in all 33 affected districts. During these meetings, the reconstruction planning process was explained and the citizens were encouraged to communicate their opinions. In addition, the Planning Division conducted a survey questionnaire in July 2011 in order to gather the citizen's views and ideas for the reconstruction. This questionnaire also queried where the affected citizens intended to live in the future. To speed up the planning process and to save valuable time and personnel resources for the reconstruction planning in the ten most affected districts, the city's Planning Division used the information from these questionnaires to directly develop the district plans for the 23 city districts with 40 or less destroyed houses (Miyako City Planning Division, Employee A, 2015; Ubaura & Akiyama, 2016, p. 487).

Citizen participation in districts that suffered the loss of 100 or more houses was more comprehensive: In Taro District, Kuwagasaki District, Atago/Tsukiji/Koganji District, City Center District, Fujiwara District, Sokei District, Takahama District, Kanehama District, Tsugaruishi District and Akamae District (see illustration 44

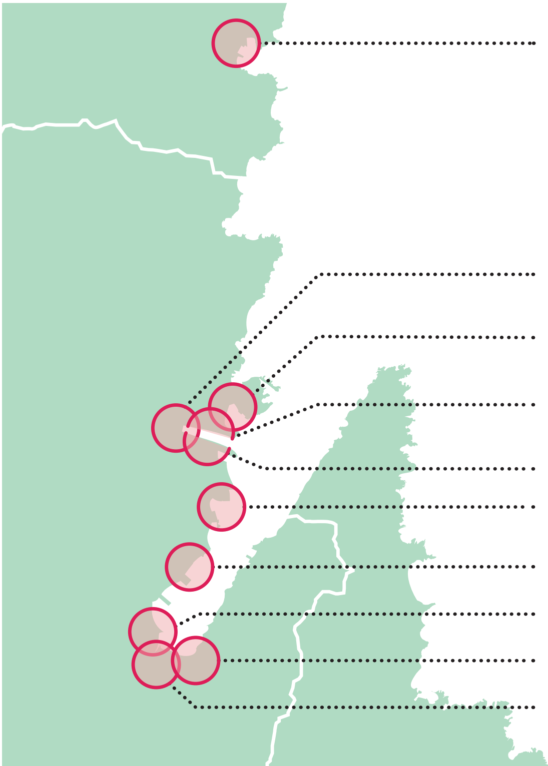


Illustration 44 | Map of the ten most severely affected districts in Miyako City | Own illustration based on Miyako City, 2012b, p. 5

for the districts' locations), 20 to 30 citizens were selected to participate in Reconstruction Town Planning Committees, which were responsible to develop a reconstruction plan for the district based on the requirements of the Post-Disaster Reconstruction Plan (Miyako City, 2012a; Miyako City Planning Division, Employee A, 2015). The committees were supported by a consultant and local spatial planners. Throughout their four meetings, the committees developed draft versions for the District Reconstruction Town Development Plans. These plans were discussed with the wider public, before they were submitted to the mayor in February 2012 (Ubaura & Akiyama, 2016). For a more elaborate summary of the committees' work, see Chapter 8.4.3.

Table 22 gives an overview of the damages in the ten most severely affected districts.

Besides the cooperation with selected citizens in the Reconstruction Town Planning Committees and the exchange at the meetings for town reconstruction and the preview meetings, all citizens were given information about the planning processes through the distribution of the "District Reconstruction Urban Development News". This newspaper was published continuously to support the reconstruction process and offer the citizens the chance to contribute their ideas via letter, e-mail or in person. The gathered opinions were then included in the discussions at the next committee meeting (Miyako City Planning Division, Employee A, 2015).

Based on the District Reconstruction Town Development Plans and the information gathered from citizens in the 23 less affected districts, the city administration developed the final plan called "Miyako City: The Great East Japan Earthquake

Name of District	Flooded area	Maximum inundation height	No. of damaged buildings	Percentage of damaged buildings completely destroyed
Taro	121.2 ha	T.P. +7.1-14.7 m	1,076	84 %
Kuwagasaki	39.1 ha	T.P. +5.4-9.0 m	800	88 %
Atago/ Tsukiji/ Koganji	12.2 ha	T.P. +3.4-7.0 m	312	75 %
City center	48.4 ha	T.P. +3.3-5.2 m	1,270	14 %
Fujiwara	40.9 ha	T.P. +2.3-5.0 m	497	25 %
Sokei	113.4 ha	T.P. +2.3-7.0 m	729	30 %
Takahama	42.0 ha	T.P. +3.4-15.0 m	259	47 %
Kanehama	29.4 ha	T.P. +10.8-13.0 m	242	94 %
Tsugaruishi	83.5 ha	T.P. +5.0-11.7 m	830	54 %
Akamae	82.9 ha	T.P. +6.0-13.0 m	340	74 %

Table 22 | Damages in the most severely affected districts of Miyako City | Own illustration based on Taro District Reconstruction Town Planning Committee, 2012; Kuwagasaki District Reconstruction Town Planning Committee, 2012; Atago/ Tsukiji/ Koganji District Reconstruction Town Planning Committee, 2012; Central District Reconstruction Town Planning Committee, 2012; Fujiwara District Reconstruction Town Planning Committee, 2012; Sokei District Reconstruction Town Planning Committee, 2012; Takahama District Reconstruction Town Planning Committee, 2012; Kanehama District Reconstruction Town Planning Committee; Tsugaruishi District Reconstruction Town Planning Committee, 2012; Akamae District Reconstruction Town Planning Committee, 2012

District Reconstruction Town Development Plan". It includes the plans for all 33 affected districts, and was adopted by the city council in March 2012 (Miyako City, 2012b, 2014a; Miyako City Planning Division, Employee A, 2015). Due to the time restrictions, this plan mainly includes residential land-uses, although the committees also decided on various other aspects such as the location of industry, social services or transportation networks. The reason for this trimmed version of the plan is that the responsibility for residential land-uses solely rests with the city's Planning Division while other aspects require the agreement of sectoral planning divisions (e.g., social affairs, transport). The exchange between the different departments would have taken too long to complete the plan on time. In other cases, ideas from the committees had to be disregarded because their implementation would have been too expensive or time-consuming. In all of these cases, the Planning Division employees discussed the respective reasons for their decision with the citizens. This means that the "Miyako City: The Great East Japan Earthquake District Reconstruction Town Development Plan" especially focuses on short-term projects and solutions, while additional projects included in the committees' district plans (e.g., the future location of Route 45) will be reviewed and discussed in the future (Miyako City Planning Division, Employee A, 2015).

8.4 BUILDING RESILIENCE IN MIYAKO CITY

This chapter takes a closer look at engineering resilience, political-institutional resilience, socio-economic resilience and environmental resilience and the resilience items to assess them, as they were introduced in Chapter 5. For each item, the spatial planning options used during the reconstruction process are considered and explained.

8.4.1 Engineering resilience

Engineering resilience can be assessed by using the items vulnerable land-uses at risk, building codes, urban design solutions, sustainable building design standards, protective infrastructure, disaster resilience of utility infrastructure and disaster resilience of social infrastructure. The following chapters explain how all of these aspects were addressed during the reconstruction of Miyako City.

8.4.1.1 Vulnerable land-uses at risk

One important goal to achieve engineering resilience is to reduce the exposure of vulnerable land-uses. The UNISDR's Disaster Resilience Scorecard specifically addresses agricultural land [UN-4.1.1], economic activity [UN-4.1.2] and potential population displacement (or residential land) [UN-4.1.3] (UNISDR, 2015d). As explained in Chapter 4.7, land-use planning is a useful option to reach this goal. The importance of land-use planning for the reduction of vulnerable land-uses at risk in Miyako City is addressed in the Post-Disaster Reconstruction Plan, which intends to create a safe place to live, to reduce the economic activity at risk to a minimum and to revitalize agricultural land (Miyako City, 2012a). Nevertheless, planning certain land-uses can demand additional coordination with sectoral planning departments (e.g., Environmental Division, School Education Division), which can take much time and effort. In Japan, this problem especially concerns land that is not designated as urban in the Land-Use Basic Plan. Such land falls within the scope of different ministries. For example, the Ministry of Agriculture, Forestry and Fisheries is responsible for agricultural and forestry areas. To change these designation is a complex and time consuming process and needs the approval of the national government. The completion of the District Reconstruction Town Development Plan for Miyako City was a pressing issue. Accordingly, the plan only addresses the reduction of residential land-uses at risk, other topics, although partially included in the citizen's proposal, were not adopted because the coordination with the responsible sectoral planning divisions would have taken too long (Miyako City Planning Division, Employee A, 2015). This chapter therefore focuses on residential land-uses.

The post-disaster reconstruction of Miyako City includes the following approaches to reduce vulnerable land-uses at risk:

- Minimization of exposure of urban areas: Land-use control in hazardous areas
- Minimization of exposure of urban areas: Relocation through relocation programs or land-readjustment projects
- Hazard Mitigation: Protective infrastructure
- Hazard mitigation: Land readjustment and raising program

The construction of the seawall to mitigate the hazard and reduce vulnerable land-uses at risk is considered in Chapter 8.4.1.5 on protective infrastructure. The preparation of hazard maps as the basis for the designation of hazardous areas is discussed in Chapter 8.4.2.2. This chapter discusses the additional measures that are taken to reduce vulnerable land-uses at risk through the designation of hazardous areas and the relocation of affected citizens to control urban land-uses in hazardous areas. Furthermore, the chapter also examines the possibility to mitigate the hazard through the raising of the ground.

Minimization of exposure of urban areas: Land-use control in hazardous areas

The designation of hazardous zones after the GEJE is based on hazard maps. The preparation of these maps is further explained in Chapter 8.4.2.2. The maps follow the concept of "more frequent less height tsunamis" (L1-tsunami) and "less frequent large height tsunamis" (L2-tsunami) (Central Disaster Management Council, 2011, p. 10; Dzurdženík et al., 2015, p. 30; Iuchi, 2016, p. 25) and consider the construction of seawalls along the coastline. While the construction of seawalls along the coastline of Tohoku will protect the cities from future L1-tsunamis, the extreme height of L2-tsunamis can overflow the seawall and inundate the low lying land behind the concrete structure. In Miyako City, the areas, with an inundation height of 2 m or more after the occurrence of a L2-tsunami, are designated as hazardous. For these areas, residential land-uses are prohibited (see Chapter 8.4.1.2). These areas are also excluded for the relocation of residential areas.

One example how the hazard maps guided the decision making for the reconstruction is Kuwagasaki District. After the GEJE, the citizens in the Reconstruction Town Planning Committee of Kuwagasaki intended to relocate to higher ground. Nevertheless, after the construction of the planned 10,4 m seawall along the harbor, the previous area of Kuwagasaki District will not be designated as hazardous. This means that the local citizens would not get any subsidies for a relocation to higher grounds. It was therefore immutable for them to rebuild on-site (Miyako City Consultant, 2015).

Minimization of exposure of urban areas: Relocation through relocation programs or land-readjustment projects

One option to reduce the residential land-uses at risk, is the relocation of people to safer places. In Miyako City's Taro District, this was achieved through the development of completely new settlements. In Tsugaruishi District, on the other hand, the affected residents moved to fill in an existing settlement, which was not affected by the disaster. In Miyako City, the relocation of affected citizens followed several steps, which are explained in the following paragraphs.

- Before the relocation can start, it is important to find a sufficient relocation site. In case of Miyako City, the decision to relocate was taken based on the citizen's opinion. If the prerequisite that the previous residential area was designated as hazardous was given, the citizens at the committee meetings discussed possible relocation sites, which had to be located outside the hazardous zones. The city's spatial planners checked the possible locations for their feasibility. The check included the relocation site's distance to existing settlements, the potential to build appropriate infrastructure and the expenditure of the project. Furthermore, additional risks that are linked with the relocation, e.g., an increased risk of landslides when relocating onto a hill, must be considered. One example for the decision between different options for relocation is Tsugaruishi

District: Half of the community wanted to move into the existing village of Tsugaruishi, the other half wanted to move onto a nearby hill. Nevertheless, the relocation onto the hill would have been very expensive and the road to the new settlement would have been very steep and long. Therefore, the local spatial planners convinced the people that a collective relocation into the existing village would be a more convenient solution (Miyako City Planning Division, Employee A, 2015).

One aspect that has to be considered when planning the relocation site is the number of required housing lots. In Miyako City, the number of planned lots per site was based on the affected citizen's information gathered through a survey which was conducted shortly after the GEJE. This survey inquired where the people planned to live and whether they intended to repair their house, construct a new house, live in a private rental apartment or in public housing (Miyako City, 2014b). However, the planning for reconstruction takes time and people tend to change their opinion in the meantime. The reason for this might be that they decide to move away or they realize that they will not be able to afford the construction of a new house. This development usually results in too many lots for private houses and a shortage in public houses. To correct this problem in Taro District, the allocation of private and public houses was changed as follows: First, a smaller area with three to four story public houses was planned, but because of the decreased demand for private housing lots, the area for public houses was expanded. This also enabled the reduction of the building's height to two stories (see illustration 45) while still increasing the overall number of public housing units (Taro District Citizen B, 2015).

› After the selection of a relocation site, the area's land-use has to be designated for residential uses. As described in Chapter 4.6, the Land-Use Basic Plan provides for the following five general land-uses: urban, agricultural, forestry, national park and nature conversation. To obtain the local Planning Division's responsibility for the relocation site and enable the ability to carry out land readjustment projects, which are one instrument of spatial planning to implement relocation projects, the site must be designated as urban area. However, in many cases the relocation sites are located on forested hills and therefore fall within the scope of the Forest Act. This means, before any further planning can take place, the designation has to be changed. The permission for this change can only be granted by the national government and the process is complicated and time consuming (Miyako City Consultant, 2015). For example, this was the case for Otobe Hill in Taro District (Miyako City Consultant, 2015).

› For the implementation of the relocation projects, the city administration had to purchase the adequate land. This required the land owner's agreement to sell their land[8]. The comprehensive citizen participation during

[8] The Japanese law also provides the ability of land confiscation in case that a land owner refuses to sell his or her land. In reality, this option is rarely used because property rights play an important role in Japan. Instead, spatial planners try to persuade land owners to agree to their plans by offering subventions or compensation payments (Hohn, 2000)

Illustration 45 | Construction of public houses in Taro District | Photo by author, October 2015

the planning process created a broad acceptance of the reconstruction plans by the citizens. Due to this, the land owners were very cooperative to sell their land and the purchase was carried out smoothly (Miyako City Planning Division, Employee A, 2015).

› Land readjustment projects are an important spatial planning instrument in Japan (see Chapter 4.7) and are also used for the planning procedure of relocation projects after a disaster. Nevertheless, the procedure to plan the land-use of the new urban area differs from land readjustment projects in existing areas, where the land owners contribute their land into the land readjustment pool. One aspect that is different is that the city administration purchases the entire property before the project begins and resells it to the new residents after the project is completed. The instrument of land readjustment is used to plan the plots for private and public housing, transportation networks and parks (see illustration 46 on the next page).

› After the plans are finalized, the construction work to prepare the land for settlement can start. The construction can involve elaborate procedures such as blasting operations because many relocation sites are located on hills.

› After the housing lots are planned, affected people, who were interested to live on the relocation site can request housing lots that they prefer to purchase. Due to the complexity of the large-scale relocation projects, people were only allowed to make a first and second wish for the location of their lot. The final distribution of the lots was made through lottery drawing, whereby it was attempted to fulfill the people's wishes in the best possible way. To maintain existing communities and prevent the decline of residents in certain districts, affected people were only able to select a relocation site within their former district. The reason for this was that the larger relocation projects generally progressed slower than the smaller projects. An unrestricted selection of relocation sites

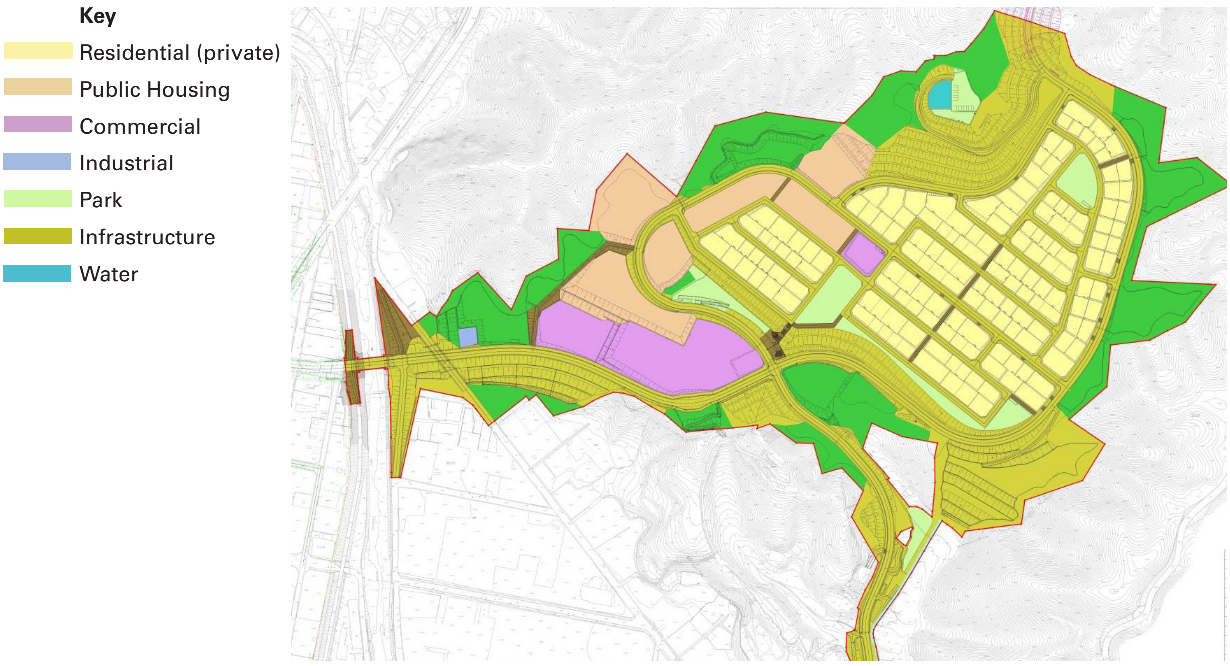


Illustration 46 | Land-use plan for the relocation site in Taro District | Miyako City, 2015c, p. 5

would have resulted in a concentration of citizens in districts where the relocation projects finished first because the citizens wanted to move into their permanent houses as fast as possible. However, after most citizens moved to their new permanent houses, the remaining lots that are still vacant are free for purchase by everyone (Miyako City Planning Division, Employee A, 2015).

› The construction activities on the relocation site in Taro District were planned to begin at the same time. Therefore, there were several details that had to be discussed before the construction could begin. One important issue was the design of the demarcation between the housing lots (Miyako City Consultant, 2015). Nevertheless, these discussions between the future neighbors of the relocation site were not part of the official participation process. To enable the citizen's exchange about relevant topics, one of the city's consultants voluntarily collected the names and addresses of the future residents and organized a well-attended meeting (Miyako City Consultant, 2015). This shows that the relocation process requires a major amount of coordination and support for the local citizens to run smoothly.

Hazard mitigation: Land readjustment and raising program

As explained in Chapter 4.7, land readjustment and raising programs are one option to mitigate the hazard and by this means reduce vulnerable land-uses at risk. There are multiple areas in Miyako City where the raising of land is planned. Nevertheless, compared to other cities in Tohoku, the amount and extent of land raising projects in Miyako City is low. One example for a land raise project is the area west of highway 45 in Taro District, which will be raised up to 3 m (see illustration 47) to adapt the land to highway 45, which will also be raised.

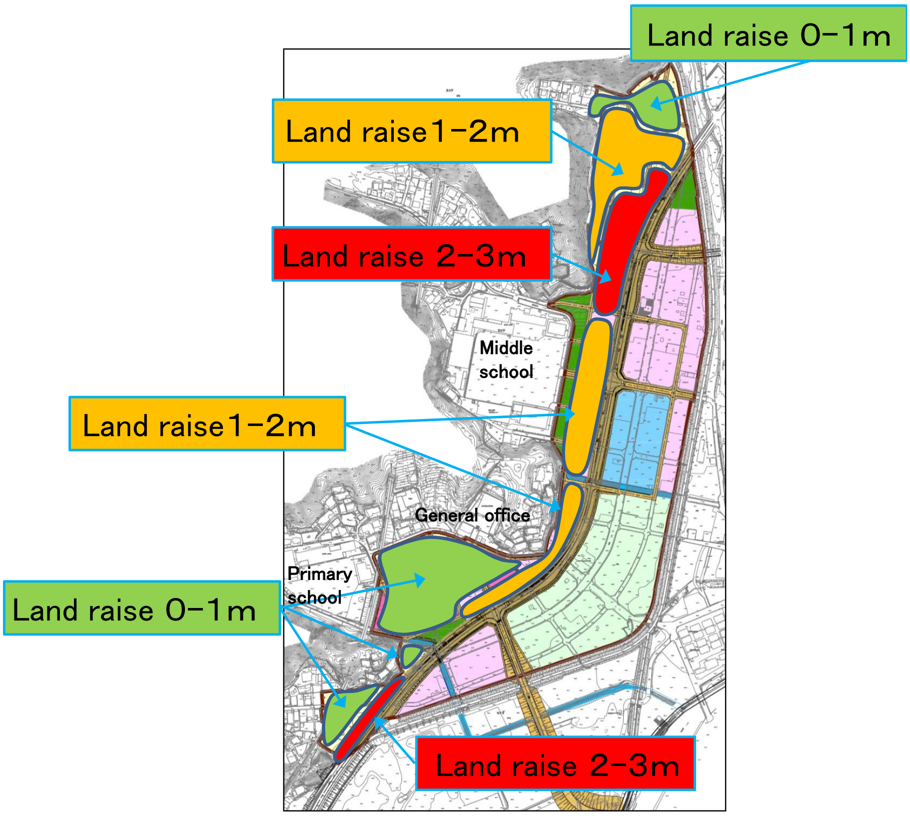


Illustration 47 | Map of the land raise project in Taro District | Map adapted from Miyako City, 2013, p.17

Because this project is implemented in an area with an existing urban land-use, the project's step follow the classic steps of a land readjustment project as described in chapter 4.7.2.1 more closely. Therefore, the project's main steps are only briefly described below:

- The land owners contribute their plots to the land readjustment pool.
- The land is reduced by the amount of land needed for the development of public infrastructure and the land for the reserve area pool.
- The readjustment council is established. It consists of local citizens and experts and discusses the developed Replotting Design Proposal and accompanies the entire planning process.
- The Replotting Design Proposal is developed. It gives an overview about the intended land-uses and lot distribution after the completion of the land readjustment projects (see illustration 48 on the next page).

This plan considers the specific local conditions and only plans appropriate land-uses for the reconstruction site. This includes that residential land-uses are only allowed for areas that are not designated as hazardous. To decrease the future resident's exposure to tsunamis, the area west of highway 45 is raised. In many cases, land raise projects use the soil that is removed from the hills when constructing relocation sites.

After the Replotting Design Proposal is accepted, the construction work on the site can begin. During this step, the land is raised according to the plan. Furthermore, the transportation network is adjusted and new parks are established.

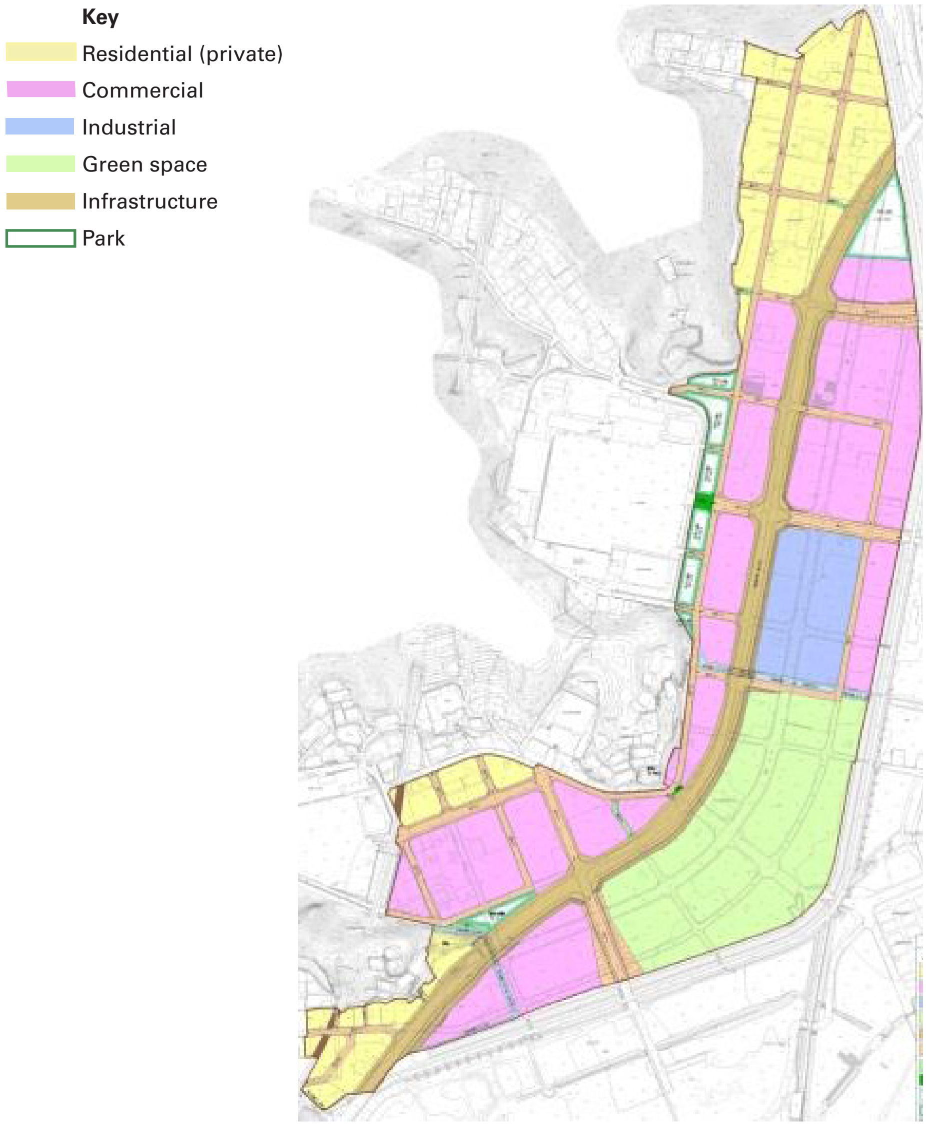


Illustration 48 | Land-use plan of land readjustment project in Taro District | Miyako City, 2015c, p. 13

After the construction work is finished, the replotted lots are distributed to the land owners.

- Depending on the change of the property value, the new housing lots are registered and their new owner either collects or delivers the settlement money.
- Finally, the reconstruction of the new houses on the land readjustment site can begin.

All of these spatial planning measures were used to decrease the exposure of vulnerable land-uses. In Miyako City, the reconstruction process initially focused on the reduction of residential land-uses at risk. Nevertheless, the interview with the city's Planning Division showed that this decision is solely an act of prioritization and additional land-uses will be addressed in the future (Miyako City Planning Division, Employee A, 2015).

8.4.1.2 Building Codes

Building codes are an important spatial planning option to increase engineering resilience (see Chapter 5). Provided that they are adequate to address relevant risks [UN-4.2.1] and are continually enforced [UN-4.2.2] and updated [UN-4.2.3]. Due to its long history with earthquakes, Japan has established a mandatory set of building codes, which are defined in the Building Standards Act (see Chapter 4.7). In Miyako City, the enforcement of building codes is a measure used to reach the requirement of the Post-Disaster Reconstruction Plan to reinforce buildings to increase their disaster resilience (Miyako City, 2012a, p. 3).

Miyako City's District Reconstruction Town Development Plan specifies how the implementation of additional building standards can increase a building's resilience. As mentioned above, the height of L2-tsunamis will overflow the constructed seawall and inundate the area behind it. While the construction of residential buildings is completely restricted in the hazardous zone with an inundation height of 2 m or more, the construction of residential buildings in areas with an inundation height below 2 m is restricted as follows: Residential buildings that are constructed in areas with an inundation height of 1 to 2 m are required to have their foundation raised 1.5 m from the street level. Furthermore, no living rooms are permitted on the building's first floor. Residential buildings that are constructed in an area with an inundation height of 1 m or lower, are compelled to have their foundation raised 0.5 m above the street level (Miyako City, 2012b, p. 3).

8.4.1.3 Urban design solutions

Creating a city where people and nature can coexist like it is the aim of the Miyako City Comprehensive Plan (Miyako City, 2015b) calls for sustainable urban design solutions [UN-4.3.1] like the development of urban green spaces, water retention areas or greenways (see Chapter 5.4). The land-use plan for Taro District includes multiple parks that promote diverse ecological and social functions. As described in Chapter 8.4.1.1, the parks were designed as part of land readjustment projects.

One example is the Three King View Park on top of the relocation site on Otobe Hill (see illustration 49 on the next page). The park has the purpose to serve as an observation point to overlook the entire district and the ocean (see illustration 50).

This view is especially important for the local fishermen who depend on their ability to see the ocean to pursue their business. The construction of Three King View Park with its comparatively large amount of parking spaces enables this. Furthermore, the park provides space for the settlement's water reservoir and a monument reminds of the GEJE.

Another park is located at the edge of the new settlement. Its purpose is the establishment of a multigenerational playground, which offers sports equipment for the elderly as well as play equipment for children. Creating a park like this does not only increase the health of the local population, but can also help to increase community cohesion (see Chapter 8.4.3.2).

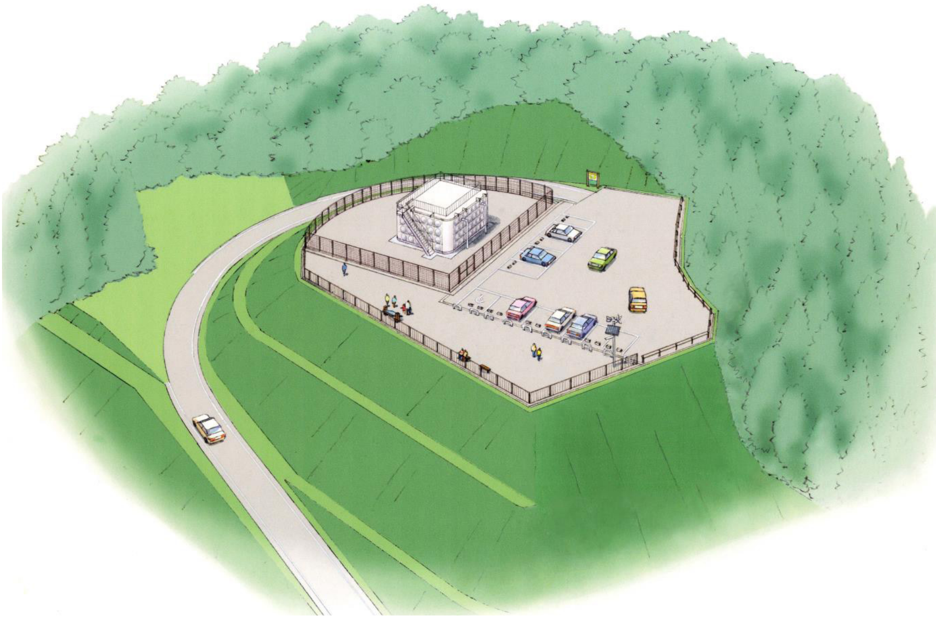


Illustration 49 | Three King View Park in Taro District (Miyako City) | Miyako City, 2015c, p. 16

Illustration 50 | View from Three King View Park in Taro District (Miyako City) | Photo by author, October 2015

Illustration 51 | Elevation of the remaining seawall in Taro District (Miyako City) | Photo by author, October 2015

8.4.1.4 Sustainable building design standards

Sustainable building designs [UN-4.3.2] can reduce a city's energy demand, increase the share of renewable energy and increase the independence of energy supply systems, which enhances the systems disaster resilience. The Miyako Renewable Energy Plan has all of these points on its agenda (Civic Life Department, Environment Division, 2013). One measure to promote the development of sustainable building design standards is the subsidization of the installation of photovoltaics (PV) on private houses with up to 200,000 JPY (Miyako City, 2016). Since the city's Environmental Division holds the responsibility for this aspect, spatial planners are required to collaborate with their colleagues at this sectoral planning division in order to address this point.

8.4.1.5 Protective Infrastructure

The construction and maintenance of effective protective infrastructure [UN-8.1.1, UN-8.1.2] is an important aspect of the Japanese approach to increase resilience, which is also adopted in Miyako City. This becomes clear in the city's Post-Disaster Reconstruction Plan that states that the establishment of protective infrastructure (e.g., tide barriers or seawalls) is one important aspect to create disaster resilience (Miyako City, 2012a, p. 5). In this regard, protective infrastructure is understood as the first line of a multilayered disaster resilience approach. The installation of protective infrastructure can help to reduce the damage to a minimum – however, as the GEJE showed, disaster resilience should never solely rely on it (Miyako City, 2012a, p. 3).

The multilayered concept becomes noticeable when taking a look at the determination of the tsunami seawall's height: The height was determined through a computer simulation based on the concept of L1-tsunami and L2-tsunami (see Chapter 4.7.1). The height of the seawall is designed to protect the city from L1-tsunamis, but not from L2-tsunamis. This emphasizes the importance to not solely rely on protective infrastructure, but also use additional soft measures to build resilience.

In Taro District, the existing tsunami-seawall with a height of 10 m was raised by 70 cm to compensate the land subsidence caused by the GEJE (see illustration 51) (Miyako City Planning Division, Employee B, 2015). In the future, this will be the second defense line against tsunamis because another seawall with a height of 14.7 m along the shore is planned. This two-line defense system is planned to protect the land behind the second seawall from L1-tsunamis (Mägdefrau, 2018).

The ability of protective infrastructure to increase resilience can be observed in Kuwagasaki District. Although the district also has a long history of dealing with tsunamis, there was never a seawall constructed. The reason for this is the historic importance of the local port. After the GEJE, the people wanted to relocate to higher ground. Nevertheless, the tsunami simulation revealed that the construction of a 10.4-meter-high seawall is able to protect the entire area of the district from L1- as well as L2-tsunamis. This means, the former residential area is safe to live and the people are able to reconstruct their houses on-site. This also means that the people cannot receive any subsidies for relocation, which is why the people agreed to reconstruct on-site. Nevertheless, to improve the local infrastructure, the reconstruction in Kuwagasaki District is also implemented as a land readjustment project (Miyako City Consultant, 2015).

8.4.1.6 Disaster resilience of utility infrastructure

Utility infrastructure combines communication networks [UN-8.2.1, UN-8.2.2, UN-8.2.3], electricity [UN-8.3.1, UN-8.3.2, UN-8.3.3] and gas [UN-8.5.1, UN-8.5.2, UN-8.5.3, UN-8.5.4] networks, water and sanitation networks [UN-8.4.1, UN-8.4.2, UN-8.4.3] as well as transportation networks (incl. roads, evacuation routes, railroads, airports, ports and other public transportation networks) [UN-8.6.1, UN-8.6.2, UN-8.6.3, UN-8.6.4, UN-8.6.5, UN-8.6.6]. The disaster resilience of these services is of special importance, so that their continuous provision in case of a disaster is ensured as far as possible. The importance to improve the disaster resilience of utility infrastructure is reflected in Miyako City's reconstruction process, which intends the establishment of independent energy supply systems and disaster resilient water/ sanitation, electricity and communication networks and the reconstruction and improvement of the transportation system (incl. road, train and bus networks, ports and the development of new and safe evacuation routes) (Miyako City, 2012a; Miyako City Planning Division, Employee A, 2015).

The local spatial planners had to prioritize the reconstruction of residential areas over other aspects because of the immense time pressure after the disaster. Simultaneously, the planning for disaster resilient utility infrastructure was mostly postponed because it required the exchange of various sectoral planning departments. In some cases, projects were also postponed because the city's current budget is too limited to implement them at the moment (Miyako City Planning Division, Employee A, 2015). Nevertheless, this does not mean that the projects will not be realized in the future and some projects to increase the disaster resilience of the city's utility infrastructure are already realized.

Transportation

One example for the revision of the transportation network, is the transfer, widening and raise of highway 45 in Taro District. To improve the street's ability as an evacuation route and prevent traffic congestions in case of a disaster, its width is increased by 5 m, from 12 m to 17 m (see illustration 52). In addition to this,

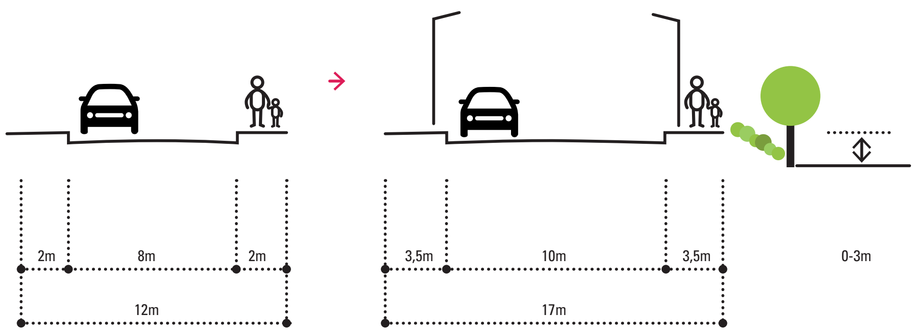


Illustration 52 | Widening of Highway 45 in Taro District (Miyako City) | Own illustration based on Miyako City, 2013, p. 14

moving the road from its former location up to 45 m inland and a raise up to 3 m should ensure that the road will not become flooded in case of a tsunami (Miyako City, 2013). This is an important aspect to ensure that people are not cut off from evacuation and become trapped. The entire road project was planned out as part of the land readjustment project described in Chapter 8.4.1.1.

Energy

The blackout in Miyako City after the GEJE and Tsunami displayed the weaknesses in the city's energy supply system. One goal of the reconstruction process therefore is to build disaster resilient energy supply networks (Miyako City, 2012a). Furthermore, the accident at Fukushima Daiichi nuclear power plant lead to the realization of the risk that is connected with nuclear energy. As a consequence, the new disaster resilient energy supply system is intended to use clean resources such as "solar, wind, wave and water power" (Miyako City, 2012a, p. 6). To reach this goal, the supply with renewable energy on the disaster affected sites should be advanced. This includes the installation of large-scale power generation facilities like the solar power plant in Taro District to locally produce energy (see illustration 53) or the support of the installation of solar power systems on private houses (Civic Life Department, Environment Division, 2013). The independent energy production on the household level (e.g., through solar panels on the roof) is especially useful to increase the household's autonomy in case of a disaster.

While the Planning Division possesses a certain responsibility for the planning of the utility networks, it must be considered that it is dependent on the cooperation with the respective sectoral planning divisions. In case of the energy supply network, this is the Civic Life Department's Environment Division. This mandatory cooperation complicates and prolongs the planning process, which resulted in the delay of these aspects.

Illustration 53 | Solar power plant in Taro District (Miyako City) | Photo by author, October 2015

8.4.1.7 Disaster resilience of social infrastructure

The disaster resilience of social infrastructure is just as important as the one of a city's utility infrastructure. Social infrastructure includes the police and first responders [UN-8.7.1] whose continuous work is of special importance in case of a disaster, the disaster resilience of the prison system [UN-8.7.2], the education facilities [UN-8.8.1] and the health care and emergency facilities [UN-8.9.1]. Furthermore, the basic administrative functions should be secured [UN-8.10.1]. In the context of spatial planning, this can be done by locating them outside of hazardous zones, so that they will not be affected by any hazardous events.

As the Post-Disaster Reconstruction Plan states the restoration of educational, healthcare and welfare facilities in a short period of time after a disaster to enable the city's population to continue their lives as normal as possible, was an important effort (Miyako City, 2012a, p. 3). However, to ensure the safety of public facilities by relocating them into safe areas, requires the Planning Division's cooperation with the responsible departments of the city administration (e.g., the School Education Division for the relocation of schools). One example for this is the relocation of the police office, the hospital and additional social facilities to the border of the new settlement on Otobe Hill, which was planned as part of the land readjustment project (Taro District Citizen A, 2015). The relocation of other public facilities (e.g., the administration office, elementary and junior high school) was also discussed. However, because these facilities were only insignificantly affected by the GEJE and are not located in the hazardous area, their relocation to the hill could not be subsidized, which is why they will stay where they have been (Miyako City Consultant, 2015). Another example is the relocation of the City Hall, which is currently located directly adjacent to the water and which was flooded up to the second floor (Miyako City Great East Japan Earthquake and Tsunami Records Editorial Committee, 2015, p. 32). It will be relocated and its former site will be utilized by less vulnerable land-uses (Taro District Citizen A, 2015).

8.4.2 Political-institutional resilience

Political-institutional resilience can be achieved through proposal evaluation for disaster resilience, the implementation of risk assessments, pre-event planning for disaster recovery and the use of learning loops. All of these items are discussed in detail in the following paragraphs.

8.4.2.1 Proposal evaluation for disaster resilience

The importance to check proposals for their benefits or impairments for disaster resilience [UN-1.2.1] becomes more and more important as time passes. While the major impact of a disaster enables changes in the city's structure and the fresh memories of the people prevents the development of vulnerable land-uses in hazardous areas, perceptions can change in the long run. Therefore, each spatial plan should be checked for its compliance with Miyako City's intention to create and maintain safe communities (Miyako City, 2012a). While this is the case at the moment (e.g., there are no residential buildings located within the hazardous area), only time will tell if this point will also be considered in 10, 50 or 100 years from now.

8.4.2.2 Risk assessment

When dealing with risks, knowledge about the dimension of possible hazards [UN-2.1.1], the city's exposure and vulnerabilities [UN-2.1.2] and an understanding of critical assets and their linkages with each other [UN-2.1.3] are important aspects to facilitate resilience (Dzurdženík et al., 2015, p. 14). Risk assessment combines all of these elements. Spatial planning's contribution to risk assessment focuses on the preparation of hazard maps [UN-2.1.4], which provide valuable information for the risk assessment. In Miyako City, the hazard maps were prepared based on the concept of L1-tsunamis and L2-tsunamis (see Chapter 4.7.1)

The determination of hazardous areas is based on computer simulations (see illustration 54). While areas with an inundation depth of 2 m or higher, caused by a L2-tsunami, are designated as hazardous and the construction of residential buildings is prohibited, areas with a lower inundation depth are generally available for residential uses (although additional requirements are set for areas with an inundation depth of more than 1 m, see Chapter 8.4.1.2). In Miyako City, the designation of hazardous zones followed an equivalent standard for the entire area of the city (Miyako City Planning Division, Employee A, 2015).

In order to be useful, the risk scenarios need to be updated frequently [UN-2.2.1]. This can be required because general information about relevant risks change or because land-use adjustments decrease the exposure to certain hazards, while the exposure to other hazards is increased. One example is the increased risk of landslides which results from the relocation of residential land-uses onto the hill. This increase should be included in the risk assessment, so that citizens can be informed about the risks and prepare themselves accordingly (Miyako City Planning Division, Employee A, 2015).

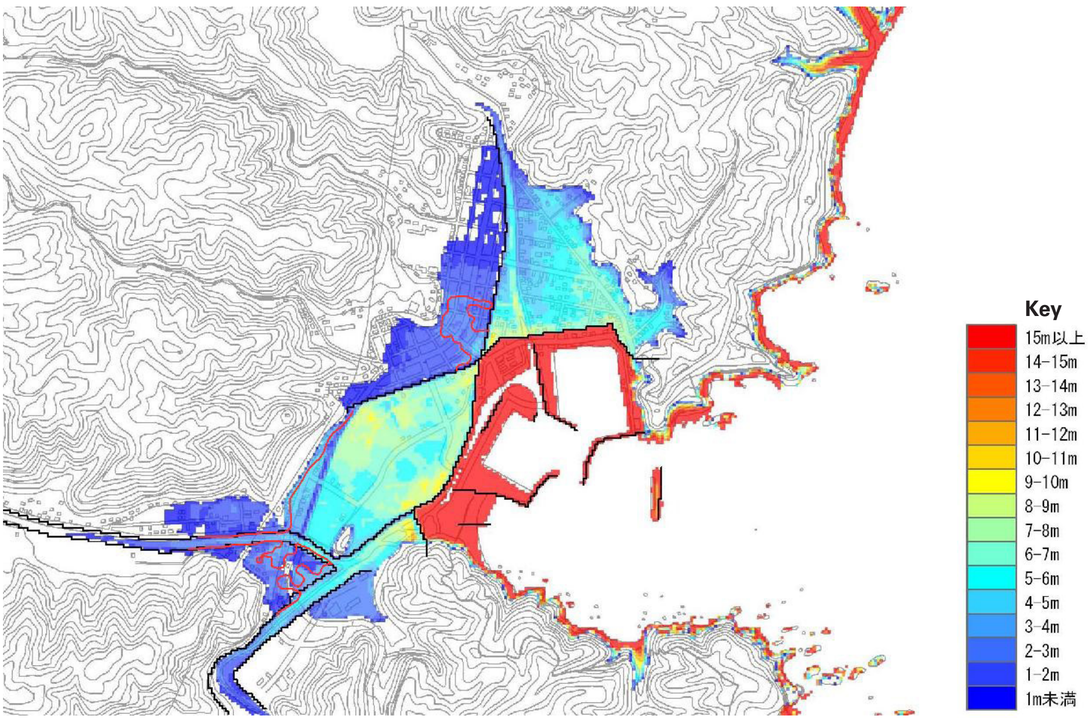


Illustration 54 | Results of the L2-tsunami simulation for Taro District (Miyako City) | Taro District Reconstruction Town Planning Committee, 2012, p. 10

8.4.2.3 Pre-event planning for disaster recovery

To optimally use the window of opportunity after a disaster, it is helpful to be prepared in advance [UN-10.1.1]. With regard to spatial planning this would require a spatial vision that the reconstruction process can follow once a disaster occurs. Nevertheless, the field work revealed that this is easier said than done. Although Miyako City has a long history of tsunamis, there was no plan that provided the city with possible relocation sites or additional information that could have been useful to use the short amount of time after the disaster in the best possible way. However, the city's Comprehensive Plan, which was adopted in 2011 and usually is revised every five years, was used to guide the reconstruction process. Although the plan was prepared completely disconnected from the disaster, its content served as a vision for the reconstruction process. While spatial planners and citizens agreed that a pre-event prepared land-use plan for the time after the disaster would have been helpful (Miyako City Planning Division, Employee A, 2015; Taro District Citizen B, 2015), the reasons why it was not developed are comprehensible: The citizens were not interested to discuss possible relocation options before the occurrence of the disaster because they were unable to imagine the extent of the devastation. Furthermore, the existing seawall in Taro District caused the district's citizens to feel safe (Taro District Citizen A, 2015; Taro District Citizen B, 2015). In addition to this, it is impossible to foresee the actual location where the tsunami may hit the coast, how far it may reach inwards into the city and the degree of the damage that it may cause. Therefore, the land-use plan could never include all relevant aspects for the reconstruction process (Miyako City Planning Division, Employee A, 2015).

There are certain points that the interviewees considered to be useful to be in place before the disaster in order to enable a smooth start of the reconstruction process. There should be guidelines for the local spatial planners that includes the main planning procedures after a disaster. These guidelines should explain where to begin and which steps to take. This is of high relevance because the decision what to do first was very complicated for the staff of the Planning Division (Miyako City Planning Division, Employee A, 2015). The citizens should have selected a leader for their community beforehand or they should have built a core group consisting of various leaders from different associations (e.g., commerce association or fire prevention association). Having a strong leader is an important factor of success for the reconstruction process (Taro District Citizen B, 2015). Local spatial planners usually lack the experience to plan and implement the reconstruction process after a disaster and pre-event preparation rarely occurs in reality. Therefore, the involvement of experts can help to increase the quality of the reconstruction process. For instance, the consultant agency proposed the comprehensive participation process which resulted in the smooth implementation of the reconstruction projects in Miyako City (Miyako City Planning Division, Employee A, 2015). Furthermore, the citizens are certain that the planning process would never have been possible without the help from these experts (Taro District Citizen B, 2015).

8.4.2.4 Learning loops

Learning loops are an important aspect to create resilience [UN-10.1.3]. With regard to spatial planning, learning from past disasters especially concerns the city structure and its reinforcement and reorganization processes to increase resilience (Miyako City, 2012a, p. 2; for more on this interpretation of learning loops, see Chapter 8.4.1).

In addition to this, political-institutional processes can be improved to prepare the system for risks and to increase its ability to cope with hazardous events. For these processes, the lessons learned from previous disasters are very valuable. For instance, the GEJE taught that actual disasters can go far beyond anticipation. This means, people should not solely rely on built infrastructure, but expect the unexpected and live with these uncertainties. The most important point is the people's ability to evacuate (Miyako City Planning Division, Employee A, 2015). In case of a tsunami, people must evacuate and not return for at least one hour (Miyako City Consultant, 2015).

It is also possible to learn from disasters that occurred elsewhere. The planners and consultants of Miyako City integrated an important lesson from the Great Hanshin-Awaji Earthquake, which occurred in Kobe in 1995, into the reconstruction process: the importance to keep the communities together. This is the reason why the city administration constructed temporary housing sites for each community to enable the people to stay together with their neighbors (Miyako City Planning Division, Employee A, 2015). The advantages of this approach are discussed in the following chapter.

It is important to also preserve the memories from the GEJE. To reach this goal, the city administration of Miyako City intends to establish a tsunami heritage site in Taro District. This building will not only preserve the experiences from the tsunami for the local citizens, but also enable to share the lessons learned with visitors from elsewhere (Miyako City, 2012a, 2012b).

8.4.3 Socio-economic resilience

Socio-economic resilience can be achieved by addressing the following items, which are discussed in the following chapters: citizen participation, social connectedness and neighborhood cohesion and the provision of safe shelter.

8.4.3.1 Consideration of citizen's needs

The relevance of grassroots organizations for spatial planners basically encompasses their ability to participate as one stakeholder in the planning process. This cooperation can intensify if the grassroots organization focuses on a field where the coordination with the city's planning section is required (e.g., when a grassroots organization focuses on designing local playgrounds). The wider the coverage of the city's area with grassroots organization is [UN-7.1.1] and the better they are able to use their networks [UN-7.1.2], the better they can represent the local citizens in the participation process. Grassroots organizations are especially important for the participation process after a disaster because the contact person of a local grassroots organization is easier to identify and contact and – in the best case – he or she can represent the interests of a larger group. In Miyako City, the selection of the reconstruction committee members also occurred based on the people's affiliation with local organizations (e.g., the leader of the fire department) (Miyako City Planning Division, Employee A, 2015). Besides the integration of grassroots organizations, the participation process also needs to engage vulnerable segments of the population [UN-7.1.4]. This is especially important to incorporate their special needs into the planning process.

The Post-Disaster Reconstruction Plan for Miyako City acknowledges the importance of public participation for the reconstruction process. It states that "citizens, community groups, civil organizations, companies and businesses" (Miyako City, 2012a, p. 1) should be integrated and it emphasizes the importance of the "participatory and cooperative efforts of citizens and [the] local government working in partnership" (Miyako City, 2012a, p. 8). The comprehensive participation process in Miyako City was proposed by one of the consultants that were engaged into the planning aid project by the national government's Ministry of Land, Infrastructure Transport and Tourism (Miyako City Planning Division, Employee A, 2015). The city administration was very sceptic about such a comprehensive participation process because citizen participation in Miyako City failed in the past (Miyako City Consultant, 2015). Nevertheless, the consultant was able to convince the administration and reconstruction committees were established for the ten most affected districts. These committees were supported by local spatial planners and consultant companies.

The importance of citizen participation for the reconstruction process and its various types were described in Chapter 2.4.3. In Miyako City, spatial planners focused on information of the citizens, consultation for the 23 less affected districts and active involvement for the ten districts where citizen committees were established to develop their own district plans. Even though the participation process in Miyako City was very comprehensive and exceeded legal requirements, the final decision about the plans was made solely by the city administration – which means that the citizens were not included in this step, e.g., through collaborative planning. One example for this is the decision about the relocation site in Taro District, which was finally taken by the city administration after the local residents had proposed various areas (Miyako City Consultant, 2015).

Citizen information

The information of the citizens built the basis for the more meaningful participation tiers of consultation and active involvement. The city administration ensured the provision of comprehensive information for the citizens (including a report of all damages). This enabled the citizens to get involved in any further reaching activities (e.g., the participation in the community committees). The distribution of information was also able to prevent rumors, inside and outside the region, from spreading (Miyako City, 2012a). The city of Miyako distributed the information about the reconstruction process through the "District Reconstruction Urban Development News". The newspaper was published continuously throughout the district reconstruction planning process (October 2011 till March 2012) and was delivered to each household in Miyako City (Miyako City Planning Division, Employee A, 2015). The "District Reconstruction Urban Development News" also informed the citizens about their opportunity to submit their opinion to the city administration. The comments from the local citizens directly entered into the discussion process at the Reconstruction Town Planning Committee meetings (Miyako City Planning Division, Employee A, 2015).

Some of the aspects from the citizen's district plans could not be adopted into the final version of the plans, for example because the projects were unrealistic or too expensive. In these cases, the spatial planners informed the citizens about their decision and explained the reasons why the decision was taken, so that the local people could easily understand the reasons for the decision-making (Miyako City Planning Division, Employee A, 2015; Taro District Citizen A, 2015). One example for this is the relocation of people in Tsugaruishi District. Half of the community wanted to relocate onto a hill, which would have been a very inconvenient and expensive solution. Therefore, the spatial planners convinced the people that the relocation together with the rest of their community into the existing settlement of Tsugaruishi District would be the more convenient solution (Miyako City Planning Division, Employee A, 2015).

Citizen consultation

Consulting the local citizens was another element of the participation process in Miyako City. At the beginning of the planning process, the city administration conducted a survey to enable the spatial planners to get to know the needs and recommendations from the citizens and include them into the further planning process (Miyako City, 2012a). The "District Reconstruction Urban Development News" continuously encouraged the people to submit their opinions about the reconstruction process. Furthermore, the city administration performed meetings for town reconstruction in all 33 affected districts. The purpose of those meetings was to inform the citizens about the reconstruction process and to enable them to contribute their opinions. To save time, the city's Planning Division used the information that was received through the consultation of the citizens to directly develop the reconstruction plans for the 23 districts with 40 or less destroyed houses (Miyako City Planning Division, Employee A, 2015; Ubaura & Akiyama, 2016, p. 487).

Citizen's active involvement

For the ten districts with more than 100 affected households, the city established Reconstruction Town Planning Committees, which were responsible to develop the districts reconstruction plan with the help from consultants and local spatial planners (Miyako City Planning Division, Employee A, 2015). The city administration selected the 20-30 citizens per district that participated in the Reconstruction Town Planning Committees because time was short after the disaster. The selected people were people with a certain function within the community, such as the chief of neighborhood associations, the chief of the parents and teacher association or the chief of the fire department (Miyako City Consultant, 2015; Miyako City Planning Division, Employee A, 2015). The committees consisted of a mixture of affected and unaffected citizens because the district plan should contain the entire area of the district, not just the affected parts (Miyako City Planning Division, Employee A, 2015). The approach to select the committee members resulted in the fact that only a small number of participants (7%) were woman and only 5% of the city's 204 committee members were 50 years or younger (Ubaura & Akiyama, 2016, p. 487). The active involvement of the citizens in the ten most affected districts is a specifically interesting example of how socio-economic resilience can be built. Therefore, the following paragraphs give a comprehensive overview of this process.

The Reconstruction Town Planning Committees were supported by consultants as well as local spatial planners. The committees started their work in October/ November 2011, seven to eight months after the disaster, and held four monthly meetings in each district (Miyako City Planning Division, Employee A, 2015). The first local study meetings were used to explain the planning process, introduce the time schedule and gather first ideas on town reconstruction, land-use planning and transportation networks (e.g., evacuation routes). The purpose of these meetings was solely to collect ideas; it was not intended to come to a consensus at this point (Ubaura & Akiyama, 2016). At the meetings, the people were able to draw their ideas into the plan, which was later edited by the consultant to incorporate the people's ideas. These edited maps then provided the basis for the discussion at the next meeting (Miyako City Consultant, 2015).

At the second local study meetings, in November/ December 2011, the results from the first meetings were presented and discussed more precisely. An emphasis was to narrow down the options for land-use planning, transportation and protective infrastructure. The advantages and disadvantages for possible reconstruction solutions (e.g., relocation or land raising) were discussed and all districts agreed to determine the relocation sites based on "technical studies" (Miyako City Consultant, 2015; Ubaura & Akiyama, 2016, p. 489).

For the third local study meetings, which were held in December 2011/ January 2012, the city administration prepared a preliminary draft plan that covered most points that were discussed in the first and second committee meetings. Nevertheless, some points had to be disregarded because they were technically infeasible, ineffective or unnecessary. The aim of these meetings was to agree on a draft version of the District Reconstruction Town Development Plans; a goal which was achieved in most of the districts with the exception of Fujiwara, Sokei and Taro District (Ubaura & Akiyama, 2016). Between the third and fourth local study meeting, the draft plan was publicly displayed for several days and the citizens were able to submit their opinion at preview meetings. At these preview meetings, the substantial part of the plan was presented by committee members. In this way the citizens' comprehension should be enhanced and the consensus building should be facilitated. To ensure professional competence, city officials also attended the meetings and added technical and financial details. Most preview meetings closed with an agreement on the draft plan. The only exception being Fujiwara, Sokei and Taro District (Ubaura & Akiyama, 2016).

At the fourth and final local study meeting, in January/ February 2012, the draft plans were modified according to the citizens' comments from the preview meetings and the final District Reconstruction Town Development Plans were developed (Ubaura & Akiyama, 2016). These plans were once more publicly discussed in a second meeting for town reconstruction and finally all districts agreed on the final version of their district's reconstruction town development plan. All ten plan proposals were submitted to the mayor in February 2012 (Ubaura & Akiyama, 2016). After the draft plans were received, the Planning Division developed the final version of each plan and combined them into the "Miyako City: The Great East Japan Earthquake District Reconstruction Town Development Plan" (Miyako City, 2012b), which was adopted in March 2012 and is currently implemented (Miyako City Planning Division, Employee A, 2015). With the submission of the draft District Reconstruction Town Development Plans to the mayor, the official participation process concluded (Miyako City Consultant, 2015).

The active involvement of citizens in the planning process went beyond the legal requirements for participation in Japan (see Chapter 4.7.3). The participation was based on the voluntarily commitment of the involved consultants, spatial planners and citizens because there is no institutional system to make the people participate actively in the planning process (Miyako City Consultant, 2015). For example, the citizens were very interested in discussing their thoughts about the reconstruction process in the first year after the disaster. This meant that the consultant held meetings in her office that often lasted from one evening until the next morning to meet the requirements of the local population (Miyako City Consultant, 2015). In the interview, a citizen of Taro District confirmed, that many local activities (e.g., the establishment of a community café) could only be achieved with the help of the consultant (Taro District Citizen A, 2015). This displays the importance of personal commitment for a successful participation process. In the end, the comprehensive participation process paid off and resulted in a wide acceptance of the plans by the local citizens. One indicator for this is the fact that local land owners cooperated by selling their land to the city authority, if it was needed for the realization of the planned relocation projects. This wide acceptance helped to implement the plans much faster and enabled the development of the relocation sites by 2015 (Miyako City Planning Division, Employee A, 2015).

After the official participation process ended, the people in Taro District did not want to end their discussion. To continue their dialogue, the citizens established a *machizukuri*. Although *machizukuri* are an important element of spatial planning on the community level, they are not integrated into the legal spatial planning system, which is why there are no subsidies for their establishment (see Chapter 4.7.3.; Miyako City Consultant, 2015). The establishment of such an association therefore is another example for the voluntary commitment of individual experts: Because the vice mayor was against the establishment of the *machizukuri* and the consultant was contracted by the city, she could not officially support the local citizens with their efforts. To still assist the citizens, the consultant supported the establishment of the *machizukuri* in Taro District in her free time (Miyako City Consultant, 2015). Today, the *machizukuri* does not only discuss topics with relevance for Taro District (e.g., the relocation of Taro District's police office and hospital), but also issues that concern the entire city (e.g., the relocation of Miyako City Hall) and the city administration is interested in the citizen's opinion on these topics (Taro District Citizen A, 2015).

To inform the people about the work of the *machizukuri* the association publishes a monthly newspaper, which is distributed to all 1,000 households in Taro District. It informs about current discussions and community activities (Miyako

City Consultant, 2015). Nevertheless, it is complicated to reach the people and encourage them to get involved in the voluntary work of the *machizukuri* (Taro District Citizen A, 2015).

To finance the activities of the *machizukuri*, the citizens obtained the redirection of a 10 million JPY-budget, which was originally intended for the realization of local events (e.g., sports festivals). In Taro District, for the management of the *machizukuri*, e.g., for copies, office material or the publication of the monthly newspaper, which costs 50,000 JPY per issue (Miyako City Consultant, 2015).

8.4.3.2 Social connectedness and neighborhood cohesion

Social connectedness and neighborhood cohesion [UN-7.1.3] is an important factor of socio-economic resilience. The importance to keep communities together in the aftermath of a disaster, was demonstrated by the reconstruction process in Kobe after the Great Hanshin-Awaji Earthquake in 1995. In Kobe, people were moved into the temporary housing sites based on their vulnerability, which resulted in segregated housing sites with old people and many cases of solitary death (kodokushi) (Kadoya, 2005). The city administration of Miyako City based its actions on these experiences made in Kobe and set community building as one important aspect for the city's reconstruction process. This included to keep existing communities together when moving them into the temporary housing sites as well as the revitalization of communities after the relocation into the temporary houses (Miyako City, 2012a, p. 11; Miyako City Planning Division, Employee A, 2015). Although this process took more time, the city administration prioritized keeping the communities together (Miyako City Planning Division, Employee A, 2015).

Temporary Housing

In Taro District, there were four evacuation places directly after the disaster, but the people were all united at one place. Elderly citizens were evacuated into a hotel. Each temporary housing site was constructed for one of the district's neighborhoods (e.g., southern neighborhood, central neighborhood) and the people were mutually moved from the evacuation shelter to the temporary housing site after their site was constructed. At this point, the people from the evacuation shelter were also reunited with the elderly, who stayed at the hotel, to ensure the maintenance of the existing social structure (Miyako City Consultant, 2015). Even though the city administration tried to keep people from each district together when moving them into temporary houses, the process had its weak points and some people still got separated from their former neighbors. This especially happened when people decided to move into empty regular apartment buildings, which are called "quasi temporary houses" and are dispersed all over the city (Miyako City Planning Division, Employee A, 2015; Taro District Citizen A, 2015). For this reason, the community cohesion could not be completely ensured in all cases (Taro District Citizen A, 2015).

Permanent Housing

The relocation to permanent houses occurred based on the people's former districts and their information from the survey, which was conducted at the beginning of the relocation process. At first, people were only allowed to select a lot for their permanent house that was located within their district. The reason for this was to keep the communities together and to prevent the population decrease in districts where the relocation sites finished behind schedule (Miyako City Planning Division, Employee A, 2015). Although communities were not forced to move together, spatial planners tried to convince them of more convenient solutions in case it was reasonable (e.g., in Tsugaruishi District) (Miyako City Planning Division, Employee A, 2015). Nevertheless, keeping neighborhoods together during this step was complicated: For instance, one citizen of Taro District intended to relocate together with his existing community. This was impossible because of two reasons: First, some people from the community wanted to stay in Taro District, the other half wanted to move out of Taro District. Second, the remaining people were interested in housing lots with different sizes. Some wanted to buy a lot with 250 m^2, while others preferred a lot with 500-600 m^2. The group was forced to split because the land development had already started and the bigger and smaller lots were not planned next to each other (Taro District Citizen A, 2015).

Citizen Participation

Another aspect that increased community cohesion was the participation process, which was explained in detail in the previous chapter. The ability of affected as well as non-affected people to participate in the reconstruction committees, resulted in a mutual consideration of all important aspects for the recovery of the district as a whole. The result of this was the quick agreement of local land owners to sell their land to the city, which enabled a fast implementation of the reconstruction projects (Miyako City Planning Division, Employee A, 2015).

To have a meeting place for the local people, one of the city's consultants established a community café in Taro District (Miyako City Consultant, 2015). This way, the people have a place to meet and exchange about their current issues.

Considering special requirements of elderly people

To enhance community cohesion, it is important to meet the special requirements of different population groups. In Miyako City, the group of elderly people especially needs to be considered because of the ongoing demographic change. Concerning this topic, the Post-Disaster Reconstruction Plan stresses the importance to create livable neighborhoods and intends to build houses that meet people's special requirements, specifically addressing elderly people (Miyako City, 2012a). One measure to achieve this goal is the planned recovery of Miyako City's city center based on the compact city concept. This involves the concentration of important urban functions at one place and establishes the accessibility on foot (Miyako City, 2012a).

To address demographic change, the relocation of affected people onto empty lots in existing settlements was planned. One example for this is the relocation of people in Tsugaruishi District. After the spatial planners convinced the citizens of the convenience of the solution, they agreed to move into the existing settlement of Tsugaruishi District, which also helped to counteract vacancies caused by demographic change (Miyako City Planning Division, Employee A, 2015).

In Taro District, the people initially intended to relocate the entire village (including not affected households, social infrastructure and shops) onto Otobe Hill. This would have been a convenient solution, with short distances. Nevertheless, because there was no subsidy to relocate non-affected facilities and private houses, this plan could not be pursued and the district administration and elementary and junior high school had to stay where they were (Miyako City Consultant, 2015).

8.4.3.3 Provision of safe shelter

To ensure socio-economic resilience, it is important to provide safe shelter in the three phases after the disaster [UN-9.5.2]. First, the people are accommodated in evacuation shelters, where they stay between a month up to one year (Iuchi et al., 2015, p. 39). The establishment of evacuation buildings can save lives in case of a disaster. It is important that all population groups are considered, when planning evacuation routes to reach these evacuation shelters. This especially concerns vulnerable population groups (e.g., the elderly) and is the reason why their needs should be especially addressed throughout the planning process (Miyako City, 2012a). After the GEJE, elderly affected people in Taro District were accommodated in a hotel instead of the regular evacuation shelter to ensure them with a minimum of comfort and privacy (Miyako City Consultant, 2015).

After the temporary housing units are established, people begin to move into their temporary homes, where they often stay for several years (Iuchi et al., 2015, p. 39). One important factor to secure a healthy living environment for the residents of the temporary housing units was the coherence of existing communities that was an important aspect of the reconstruction process in Miyako City (Miyako City Planning Division, Employee A, 2015).

Still, it is important for the citizen's healing process after a disaster to move into permanent houses. Only this way they are able to move on with their lives and fully process their experiences (FEMA, 2009, p. 4). This is the reason why the completion of permanent houses for the affected people should not take too long – even though there are various aspects that need to be considered when planning and constructing these houses (Miyako City, 2012a). In Miyako City, the permanent housing sites were planned based on the results from a survey, which was conducted at the beginning of the reconstruction process. In this survey, the people were able to state where they were planning to live after the reconstruction of the city (Miyako City Planning Division, Employee A, 2015). At the point of the survey, many affected people declared their interest to build a new privately financed house. However, as time went by many of them realized that they were unable to finance the construction of a private house. The reasons for this are numerous: the compensation for their old house was to small, they did not have enough savings or the bank denied to give them credit (either because they already had a credit for their old house or they were too old). This resulted in a raised demand for public housing units. At the same time, the demand for private housing lots decreased, partly because the people decided to move into public houses instead, partly because they decided to move away from the city. To ensure a sufficient housing supply for all people, it is important that spatial planners are able to react to this changing demand. For instance, in Miyako City the original plan was changed: While the number of private housing lots was decreased, the number of public houses was increased (Taro District Citizen B, 2015).

8.4.4 Environmental Resilience

Environmental resilience can be achieved by preserving or restoring ecosystem health, in case that it is disturbed. The following chapter explains how this aspect was addressed in Miyako City.

8.4.4.1 Ecosystem health

Ecosystem health is one important factor of environmental resilience. It relates to people's dependence on ecosystem services (e.g., clean air and water) to survive. As an example, healthy forests are able to secure timber wood for the construction of buildings or for the generation of energy. It is therefore important to know about the importance of these ecosystem services [UN-5.1.1] and to preserve the forest's health or restore it when it is disturbed (e.g., through a disaster) [UN-5.1.2]. The goal of Miyako City's Comprehensive Plan to create "an oasis where 'forests, rivers and the ocean' and people can coexist" (Miyako City, 2012a, p. 1 citing the Comprehensive Plan; Miyako City, 2015b) shows that there is a general awareness of the importance of nature and the health of the ecosystem. This goal is also reflected in the Post-Disaster Reconstruction Plan, which intends the revitalization of the forests. Nevertheless, a closer look reveals that this intention is directly linked to the revitalization of the local timber industry (Miyako City, 2012a, p. 4). How exactly the sustainable coexistence between humans and nature regarding forests is intended to be achieved remains unclear. Nevertheless, there are some examples of measures taken to improve the health of the ecosystem. One of them is the intended distribution of renewable energy sources, such as "solar, wind, wave and water power" (Miyako City, 2012a, p. 6) on the large as well as on the smaller scale.

According to the UNISDR's Disaster Resilience Scorecard, spatial planners should consider the importance of healthy ecosystems for a city's disaster resilience when developing land-use plans. This includes the determination of impacts that intended land-uses can have on ecosystem services [UN-5.1.3]. One instrument to reach this aim is the EIA (see Chapter 4.7.1), which, for example, has to be conducted for the "construction of roads, dams, railways, airports and power plants" (Ministry of the Environment, Government of Japan, n. d., p. 4). Even though the construction of the giant seawall along the coast of Tohoku can be expected to have severe impacts on the coastal ecosystem, the Environmental Assessment Law does not require the performance of an EIA for this case (see Chapter 4.7.1). Although this simplifies the planning and construction process, it also results in the neglect of the ecosystem health in favor of safety (Bird, 2013).

8.4.5 Spatial planning measures to build resilience

The following chapter summarizes the spatial planning options that were used to build engineering and evolutionary resilience in Miyako City, elaborates which spatial planning options were especially useful and identifies room for improvements.

Which spatial planning options were used to build engineering resilience?

In Miyako City, spatial planning for reconstruction based the designation of hazardous areas to prevent urban development in areas that are exposed to hazards. In a second step, people who used to live in these areas were either relocated or the area of their former home was raised (the second option was used less often). Both of these spatial planning options intend to achieve the minimization of exposure of urban areas. The preparation of the new residential areas was achieved through the implementation of group relocation programs or land readjustment projects. The absence of built structures in the affected areas after the disaster favors these planning processes. Thereby it is important that the planning instruments are applied with a certain degree of flexibility, so that they can be adapted to the changing situation in the post-disaster city. Furthermore, the projects should be implemented efficiently because the reconstruction of the city is a time sensitive issue (Miyako City, 2012a).

In addition, the need to implement additional building requirements (e.g., raising a house's ground floor) in areas that can get affected by future L2-tsunami and the general application of the legally binding building codes ensured that the resilience of the city's built structure was also increased. The construction of protective infrastructure in form of the seawall along the coast helps to mitigate the hazard.

In many cases, the utility infrastructure was improved. This especially concerns the transportation network, which was thoroughly improved by readjusting intricate and widening narrow roads. For this purpose, spatial planners also made use of land readjustment projects. The social infrastructure was only relocated to safer ground, when it was significantly affected by the GEJE and Tsunami. For all other facilities the relocation could not be funded. It needs to be considered that the planning of many of these aspects requires spatial planners to work in cooperation with sectoral planning departments. This concerns the Environmental Division, when sustainable building standards should be achieved or the School Education Division, when schools have to be relocated. In these cases, the required coordination lead to an extension of the planning process.

In summary it can be said that the influence of spatial planning options to build engineering resilience can be regarded as significant. This especially concerns items which include the change of land-uses or building codes. Nevertheless, spatial planners can also give important impulses for resilience items that require the cooperation with sectoral planning departments (e.g., utility or social infrastructure).

Which spatial planning options were used to build evolutionary resilience?

Political-institutional resilience includes the preparation for hazardous events by assessing the risk and creating strategies to handle them. This includes the cooperation of spatial planners, especially for the preparation and provision of spatial information, like hazard maps. The preparation for a disaster concerns all units of the city administration, thus also the Planning Division. Currently all spatial plans in Miyako City are checked for their accordance with the aim to build a disaster resilient city. It could therefore be assumed that the disaster helped to raise the awareness and the political-institutional resilience. Nevertheless, only time can tell if these achievements will be maintained in the future.

The reconstruction process after the GEJE and Tsunami revealed that guidelines with necessary steps to take after a disaster would have been a useful tool for spatial planners to start the reconstruction work. None of the local spatial planners was experienced with the reconstruction process after a large scale disaster, which complicated the decision where to begin and prolonged the start. The opinions regarding the pre-event development of a spatial reconstruction plan was regarded as useful, but infeasible. Instead, the reconstruction process was based on the city's existing Comprehensive Plan. The case of Miyako City shows, that spatial planners are able to contribute to the increase of political-institutional resilience. These contributions are constituted of the assistance for risk assessment (e.g., by preparing hazard maps), their responsibility to integrate disaster risks into spatial plans and the improvement of the spatial planner's ability to handle a hazardous event if it occurs (e.g., through the development of guidelines).

Socio-economic resilience can be built by including citizens into the planning process, keeping existing communities together and providing safe shelter through all phases of the reconstruction process. The comprehensive participation process in Miyako City notably brought community members closer together, which lead to great advantages for the city (Miyako City Planning Division, Employee A, 2015). Some of these advantages are the acceleration of the implementation of the land-use plans, which supported spatial planner's efforts to build engineering resilience (Miyako City Planning Division, Employee A, 2015). The analysis shows that building socio-economic resilience cannot be achieved by strictly following legal requirements because they are not extensive enough to enable a truly meaningful interchange between the city administration and the local citizens. As the example of Miyako City shows, building socio-economic resilience requires the personal dedication of all people involved: spatial planners, consultants and the local citizens.

The EIA is an important instrument for spatial planners to determine the impact of certain construction projects on ecosystem health. It should therefore consequently be applied before large construction projects are implemented. Unfortunately, this was not the case for the construction of the seawall in Miyako City. Ignoring the impacts of this project for the environment is counterproductive for the intended improvement of the relationship between man and nature, which is the main goal of Miyako City's Comprehensive Plan. Achieving this goal of a respectful relationship to nature would also result in an increase of environmental resilience. However, this goal cannot be achieved if the instrument to ensure a responsible handling of nature is not applied.

Which spatial planning options were able to build resilience? Which additional spatial planning options would have been useful to build resilience?

Generally speaking, the existing options that spatial planners have in their repertoire are able to build resilience. Nevertheless, the engineering background of the discipline results in the fact that most spatial planning options are able to build engineering resilience more easily than evolutionary resilience.

In Miyako City, evolutionary resilience could especially be built through the comprehensive participation process and the concentration on the maintenance of existing communities. This approach enabled a significant increase of social resilience, which was also confirmed by a spatial planner of the city's Planning Division (Miyako City Planning Division, Employee A, 2015). Nevertheless, this increase of social resilience was only enabled by the personal effort that the local spatial planners, the city's consultants and the involved local citizens put into the planning process, since such a comprehensive participation process is not legally required.

Political-institutional and environmental resilience leave some room for improvements: Political-institutional resilience could be enhanced by the development of reconstruction guidelines with a list of relevant steps for a successful reconstruction process. Environmental resilience could be improved through the consistent application of the EIA to ensure the health of the ecosystems along Tohoku Coast.

8.5 USING THE WINDOW OF OPPORTUNITY

This chapter discusses the constitution of the window of opportunity in Miyako City, how well the reconstruction process was prepared in advance of the disaster and which options could be taken in order to improve the ability to use the window of opportunity more effectively.

How was the window of opportunity constituted in Miyako City?

One spatial planner of the city's Planning Division stated in an interview that he does not perceive the development of the built infrastructure as an improvement of the city structure. He bases this estimation on the large scale destruction of the city structure, which still needs to be restored (Miyako City Planning Division, Employee A, 2015). The estimation is justified because the city is currently still under construction and it will take more time until the city will be able to completely recover from the GEJE. This means, that the evaluation whether the window of opportunity could be used to improve engineering resilience cannot conclusively happen until in several years. Nevertheless, according to the analysis in Chapter 8.4, it can be stated that the destruction through the GEJE and Tsunami could be used to build engineering resilience, e.g., by minimizing the amount of vulnerable land at risk through relocation. In contrast to this, the same spatial planner understands the building of socio-economic resilience through the preservation of existing communities and the comprehensive participation process as an opportunity enabled by the disaster that the city used (Miyako City Planning Division, Employee A, 2015).

Did Miyako City have any spatial plans for reconstruction prepared before the disaster?

Before the GEJE happened, Miyako City did not have any plan for the city's spatial reconstruction after a disaster. The superordinate spatial plan that existed was the city's Comprehensive Plan, which set the guiding principle for the city's future spatial development. The plan was adopted in 2011, before the GEJE, and was completely unrelated to the possible occurrence of a disaster. The plan therefore did not make a point regarding the location of temporary housing sites or intended adjustments of the city's built structure. This meant, that the local spatial planners and the involved consultants had to start from scratch after the GEJE occurred; a process that was very complicated and time consuming (Miyako City Planning Division, Employee A, 2015). At least, the spatial vision of the Comprehensive Plan could be adopted as the main aim for the reconstruction process and thereby support the spatial planners.

How can the preparation of spatial plans for reconstruction before a disaster help to use the window of opportunity more effectively?

Having a spatial plan for the city's reconstruction after a disaster prepared in advance, can speed up the planning process and enable the spatial planners to use the time after a disaster more effectively. Nevertheless, all interviewees in Miyako City agreed that the development of such plans would have been very complicated if they would include spatial details. The reasons for this are that it was impossible to foresee the actual impact of the disaster in advance and prepare the plan accordingly. Furthermore, local people were not interested to discuss possible options for relocation in advance of the disaster because they did not expect it to happen (Miyako City Planning Division, Employee A, 2015; Taro District Citizen A, 2015). Instead of the preparation of a spatial plan for reconstruction, it was suggested to prepare guidelines, which include all relevant steps to take after the disaster (Miyako City Planning Division, Employee A, 2015). Such guidelines could assist the spatial planners and speed up the reconstruction process. This would help them to use the window of opportunity more efficiently.

9. CASE STUDY B: ISHINOMAKI CITY

To extent the experiences from Miyako City in Iwate Prefecture, this chapter provides insight into the reconstruction efforts in Ishinomaki City, which is located in Miyagi Prefecture. The chapter gives an overview about the city's geographic and demographic structure, explains the impacts that the GEJE and Tsunami had and illustrates the main goals of the reconstruction process in Ishinomaki City. Furthermore, the chapter addresses the following guiding questions:

› Which spatial planning options were used to build engineering resilience?

› Which spatial planning options were used to build evolutionary resilience?

› Which spatial planning options were able to build resilience? Which additional spatial planning options would have been useful to build resilience?

› How was the window of opportunity constituted in Ishinomaki City?

› Did Ishinomaki City have any spatial plans for reconstruction prepared before the disaster?

› How can the preparation of spatial plans for reconstruction before a disaster help to use the window of opportunity more effectively?

9.1 INTRODUCTION OF ISHINOMAKI CITY

Ishinomaki City is located in the north-east of Miyagi Prefecture (see illustration 55 on the next page). It is the most severely affected city by the GEJE and Tsunami. Like in Miyako City, Ishinomaki City's current size of 554.5 km^2 was also obtained through the Great Heisei Agglomeration in 2005 (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2016a). Today, the city consists of the formerly independent parts Ishinomaki City, Kahoku Town, Ogatsu Town, Kanan Town, Monou Town, Kitakami Town and Oshika Town (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2014, Table No. 62). The only neighboring town which remained independent is Onagawa Town, whose land-side is now completely surrounded by Ishinomaki City. Besides Onagawa Town in the east, Ishinomaki City borders the Pacific Ocean in the east and south. Ishinomaki City's western neighbors are Higashi-Matsushima City, Misato Town and Wakuya Town. In the north it borders Tome City and Minamisanriku Town. Kitakami River runs through the city of Ishinomaki. The river divides into two streams at the border of the city, resulting in two river mouths: Old Kitakami River flows into Ishinomaki Bay in the city's south and Kitakami River flows into the Pacific Ocean in the east of Ishinomaki City. Ishinomaki City is located at the edge between the flat coastline in the south of Miyagi Prefecture and the ria coastline, which reaches farther north. This results in the fact that the western part of Ishinomaki City is flat, while its eastern part is hilly and mountainous (Ishinomaki City, Construction Department, City Planning Division, 2009, p. 10).

In 2010, before the GEJE occurred, Ishinomaki City had a population of 160,826 people, which corresponded to an average population density of ~290 people per km^2. However, it must be considered that the majority of Ishinomaki City's population lives in the central district, while the towns that were incorporated in

Illustration 55 | Location of Ishinomaki City | Own illustration based on D-maps, 2016b

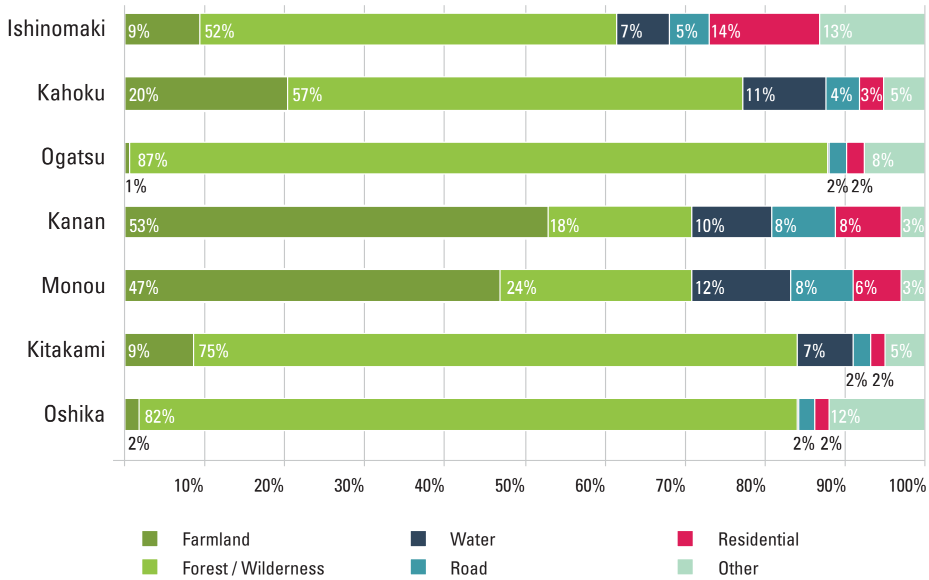


Illustration 56 | Land-uses in Ishinomaki City (as of 1 October 2003) | Own illustration based on Ishinomaki City, Construction Department, City Planning Division, 2009, p. 22

2005 tend to have a much lower population density (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2014, Table No. 62). This difference in population density was (and still is) reflected in the land-uses of Ishinomaki's districts: The more densely populated Ishinomaki District is constituted of the city's highest amount of residential area and area with other uses (incl. industrial). Nevertheless, this district was still largely rural with about 50% of the area occupied by forests and wilderness. In Ogatsu, Kitakami and Oshika Districts the amount of forest and wilderness is even higher, constituting between 75 and almost 90% of the districts' land. In Kanan and Monou District, farmland is the major land-use, constituting 53%, resp. 47% of the area (see illustration 56).

In 2015, Ishinomaki City had only 147,236 citizens, which is a decrease of about 8.5% (Statistics Bureau, Ministry of Internal Affairs and Communications Japan, 2016a). 3,600 of the lost population died or went missing during the GEJE and Tsunami (as of June 2013; Ishinomaki City Reconstruction Department, 2013, p. 1). Nevertheless, Ishinomaki City already had to struggle with the effects of demographic change before the disaster. They included both, a shrinking overall population and an increased number of elderly citizens (Ishinomaki City, Construction Department, City Planning Division, 2009, p. 11). This demographic trend is expected to continue and predictions say that the population of Ishinomaki City will shrink to 109,021 people by 2040 (see illustration 57 on the next page). However, because the number of members per household decreases, the number of households in Ishinomaki City increases despite its shrinking population. Between 1970 (with 42,447 households) and 2000 (with 57,259 households), the number of households increased by about 35%. From 2000 until 2005, the number of households started to decrease slightly by about 1% (Ishinomaki City, Construction Department, City Planning Division, 2009, p. 11).

Before the GEJE and Tsunami, Ishinomaki City was well known for its fishing and fish processing industries. Other important sectors were the shipbuilding

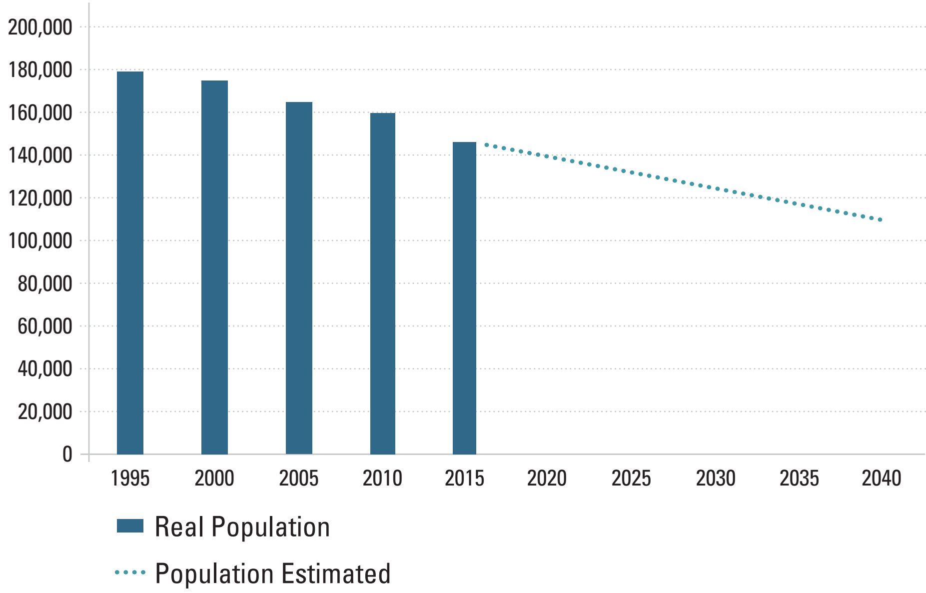


Illustration 57 | Population development of Ishinomaki City | Own illustration based on Brinkhoff, 2016b (population 1995-2015); National Institute of Population and Social Security Research, 2013 (estimates for 2015-2040)

and pulp industry (Klien, 2016, pp. 40–41). Nevertheless, the city had to struggle with economic problems even before the disaster occurred. This manifests in the decreasing number of employed people in the industrial and agricultural sector. Between 1990 and 2005 the number of people working in the industrial sector decreased from 89,178 to 77,409 people. The decrease of workers in the agricultural sector was even more severe. While 9,811 farmers worked in Ishinomaki City in 1980, the number had decreased to 5,583 farmers in 2005. In the fishery industry, the number of workers also decreased, while in 1978 8,630 fishermen worked in Ishinomaki City, in 2003 the number had decreased to 3,618 (Ishinomaki City, Construction Department, City Planning Division, 2009, pp. 13–14). A development which puts much pressure on Ishinomaki's city center is the downturn of the commercial sector. Both, the number of wholesale and retail businesses as well as the employees in this sector decreased between 1994 and 2004. Nevertheless, this trend was accompanied with an increase of sales floor area, which is a result of the expansion of large-scale retail stores, which were opened along the Sanriku Expressway (Ishinomaki City, Construction Department, City Planning Division, 2009, p. 15).

9.2 THE GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI IN ISHINOMAKI CITY

Ishinomaki City was the most severely affected city by the GEJE and Tsunami considering casualties as well as destroyed buildings. The tsunami reached the coastline with a height up to 8.6 m (measured in Ayukawa District) (Ishinomaki City Reconstruction Department, 2013, p. 1). In Ishinomaki City, the tsunami inundated an area of 73 km^2, which amounts to approximately 13% of the city's area, leaving 3,162 people dead and 438 missing (as of 30 June 2013; Ishinomaki City Reconstruction Department, 2013, p. 1).

Number of completely damaged houses	20,039
Number of houses with large-scale destruction	13,048
Number of partially destroyed houses	23,615
Number of damaged houses	N/D
Total number of damaged houses	56,702

Table 23 | Damaged houses after the GEJE and Tsunami in Ishinomaki City | Own illustration based on Ishinomaki City Reconstruction Department, 2016, p. 1

As table 23 illustrates, the tsunami completely damaged 20,039 houses. Additional 13,048 houses suffered from large-scale destruction and 23,615 were partially destroyed. Considering the estimated number of 74,000 houses before the GEJE and Tsunami (Editorial Office of the Ishinomaki Kahoku, 2014, p. 53), this means that 76,6% of Ishinomaki City's housing stock was affected and 27% was completely destroyed by the disaster.

9.3 POST-DISASTER RECONSTRUCTION PLANNING IN ISHINOMAKI CITY

In the first year after the GEJE and Tsunami, the basic concept for the reconstruction process was discussed and decided (Ishinomaki City Consultant, 2015). The official process began on 15 May 2011, two months after the GEJE, when the city administration organized a first meeting with experts to discuss the reconstruction process for Ishinomaki City. Starting from this meeting, the Basic Reconstruction Plan Citizen Committee (hereafter: Ishinomaki Citizen Council) was established. The council met a total of eight times between 1 June and 8 November 2011 and was responsible for the development of the Ishinomaki Basic Reconstruction Plan; it consisted of various stakeholders (e.g., representatives of the Ishinomaki Chamber of Commerce and Industry, the fishing industry, medical associations, Man-bow, the children's committee, and resident's representatives from various districts) (Ishinomaki City, 2013a; Kobayashi, Onoda, Hirano, & Ubaura, 2016).

To include the citizen's opinion into the Basic Reconstruction Plan, the city administration established a second council, which was responsible for the implementation of a citizen survey. The intention behind this survey was to gather information about the current situation of the citizens and their plans regarding their future housing situation (Kobayashi et al., 2016).

These two councils were overlooked by a Steering Committee, whose main responsibility was to discuss the recovery plans. After the draft version of the Basic Reconstruction Plan was completed, the local public was involved through opinion exchange meetings and the ability to submit written comments. After this round of participation, the Basic Reconstruction Plan was finalized and approved by the city congress in December 2011 (Ishinomaki City Planning Division, Employee, 2015).

The plan sets the three main principles, policy steps and intended measures for the reconstruction process and covers the time frame from 2011 till 2020. The period from 2011-2013 is called the "reconstruction period", the second period, from 2014-2017, is called the “regeneration period” and the final phase, from 2018-2020, is called the “Take-off period” (see illustration 58).

Illustration 58 | Time frame of the reconstruction process in Ishinomaki City | Own illustration based on Ishinomaki City Reconstruction Department, 2013, p. 12

The plan includes the following three main principles, which can each be assigned to one of the types of resilience (see Chapter 3.2):

Disaster-resistant city

The Basic Reconstruction Plan intends to use the reconstruction process for the improvement of Ishinomaki City’s utility infrastructure in order to make it disaster-resistant for the future, specifically stating the electricity and water supply networks. This also includes the expansion of new energy resources to broaden the used energy sources and make the energy system less failure-prone (Ishinomaki City Reconstruction Department, 2013, p. 12). This principle especially focuses on the improvement of the city’s engineering resilience because it addresses the improvement of the disaster resilience of the built infrastructure.

Business renewal

Recovering Ishinomaki City’s economy is another important aspect of the Basic Reconstruction Plan. To reach this goal, the plan intends to revitalize the local industries, including the paper industry, pulp industry, animal feed industry, fertilizer industry and laminated board production industry on the one hand and the agricultural and fishing industries on the other hand (Ishinomaki City Reconstruction Department, 2013, p. 12). This aspect addresses socio-economic resilience with an emphasis on the economic continuity of local businesses.

Vibrant community with bonding and cooperation

The third principle intends to create vibrant communities with strong social connections. To reach these goals, the Basic Reconstruction Plan intends the local citizens’ support through the city authorities, their communities, companies, the university as well as non-profit organizations (Ishinomaki City Reconstruction Department, 2013, p. 12). This principle aims at the improvement of socio-economic resilience with a focus on social aspects such as community cohesion.

The plan sets an overall budget of 1 trillion JPY for the ten-year reconstruction process of Ishinomaki City, a budget that corresponds to a regular budget of 100 years. This means, that the reconstruction process after the GEJE condenses the activities of the public authorities from 100 years into ten years (Ishinomaki City Planning Division, Employee, 2015).

Another important aspect of the reconstruction process, although not addressed in the Basic Reconstruction Plan, is the revitalization of the city center of Ishinomaki City, which is intended to counteract the city's urban sprawl that has been ongoing since the 1980s (Otsuka, 2014; Downtown Creative Reconstruction Committee, 2013). In connection with the demographic development, the urban sprawl results in an increased financial burden for the city administration in order to keep up the basic utility infrastructure for the entire area of the city (Ishinomaki City Planning Division, Employee, 2015). The concentrated development in the city center based on the compact city policy attempts to solve this problem (Otsuka, 2014).

After the Basic Reconstruction Plan was established, the Steering Committee was transferred into the Ishinomaki Revival and Town Building Council (hereafter: Town Building Council). The Town Building Council consists of representatives from the local, prefectural and national government, private consultants, representatives from academia and supporting expert groups (e.g., ArchiAid, Japan Institute of Architects (JIA)). To organize the wide range of reconstruction efforts, the Town Building Council is subdivided into three working groups: The Urban Area Working Group is concerned with recovery aspects in the urbanized area of Ishinomaki City. This area includes the part of the city, which used to be Ishinomaki City before the Great Heisei Agglomeration in 2005. The Peninsula Working Group is concerned with recovery projects in the remaining, more rural area on the peninsula. The third working group focuses on Public Housing. Each working group is constituted similar to the Town Building Council, consisting of representatives from the government, private consultants, representatives from academia and supporting expert groups. The council and the three working groups are all chaired by university professors (see illustration 59 on the next page).

During the second year after the GEJE, the Town Building Council had to decide on the actual reconstruction plans in order to proceed with the projects (Ishinomaki City Consultant, 2015). This time pressure to proceed resulted in a low amount of public participation. To speed up the reconstruction planning, it was primarily controlled by the public sector. The private sector was only able to introduce their expectations and opinions into the three working groups and therefore had to rely on the working groups approval in order to have their ideas realized. In illustration 59 the public opinion is included in the right part of the figure.

In the third year after the GEJE, the implementation of the planned reconstruction projects started. A process that is still ongoing (Ishinomaki City Consultant, 2015). In October 2015, each of the three principles for reconstruction – safety, industry and housing – had been progressed to about 40-50%, which means that there is still lots of work that needs to be done. The construction of housing is planned to be finished in 2017 (Ishinomaki City Planning Division, Employee, 2015).

9.4 BUILDING RESILIENCE IN ISHINOMAKI CITY

Building resilience involves the consideration of engineering resilience, political-institutional resilience, socio-economic resilience, and environmental resil-

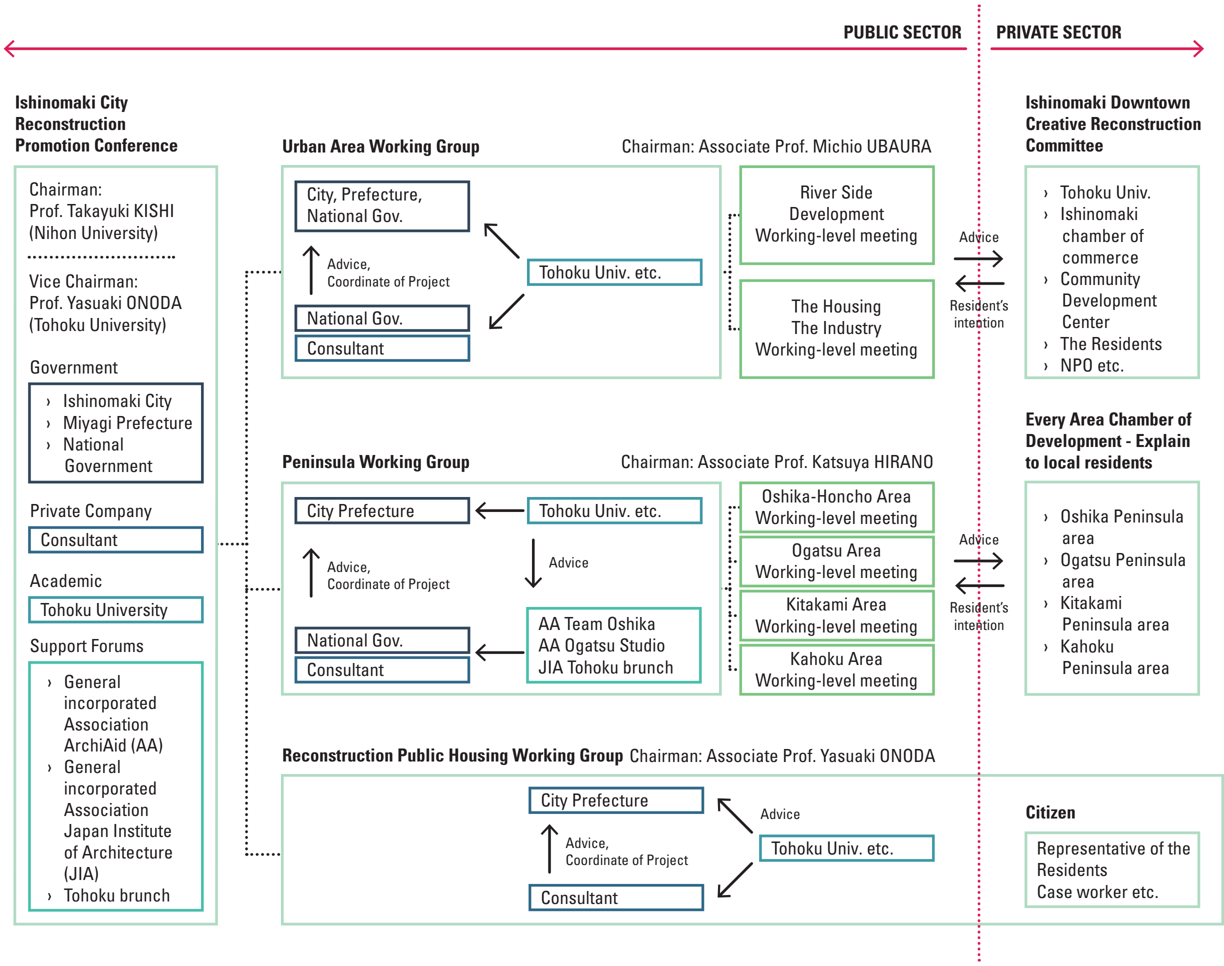


Illustration 59 | Organization structure of the reconstruction process in Ishinomaki City | Own illustration based on Kobayashi et al., 2016, p. 266

ience. The following chapters give an overview of the spatial planning options that were used in Ishinomaki City in order to build these four spheres of resilience based on the resilience items introduced in Chapter 5.

9.4.1 Engineering resilience

The following chapters elaborate how the resilience items vulnerable land-uses at risk, building codes, urban design solutions, sustainable building design standards, protective infrastructure, disaster resilience of utility infrastructure and disaster resilience of social infrastructure were addressed throughout the reconstruction process of Ishinomaki City to build engineering resilience.

9.4.1.1 Vulnerable land-uses at risk

The reduction of vulnerable land-uses at risk combines agricultural [UN-4.1.1], economic [UN-4.1.2] and residential land-uses [UN-4.1.3]. The reconstruction process in Ishinomaki City uses the following approaches to reduce vulnerable land-uses at risk:

› Minimization of exposure of urban areas: Land-use control in hazardous areas

- › Minimization of exposure of urban areas: Relocation through relocation programs or land-readjustment projects
- › Hazard Mitigation: Protective infrastructure

The option to reduce risk through the artificial elevation of land is not used for residential land in Ishinomaki City. Instead of raising the land, residential land-uses will be protected through the construction of a two-tier levee and a river embankment. The reason for this decision is, that even after the GEJE and Tsunami destroyed many buildings in Ishinomaki City's central area, a significant amount of buildings withstood the disaster and still remain in the area. Raising the land of the city center would have resulted in the need to demolish all of these buildings and rebuild them on top of the raised land (Ishinomaki City, Downtown Creative Reconstruction Committee Member, personal communication, 24 February 2015).

In Ishinomaki City, one of the main measures to reduce the exposure of vulnerable land-uses to hazards is the construction of protective infrastructure. This includes the construction of a first and second levee along the coastline as well as the construction of a levee along the river mouth of Old Kitakami River to protect the city center. These measures will be discussed in Chapter 9.4.1.5. The preparation of hazard maps as a tool to prepare the land-use measures discussed in this chapter, will be reviewed in Chapter 9.4.2.2. This chapter discusses the additional measures that were taken in order to protect vulnerable land-uses from hazards in case that the protective infrastructure fails.

Minimization of exposure of urban areas: Land-use control in hazardous areas

In Ishinomaki City, hazardous zones are designated based on hazard maps, which are developed on the basis of computer simulations. The hazard mapping is elaborated in detail in Chapter 9.4.2.2. The map considers the construction of a seawall along the coastline and uses the tsunami distinction between L1- and L2-tsunamis.

The reconstruction process in Ishinomaki City intends that all future residential areas should be safe from both L1- and L2-tsunami. This protection will be ensured through the construction of a first and second levee along the coast as well as a river embankment along both mouths of Kitakami River. Thus, areas which are not protected against future tsunamis were designated as hazardous in accordance with Article 39 of the Building Standards Act. For instance, this is the case for the area between the first and second levee in Minamihama-Kadonowaki District, which is located directly by the ocean. The area will be excluded from the future development of vulnerable land-uses and is planned to be developed as a memorial park. People who used to live in this area are subject to a group relocation project to Hebita District (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015; Ministry of Land, Infrastructure, Transport and Tourism, 2011). Another example for the designation of hazardous areas based on Article 39 of the Building Standards Act is the area between the first and second levee in Kama-Okaido District, which will also be prone to flooding in case of a L2-tsunami. This area is also restricted from future residential development. Nevertheless, due to the areas vicinity to the city's industrial port, the area is free for the development of industrial land-uses in order to integrate the industrial sites with the harbor. The residents who used to live in the hazardous area, are also subject for the group relocation project to Hebita District (Ministry of Land, Infrastructure, Transport and Tourism, 2011).

Minimization of exposure of urban areas: Relocation through relocation programs or land-readjustment projects

In order to reduce the vulnerable land-uses at risk, the administration of Ishinomaki City planned the relocation of residential land-uses from hazardous to safe areas. The people in Ishinomaki City were free to choose where they wanted to relocate to and if they wanted to relocate as part of a group relocation project or individually.

The city administration developed six relocation sites within Ishinomaki District and additional 46 relocation sites in the suburbs. The six relocation sites in Ishinomaki District (see table 24) were projected to cover an area of about 123 ha with 2,950 houses for 7,570 residents (Ishinomaki City Reconstruction Department, 2013).

The relocation of affected citizens in Ishinomaki City followed several steps, which are explained in the following paragraphs.

- The number of required houses was determined with two questionnaires, which were conducted by the city administration in May 2011 and May/ June 2012. The questionnaires surveyed the relocation plans of the affected citizens and served as a basis for the selection of the relocation sites (Ishinomaki City, 2013e; Ishinomaki City Reconstruction Department, 2011). Besides the information from the questionnaires, time was another important criterion for the selection of relocation sites in Ishinomaki City. The city administration mostly selected larger sites, which were located in the suburbs because the number of land owners

<table>
<tr><th></th><th colspan="3">2012</th><th colspan="4">2013</th><th colspan="4">2014</th><th colspan="4">2015</th><th colspan="4">2016</th><th>17</th><th>Completion</th></tr>
<tr><th></th><th>4</th><th>7</th><th>10</th><th>1</th><th>4</th><th>7</th><th>10</th><th>1</th><th>4</th><th>7</th><th>10</th><th>1</th><th>4</th><th>7</th><th>10</th><th>1</th><th>4</th><th>7</th><th>10</th><th>1</th><th>Target year</th></tr>
<tr><td>(1) Shin Hebita</td><td></td><td></td><td colspan="5">Design, etc.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2019</td></tr>
<tr><td>46.5 ha</td><td></td><td>X</td><td colspan="18">Construction</td><td></td></tr>
<tr><td>(2) Shin Hebita South</td><td></td><td></td><td colspan="6">Design, etc.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2019</td></tr>
<tr><td>27.4 ha</td><td></td><td></td><td></td><td></td><td></td><td>X</td><td colspan="14">Construction</td><td></td></tr>
<tr><td>(3) Shin Hebita South 2</td><td></td><td></td><td></td><td></td><td colspan="8">Design, etc.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2019</td></tr>
<tr><td>13.7 ha</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td colspan="11">Construction</td><td></td></tr>
<tr><td>(4) Akebono North</td><td></td><td></td><td colspan="4">Design, etc.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2017</td></tr>
<tr><td>5.6 ha</td><td></td><td></td><td></td><td></td><td>X</td><td colspan="11">Construction</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(5) Shin Watanona</td><td></td><td></td><td colspan="4">Design, etc.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2017</td></tr>
<tr><td>17.8 ha</td><td></td><td></td><td>X</td><td colspan="14">Construction</td><td></td><td></td><td></td><td></td></tr>
<tr><td>(6) Shin Watanona West</td><td></td><td></td><td colspan="4">Design, etc.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2017</td></tr>
<tr><td>11.1 ha</td><td></td><td></td><td></td><td></td><td>X</td><td colspan="11">Construction</td><td></td><td></td><td></td><td></td><td></td></tr>
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Table 24 | Timeline for the six reconstruction projects in Ishinomaki District (X = Planning decision) | Own illustration based on Ishinomaki City Reconstruction Department, 2016, p. 34

in this area was smaller than the number of land owners in the city's urban area (Ishinomaki City Consultant, 2015; Ishinomaki City Planning Division, Employee, 2015). This sped up the negotiation process and helped to start the relocation faster. However, to implement Ishinomaki City's vision to build a compact city, options that would have densified the city's existing residential areas, could have been more appropriate. One option for this could have been the relocation of affected people from Minamihama Area onto Hiyoriyama Mountain, which is a safe location. There are many old houses on the mountain, which are owned by people who are also getting old. This area could have been modernized by means of redevelopment projects in order to increase the buildings' capacity. The problem with this idea was that the houses are privately owned and the negotiation with the land owners would have taken time and time was lacking (Ishinomaki City Consultant, 2015). Another option, which was discarded for the same reason, would have been the densification of the city center through the construction of new buildings on empty lots (Machizukuri Employee, 2015).

› While some of the relocation project sites were already designated as UPA, the large scale developments in the suburbs, e.g., Shin Hebita District, were located in URA and designated as agricultural land. Accordingly, the land had to be redetermined before the land readjustment projects to develop the land could start (Ubaura, Miyakawa, & Nieda, 2016).

› The land for the relocation sites in Ishinomaki District is developed through the implementation of group relocation programs or publicly initiated land readjustment projects (Ishinomaki City Reconstruction Department, 2013). Land readjustment projects are a useful spatial planning instrument to build the technical infrastructure and green spaces of residential areas (See Chapter 4.7).

› The construction work for the six relocation projects in Ishinomaki District started between the end of 2012 and the end of 2013. While the construction work in the three smaller relocation sites (Akebono North, Shin Watanona and Shin Watanona West) concluded in the beginning of 2016, the construction work of the larger projects in Hebita are still ongoing and are scheduled to be completed in 2019 (see illustrations 60 and 61).

› After the construction work is finished, the housing sites are available for disposal. The distribution of housing lots started in 2014 and is scheduled to finish in 2017 (Ishinomaki estate information browsing WEB site, n. d.). People were able to apply for housing sites individually or as part of a group relocation project. In cases where the applications for one site exceeded the number of available housing lots, the future residents were selected via lottery. Many households, who intended to relocate to the city center, decided to apply individually because the application as a group did not provide any advantages for the relocation sites in this area. In the suburbs the situation differed and people were able to relocate together with their community more easily (Machizukuri Employee, 2015).

Illustration 60 | Land-use plan for Shin Hebita District (Ishinomaki City) | Ishinomaki Estate Information Browsing Website, n. d.

› With the distribution of the lots to the new land-owners through a lottery, the relocation process concludes and the land-owners begin with the construction of their new homes.

Agricultural land

In Ishinomaki City, 1,771 ha of agricultural land were flooded by the tsunami. This area equals 20% of the overall agricultural land in Ishinomaki City. The estimated damage for the agriculture and forestry industries was estimated with 63.4 billion JPY. The recovery of the agricultural land took place through desalinization and replanting with rice. No additional land-use planning measures were taken in order to reduce the future exposure of the agriculture land (Ishinomaki City Reconstruction Department, 2013).

Economic activity

The most important industries in Ishinomaki City before the disaster were paper, pulp, animal feed, fertilizer and laminated board production. Due to the location of these industrial sites directly by the ocean, they were completely destroyed. In addition to this, many agricultural and fishing businesses, which were vital for the city's food supply, were also affected. The reconstruction required the cooperation between businesses because not the entire former industrial area will be designated for future industrial land-uses. This means that the industrial businesses are required to move closer together (Ishinomaki City Reconstruction Department, 2013).

9.4.1.2 Building Codes

Japan's strict building codes to reduce risks (especially the impact of earthquakes) [UN-4.2.1] also apply to the reconstruction of Ishinomaki City. These

Illustration 61 | Construction site in Hebita District | Photo by author, September 2015

building codes are continually enforced [UN-4.2.2] and updated [UN-4.2.3]. Due to this frequent update, the newly constructed buildings that replace the old building stock, which was destroyed by the tsunami, will possess a larger engineering resilience than the former buildings (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

In addition to these general building codes, it is also recommended that people should not use the ground floor of their houses for residential uses. Instead, these areas should be used for shops or parking spaces in order to keep the people safe if a tsunami occurs. For houses that only consist of residential uses, the people are recommended to sleep on the first floor to be safe at night (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

9.4.1.3 Urban design solutions

Part of the reconstruction process of Ishinomaki City is the establishment of two urban parks and a green promenade along Old Kitakami River, which contribute to a sustainable urban design [UN-4.3.1]. The advantage of such areas can be the regulation of the city's climate and the absorption of possible heavy rainfalls – problems that are expected to increase with progressing global warming (see Chapter 5.4)

On Nakaze Island, where the Ishinomaki Mangattan Museum is located, a park is planned. Another park, the Ishinomaki Tsunami Memorial Park, is planned directly by the sea in Minamihama District, an area which is restricted for future urban development (Ishinomaki City Reconstruction Department, 2016). The design for the park includes a pond and wetlands, a pine tree forest along the coast and an evacuation hill (see illustration 62 on the next page; Ishinomaki City, n. d.).

Another large scale project is the planned green promenade along Old Kitakami River. The promenade should make the planned river embankment more attractive for the citizens and increase the embankments functions (Ishinomaki City, 2013f).

In addition to these large scale projects, the city administration also includes smaller green spaces and retention areas in the newly developed relocation sites. One example for this is Shin Hebita District, which includes the develop-

Illustration 62 | Design of the Tsunami Memorial Park in Minamihama District (Ishinomaki City) | Ishinomaki City, n. d., p. 2

ment of various smaller and larger parks and green spaces as well as a retention basin. The urban design for this relocation site also won the Special Urban Landscape Award for urban development projects in the fiscal year 2016 by the Urban Design Center, which accentuates its innovative approach (see illustration 60; Urban Design Center, n. d.).

The revitalization of the inner city is another important point for spatial planning because the sprawl of the city increases the (financial) burden on the city administration (Ishinomaki City Planning Division, Employee, 2015). Therefore, it is intended to concentrate the urban development on the city center. This process is still ongoing and it will take some time to know if this goal can be achieved.

9.4.1.4 Sustainable building design standards

If buildings are constructed in accordance with sustainable building design standards, it can reduce their susceptibility against natural hazards, e.g., if they are energy-self-sufficient [UN-4.3.2]. In Ishinomaki City, the restricted time after the GEJE and Tsunami resulted in an exclusion of additional aspects such as the consideration of sustainable building design standards. The main primary task was to build new housing for the affected people as fast as possible. Aspects like the selection of sustainable building material (e.g., recycled material) or additional ecological aspects were not considered (Machizukuri Employee, 2015).

The city intends the installation of solar panels on private houses to increase their independence from the energy supply system and also set up incentives to support this intention (Ishinomaki City, 2016d). If these plans are going to be realized depends on the time and money available to maintain such installations (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

Key
- Seawall (1st levee)
- River embankment
- High embankment road (2nd levee)
- Disaster prevention green space
- Main roads
- Tsunami evacuation tower
- Tsunami evacuation building
- Evacuation facilities

Illustration 63 | Map of planned protective infrastructure in Ishinomaki District (Ishinomaki City) | Ishinomaki City, 2016b, p. 32

9.4.1.5 Protective Infrastructure

In Ishinomaki City, the construction [UN-8.1.1] and maintenance [UN-8.1.2] of effective protective infrastructure is a vital aspect to increase the city's engineering resilience (Ishinomaki City Consultant, 2015; Ishinomaki City Planning Division, Employee, 2015). The construction of a two-tier levee system along the coast and the river embankment along Old Kitakami River enable the on-site reconstruction in Ishinomaki's city center and parts of the severely affected Minamihama District. However, the people of Ishinomaki are aware that the construction of protective infrastructure alone is not enough to stay safe in case of a hazardous event. Therefore, enabling the people to evacuate in case of a hazardous event and prepare them for this situation is another important aspect in order to build resilience (Machizukuri Employee, 2015). This includes the construction of evacuation facilities, such as tsunami evacuation towers, the designation of tsunami evacuation buildings, and the set up and maintenance of evacuation routes and locations (see illustration 63; Ishinomaki City Reconstruction Department, 2016).

The specialty of the two-tier levee system in Ishinomaki City is that it is intended to protect all residential areas not only from L1-, but also L2-tsunamis in order to enable the citizens to feel safe (Ishinomaki City Planning Division, Employee, 2015). The system was planned in cooperation between Ishinomaki City, the prefectural and national government (Ishinomaki City Planning Division, Employee, 2015) and is designed in the following way: The construction of a T.P. 7.2-meter-high seawall along the shore is supposed to protect the low lying land behind it from L1-tsunamis (Ishinomaki City Reconstruction Department, 2016). The height was decided by the prefectural government, which is responsible for the construction of the seawall, based on the height of historical tsunamis. The higher L2-tsunamis will overtop this seawall and flood the area between the first and second levee. However, the second levee, which is either constructed as a raised road or a raised green space (depending on the location) will prevent the water to flood the residential areas behind. The height of this secondary levee varies between T.P. 3.5 m and T.P. 4.5 m (Ishinomaki City Consultant, 2015; Ishinomaki City Reconstruction Department, 2016).

The GEJE Tsunami ran up Old Kitakami River and caused severe flooding along the riverside. Therefore, it is planned to construct a river embankment with a height between T.P. 4.1 m and T.P. 7.2 m along the river in order to protect the neighboring areas (Ishinomaki City Reconstruction Department, 2016). Kitakami River is considered a Class A river, with major importance for the national economy and people's wellbeing. Thus, its administration falls under the competence of the Ministry of Land, Infrastructure, Transport and Tourism in accordance with the River Law (Infrastructure Development Institute Japan, 1999). Accordingly, the national government is responsible for the construction of the river embankment along the river mouth. However, the development of the project is planned to be made in accordance with the city administration's plan for the new city center (Ishinomaki City Reconstruction Department, 2013).

To enable the people to evacuate in case of a tsunami, it is important to have a sufficient number of evacuation buildings available. These can either be specifically constructed tsunami evacuation towers or regular apartment buildings that are high and robust enough to be used as evacuation buildings in case of a tsunami. To increase the number of evacuation facilities in the central area in comparison to before the GEJE and Tsunami, the newly constructed public housing buildings with six or seven floors will be officially designated as evacuation facilities (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

9.4.1.6 Disaster resilience of utility infrastructure

This item considers all measures taken in order to increase the disaster resilience of Ishinomaki City's communication networks [UN-8.2.1, UN-8.2.2, UN-8.2.3], the electricity [UN-8.3.1, UN-8.3.2, UN-8.3.3] and gas [UN-8.5.1, UN-8.5.2, UN-8.5.3, UN-8.5.4] networks, the water and sanitation networks [UN-8.4.1, UN-8.4.2, UN-8.4.3] as well as the transportation networks (incl. roads, evacuation routes, railroads, airports, ports and other public transportation networks) [UN-8.6.1, UN-8.6.2, UN-8.6.3, UN-8.6.4, UN-8.6.5, UN-8.6.6]. The recognition of the importance to improve the disaster resilience of the city's utility infrastructure is reflected in Ishinomaki City's Basic Reconstruction Plan. The first principle states that the city's utility infrastructure should not simply be restored, but improved in regard to its disaster resilience (Ishinomaki City Reconstruction Department, 2013).

Despite their importance, aspects like the improvement of the utility infrastructure – beyond the recovery of the basic functions – initially had to be set aside. It was the city administration's priority to ensure people a safe environment, supply them with housing and recover the local industry (Ishinomaki City Planning Division, Employee, 2015).

Transportation

One important issue regarding the transportation network was the reconstruction of the local wharves, which included raising the descended land in order to keep the wharfs above sea level. The reconstruction process for all wharves in Ishinomaki City was scheduled to be finished in 2016. (Ishinomaki City Reconstruction Department, 2013)

There are various measures to improve the city's road network, with a special focus on arterial roads that double as evacuation routes in case of a hazardous event. For instance, raising and widening the east-west connection in Minamihama District will prevent the road to become inaccessible in case of a tsunami. In addition to this, the road network is planned to be extended through the construction of additional arterial roads in order to secure a smooth traffic stream and a safe evacuation in case of a tsunami. These projects also include the construction of a new bridge in the north of the city center in order to shorten the connection between the east and west parts of Highway 398 (Ishinomaki City, 2016b).

Planning the new road network, is especially challenging because of the cooperation needed in order to plan and implement the projects. This includes the coordination between various sectoral planning divisions on the level of the city administration (e.g., City Planning Division, Infrastructure Development Division) as well as the coordination between different administrative levels (e.g., municipal and prefectural level). The responsibility of different administrative levels is based on the type of road – while the city is responsible for the construction and maintenance of local roads, the prefecture is responsible for the construction and maintenance of highways (e.g., Highway 398) (Ishinomaki City, 2016a).

Energy

One aim for the improvement of the energy supply system is the equipment of buildings with solar panels in order to improve their energetic independence. This is especially important for buildings where people gather in the case of hazardous events, such as the disaster prevention center, emergency facilities or schools. For the case of an emergency, these buildings are furthermore equipped with storage batteries to supply them with electricity, even if the regular networks are down (Ishinomaki City, 2016c). Furthermore, a solar power plant in Shin Hebita District was opened in March 2016. The plant is supposed to deliver electricity for some of the public housing units on the newly constructed relocation site and secure a sufficient power supply in case of an emergency. The power generation of the plant amounts to 310,000 kWh/ year (Ishinomaki City, 2016c). To support the installation of solar panels on private houses and businesses, the city administration offers incentives on property taxes (Ishinomaki City, 2016d).

9.4.1.7 Disaster resilience of social infrastructure

Building the disaster resilience of social infrastructure includes police and first responders [UN-8.7.1], the prison system [UN-8.7.2], education facilities [UN-8.8.1] and health care and emergency facilities [UN-8.9.1]. In addition to this, an ongoing access to the basic administrative functions [UN-8.10.1] should be ensured. Directly after the disaster, the recovery of the basic functions for each of these aspects had priority (Ishinomaki City, 2011, p. 23). For instance, the educational services continued in temporary locations throughout the city (Ishinomaki City Reconstruction Department, 2013).

To ensure the long-term safety of these facilities, they should be located in safe areas. In Ishinomaki City, this specifically concerns the hospital and multiple schools. Planning the relocation of social infrastructure facilities requires the cooperation of the city planning division with various sectoral planning divisions (e.g., Health Section, Board of Education).

One example in Ishinomaki City, is the relocation of Ishinomaki City Hospital to its new location nearby the City Hall and Ishinomaki Station (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). The hospital was originally opened in Minamihama District in 1998. After the hospital was flooded and became unusable through the GEJE and Tsunami, it had to be demolished. The staff moved to temporary locations to maintain the main medical services. The city administration decided to relocate the hospital to its new place in order to keep it safe in case of another large-scale tsunami. The new building, which accommodates 180 hospital beds, was opened on 1 September 2016 and is now in operation (Ishinomaki Municipal Hospital, 2016). The reconstruction of the project occurred under the Miyagi Prefecture's community health system rebuilding plan (Ishinomaki City Reconstruction Department, 2013).

Another example for increased resilience of social infrastructure is the relocation of educational facilities that were partly or severely damaged by the tsunami. The most tragic example is the complete inundation of Okawa Elementary School, where 74 children and 10 teachers died (O'Dwyer, 2016). Some schools were able to be recovered in their former facilities (i.e., Minato Elementary School, Minato Junior High School, Watanoha Elementary School). These schools will be protected from future tsunamis through the construction of protective infrastructure and could reopen in April 2014. The planning procedures for Ogatsu District's combined Elementary and Junior High School (which was constituted through merging the former Elementary Schools Ogatsu and Funakoshi with Ogatsu Junior High School) and Watanoha Junior High School started in mid-2013 with the aim to move the schools to a new inland site. The schools are scheduled to reopen in 2017. Due to the relocation of these schools, the planning processes included the development of a basic concept and design before the construction work began. For the construction of Ogatsu District Elementary and Junior High School, the land had to be acquired. Watanoha Junior High School is developed as part of a land readjustment project, which is why the separated step of land acquisition was not necessary. Nevertheless, the implementation of the land readjustment project also requires time and effort (Ishinomaki City Reconstruction Department, 2013, 2016).

9.4.2 Political-institutional resilience

The following paragraphs analyze the spatial planning options used to build political-institutional resilience by addressing the resilience items proposal evaluation for disaster resilience, implementation of risk assessments, pre-event planning for disaster recovery and learning loops.

9.4.2.1 Proposal evaluation for disaster resilience

The evaluation of new planning proposals for disaster resilience [UN-1.2.1] gets more and more important as time passes. Since the current spatial planning processes prioritize the citizen's safety, it does not take avoidable risks and prevents residential land-uses in hazardous areas (Ishinomaki City Planning Division, Employee, 2015; Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). Nevertheless, the past shows that as time goes by, trade-offs between safety and convenience occur. One example for this is the relatively new urbanization of Minamihama District (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). The district does not have a long history as a residential area due to its direct exposure to the ocean (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). Therefore, it is necessary, that the city administration of Ishinomaki City secures that all future spatial plans are reviewed under the consideration of the plan's disaster resilience. One possibility to achieve this goal is to keep the lessons learned through the GEJE alive (see Chapter 9.4.2.4).

9.4.2.2 Risk assessment

Risk assessment combines assembling the knowledge about possible hazards [UN-2.1.1], a city's exposure and vulnerabilities [UN-2.1.2] and the knowledge about critical assets and their connections to each other [UN-2.1.3]. To illustrate this information, hazard maps [UN-2.1.4] are a helpful tool.

The hazard maps for Ishinomaki City were developed with the help of computer simulations using the concept of L1- and L2-tsunamis (see illustration 64). The map shows that – in case of a L2-tsunami – the entire area between the first and secondary levee will become inundated, thus revealing the importance of the construction of the secondary levee.

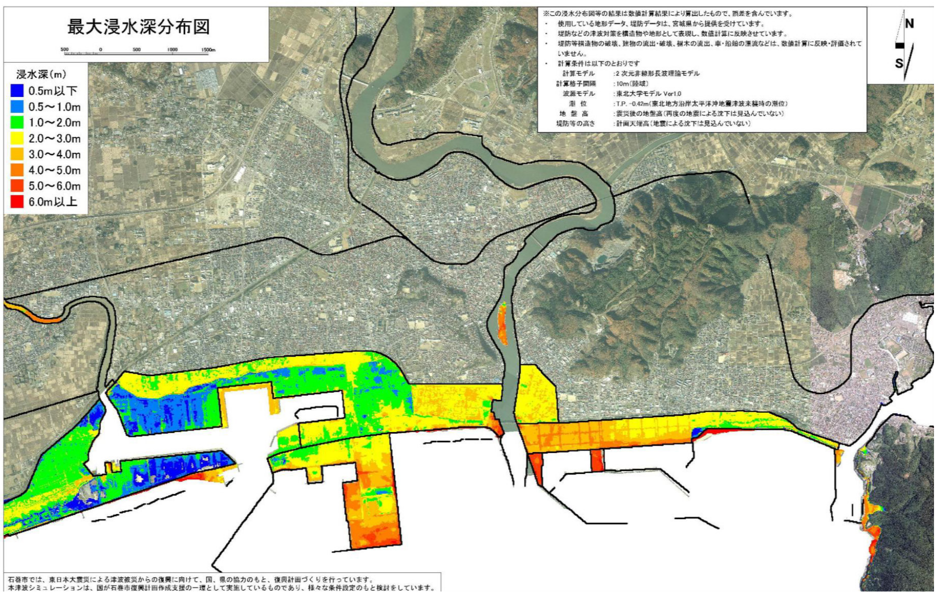


Illustration 64 | Results from the L2-tsunami simulation for Ishinomaki District (Ishinomaki City) | Ishinomaki City, 2011, References Section p. 7

In Ishinomaki City, the entire area which is expected to be flooded in case of a L2-tsunami was designated as hazardous in accordance with Article 39 of the Building Standards Act (Ministry of Land, Infrastructure, Transport and Tourism, 2011). This is an exception since many other cities allow the construction of residential buildings in areas with an expected inundation depth of less than 2 m. In many cases this permission is connected with the requirement to apply specific building standards (see Chapter 8). In the central district, parts of Minamihama-Kadonowaki District and Kama-Okaido District were designated as hazardous (Ministry of Land, Infrastructure, Transport and Tourism, 2011).

The importance to continuously update risk scenarios with the improvement of technical forecast methods [UN-2.2.1] and to consider the unexpected is illustrated by the fact that Ishinomaki City had a tsunami hazard map prepared before the GEJE and Tsunami (Machizukuri Employee, 2015). The map did not consider the possibility of such a large scale event and was therefore misleading instead of helpful (O'Dwyer, 2016). Of course the revision of the risk scenarios should also include new risks that might occur in the future (e.g., the increased occurrence of heavy rainfalls due to global warming). In Ishinomaki City, these aspects are not thoroughly considered so far.

9.4.2.3 Pre-event planning for disaster recovery

Planning for post event recovery in advance of a disaster can help to use the window of opportunity more effectively [UN-2.1.2]. In the context of spatial planning, pre-event planning can include the preparation of spatial visions or plans for reconstruction. In the case of Ishinomaki City, the city administration did not have any post event recovery plans prepared before the GEJE and Tsunami; the relocation plan for the affected people was developed after the disaster (Ishinomaki City Planning Division, Employee, 2015; Machizukuri Employee, 2015). Nevertheless, the city had a Master Plan, including the city's guiding principle and additional concepts that could generally serve as a basis for the reconstruction process. Another existing plan was the revitalization plan for the city's central area that was already developed before the GEJE and Tsunami. Although the plan did not have any connection to the occurrence of the disaster, it was used as a basis for the development of the reconstruction plan for the area. In this regard, the existing plans helped to simplify the reconstruction process. One aspect from the revitalization plan, which was then included into the reconstruction plan, was the attraction of tourists (Machizukuri Employee, 2015).

In Ishinomaki City, the expert's opinions on the usefulness of pre-event land-use planning for after a disaster differ: On the one hand, preparing a recovery land-use plan in advance would be very complicated and expensive, since all possible hazards (e.g., tsunami, earthquake, flooding, sand storm) and their potential impacts would have to be considered (Machizukuri Employee, 2015). As the GEJE shows, these estimations can easily be incorrect and the plan therefore be useless. Furthermore, the development of such a plan is associated with a necessity for action: If the plan determines certain areas as hazardous and includes possible relocation sites for the people, who live in this area, it would be necessary to relocate these households right away instead of waiting until a disaster occurs (which is also the actual intention of Article 39 of the Building

Standards Act) (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). This illustrates how thinking about certain aspects is directly linked with the need for action and the associated costs. Another reason against the development of the pre-event development of spatial disaster reconstruction plans is the citizen's lack of interest to participate in the planning process. This lack of interest is caused by the low frequency of disasters like the GEJE and Tsunami, which only occurs once in a thousand years. The citizens were not willing to be concerned with reconstruction planning before the occurrence of the disaster because they did not expect to experience such an event during their lifetime (Ishinomaki City Planning Division, Employee, 2015).

On the other hand, the in advance preparation of such a plan, including the estimated damage from the tsunami, the determination of relocation sites for residential land-uses and required protective infrastructure would have accelerated the implementation of the reconstruction plans (Ishinomaki City Planning Division, Employee, 2015). This aspect is especially relevant because time after a disaster is short and the requirement to initially develop the reconstruction plan before the actual reconstruction process can start, can result in unwanted developments: For instance, the city administration selected relocation sites on former agricultural land in the suburbs, instead of using the opportunity to fill in empty lots in the city center or renovating old houses on Hiyoriyama Mountain (Ishinomaki City Consultant, 2015; Machizukuri Employee, 2015). Such a development contradicts with the city's guiding principle of a compact city. To implement the compact city policy after the disaster, it would have been helpful to establish a plan to reach this goal in advance of the disaster (Ishinomaki City Consultant, 2015). To get the local citizens on-board for the development of a pre-event developed reconstruction plan, it should focus on the improvement of their everyday life – even if no disaster occurs. This means the plan could rather be considered as a vision for the city's development that also considers the possibility of the occurrence of a hazardous event thoroughly (Ishinomaki City Consultant, 2015). Aspiring to realize this vision, even if no hazardous event occurs, could also solve the problem of people living in hazardous areas, through their gradual relocation. In addition to this, involving the citizens into the selection of the relocation sites to a greater extent could also increase their preparedness and acceptance of the changing situation (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). Even if the development of such plans would be expensive, they would be very useful, according to one of Ishinomaki City's consultants (Ishinomaki City Consultant, 2015).

9.4.2.4 Learning loops

In order to advance political-institutional resilience, it is important to use past disasters to learn for the future (learning loops) [UN-2.1.3]. Therefore, it is important to collect lessons learned and prepare them for future use. One lesson learned from the GEJE, is the necessity to expect the unexpected. This is directly related to the necessity to have evacuation measures in place, even if the construction of protective infrastructure intends to completely protect the entire residential area from future tsunamis (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015; Machizukuri Employee, 2015).

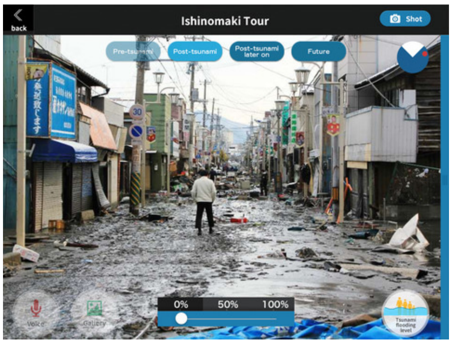


Illustration 65 | Post-tsunami picture from the Ishinomaki Tsunami AR app | Ishinomaki Future Support Association, 2015

Illustration 66 | Future vision from the Ishinomaki Tsunami AR app | Ishinomaki Future Support Association, 2015

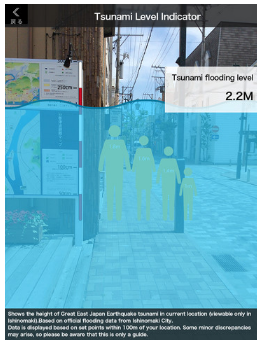


Illustration 67 | Tsunami inundation level from the Ishinomaki Tsunami AR app | Ishinomaki Future Support Association, 2015

In order to keep the memories of the tsunami's destructive force active, there are several measures taken. One example is the preservation of the Okawa Elementary School, where 74 students and 10 staff members lost their life because they did not expect the tsunami to come so far inland (O'Dwyer, 2016). Keeping this monument can remind future generations of the destructive force of tsunamis and show the importance to evacuate even though the current location might feel safe. Another project, implemented by the Downtown Creative Reconstruction Committee, is the smart phone app "Ishinomaki Tsunami AR" that enables people to personally experience the GEJE and Tsunami's impact on the city center of Ishinomaki City, by featuring pre- and post-tsunami pictures as well as future visions (see illustration 65 and 66). These pictures can be compared to the user's current location in Ishinomaki City. The app also offers to experience the inundation height of the tsunami at the current location of the user (see illustration 67). The intention behind the app is to keep the memories from the GEJE active and preserve them for visitors and future generations.

Only time will tell, if the lessons learned though the GEJE and Tsunami and the reconstruction process afterwards will be valued in the future. This includes that the land-use restrictions made in the aftermath of the GEJE (e.g., the designation of hazardous zones) will be maintained independently from the city's future development. With the aging and shrinking population that Ishinomaki City currently has to face, it seems unlikely that the pressure to develop further residential areas will get so high that the city administration decides to repeal the land-use restrictions. However, the short history of the residential area in Minamihama District (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015) illustrates that such a disastrous decision was taken at a certain point in the past and if the lessons from the GEJE are not kept alive, this could happen again.

9.4.3 Socio-economic resilience

Socio-economic resilience can be addressed with the following resilience items: citizen participation, social connectedness and neighborhood cohesion and the provision of safe shelter. The following chapters analyze the ability of spatial planning options to address these items and explain how this was done.

9.4.3.1 Consideration of citizen's needs

This item combines the coverage with grassroots organizations [UN-7.1.1] and their ability to use their networks [UN-7.1.2] in order to have their opinions heard during the planning process. In addition to grassroots organizations, participation processes should also specifically include vulnerable segments of the population [UN-7.1.4] to ensure the consideration of their needs.

The Basic Reconstruction Plan of Ishinomaki City does not specifically state goals regarding the participation of citizens in the city's reconstruction process, which corresponds with the fact that citizen participation did not have particular importance during the planning for reconstruction in Ishinomaki City. Therefore, the involvement of the public corresponds with the basic legal requirements, which provide for a two-stage participation process consisting of the information of the public (e.g., through information events) and the public display of the plans associated with the opportunity to submit comments (see Chapter 4.7). Corresponding with this, the city administration ensured the information of the citizens and enabled them to give their opinion on the reconstruction planning at citizen consultation meetings. Nevertheless, the city administration did not offer the possibility for active involvement by organizing planning workshops or similar events. Events that went beyond the legal requirements, were organized by grassroots organizations.

While some citizens were very interested in participating in the planning processes for the reconstruction of Ishinomaki City, others were not. This was especially the case for people who lost relatives in the disaster and had to cope with their grief before they were able to focus on other issues (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

Citizen information

According to the law, the citizens of Ishinomaki City were informed about the most important aspects of the reconstruction process. For instance, the city administration held a total of 33 briefings in the seven most affected districts: Kama District, Okaido District, Minato District, Central District, Kadonowaki District, Minamihama District, Watanoha District (Ishinomaki City, 2013d). At these meetings, the city administration informed the land owners from these districts about the planned reconstruction measures and the time frame for implementation. The meetings were held between 24 November and 17 December 2011 (Ishinomaki City, 2013d). As the information material for Minamihama District illustrates (see illustration 68 on the next page), the spatial plans for each area had already been prepared by the local government prior to these meetings and a discussion about their general objective was not intended (Ishinomaki City, 2013d).

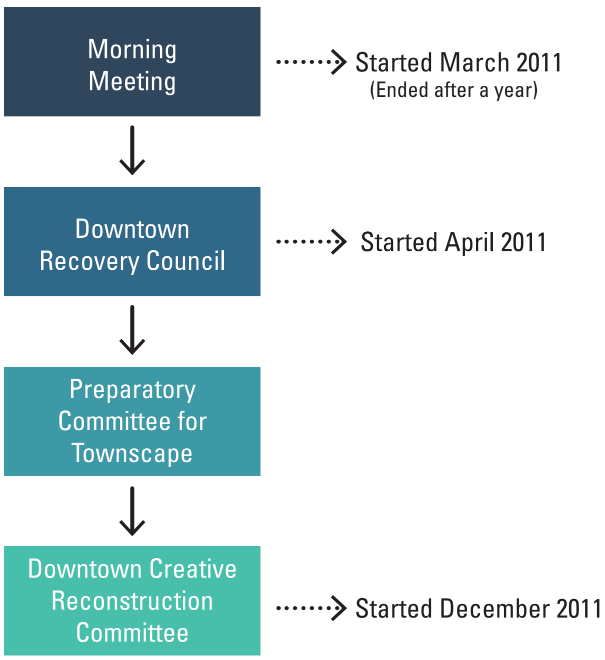
Citizen consultation

As described in Chapter 9.3, the city administration established a council with the purpose to implement a survey, to enable the incorporation of the citizen's opinions into the Basic Reconstruction Plan. The survey was conducted in May 2011 to evaluate the situation after the GEJE. It inquired information about the citizen's location before the GEJE, the damage situation of their houses and future plans for residence, including housing type and intended location. Furthermore, the survey also collected the citizen's opinion on possible measures to increase the city's disaster resilience (only offering engineering solutions) and additional aspects of the urban environment that the citizens might consider important (e.g., revitalized shopping street, green spaces, adjusting the infrastructure to the requirements of elderly people, etc.) (Ishinomaki City Reconstruction Department, 2011). In May and June 2012, the city administration conducted a second survey to collect current information about the citizens plans for reconstruction. The survey gathered information about the intended reconstruction method and the intended location to live for private as well as public housing (Ishinomaki City, 2013e). This survey served as the basis for the decision about the reconstruction sites to rebuild the city (Ishinomaki City Reconstruction Department, 2013).

Regarding the Basic Reconstruction Plan, which set the basic guidelines for Ishinomaki City's reconstruction process, the general public was invited to discuss the draft version of the plan in 15 opinion exchange meetings between 15 November and 10 December 2011 (Ishinomaki City, 2013b). Between the

Illustration 68 | Information brochure for the briefing in Kadonowaki-Minamihama District | Ishinomaki City Infrastructure Development Division, 2011

Illustration 69 | Formation of the Downtown Creative Reconstruction Committee | Own illustration adapted from Otsuka, 2014, p. 25



10-23 November 2011, the citizens were also able to submit their written comments on the draft version of the Basic Reconstruction Plan; an opportunity that twelve people, one organization and three companies used (Ishinomaki City, 2013c).

Citizen's active involvement

Grassroots organizations play an important role for the citizen participation in Ishinomaki City. One example is the *machizukuri* Man-bow, which was established in 2001 to establish the Ishinomaki Mangattan Museum on Nakaze Island. After the disaster, the previously established *machizukuri* was very helpful because the incoming people could build on its experience, history and connection with local people (e.g., shop owners), which simplified the coordination of the reconstruction planning. The ability to use existing structures from the beginning and not having to establish them saved time. Therefore, Man-bow was able to serve as a contact point for the incoming specialists from the private sector (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). To optimize the coordination of incoming NPOs, NGOs and special volunteers (e.g., doctors), Man-bow initiated the establishment of the Ishinomaki Disaster Recovery Assistance Council (IDRAC) in May 2011. The network organization changed its name to Ishinomaki Future Support Association in November 2012. (Ishinomaki Disaster Recovery Assistance Council, 2012).

In the central area of Ishinomaki City, the citizens – a mixture of shop owners and residents – started to think about the future of their neighborhood as soon as one month after the disaster. Developing from weekly morning meetings, that were established directly after the GEJE in order to exchange current information, the Downtown Recovery Council was formed in April 2011 (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). The Downtown Recovery Council, consisting of local citizens, the team of the Revival Ishinomaki Project and members of Man-bow, met in three workshops to discuss their ideas for the reconstruction process of their neighborhood with experts from academia and representatives from the local government (Otsuka, 2014). At the first workshop, general ideas were collected, at the second workshop, these ideas were prioritized and at the third workshop, the council members revised and finalized their vision. Between the workshops, the planning experts edited and prepared the outcomes for the next meeting (Toyoshima, Kariya, Utsumi, & Onuki, 2012). The finalized reconstruction plan "Spirit of Kawa-Minato, Ishinomaki" was submitted to the mayor of Ishinomaki City on 30 June 2011 (Otsuka, 2014).

The Downtown Recovery Council evolved into the Preparatory Committee for Townscape and in December 2011, the Downtown Creative Reconstruction Committee was formed (see illustration 69). The role of this committee is to promote and coordinate the reconstruction work in the city center of Ishinomaki City (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

The Downtown Creative Reconstruction Committee has a board of up to 45 members and more than 100 overall members. The committee is not an official organization, which means that everyone is allowed to join. When meetings

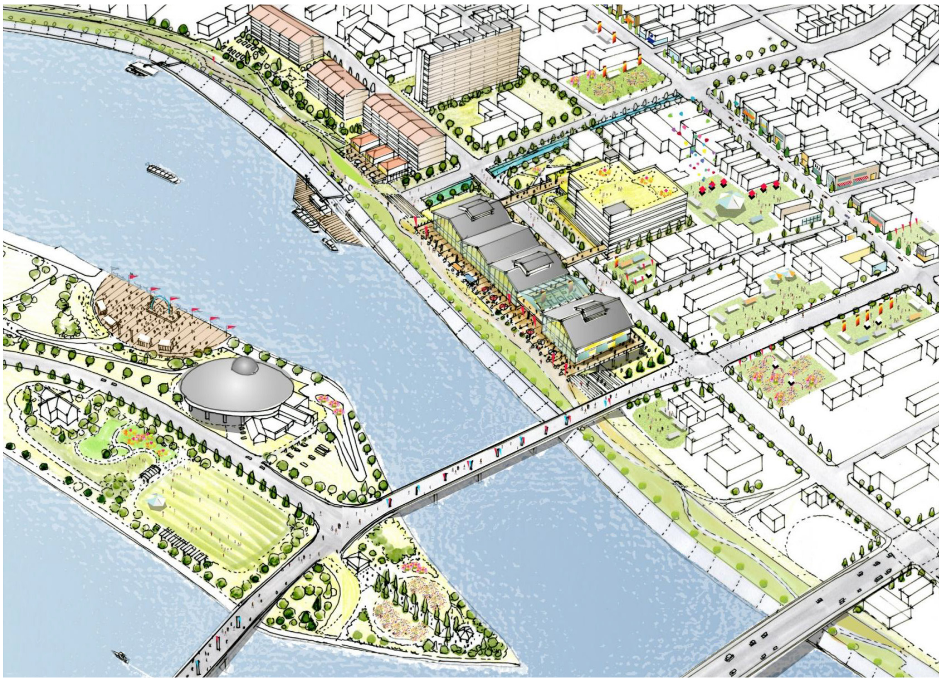


Illustration 70 | Design for the riverside in Ishinomaki City | Downtown Creative Reconstruction Committee, 2013, p. 12

are organized, people are invited via e-mail. If meetings include the development of specific plans that are supposed to be submitted to the city administration, concrete board members are personally invited based on their profession and knowledge. This includes staff from the city hall, the mayor, land owners (esp. the leaders of certain neighborhoods), and shop owners. For financial aspects, members of the chamber of commerce or staff from financial institutions are also included (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). The decision which board members are invited depends on the issues that are planned to be discussed. For instance, in case that attractions for tourists are discussed, the tourist association will be invited. For general discussions, all people who are related to the area should be invited. It is important to select the participants carefully in order to keep the number of meetings per person manageable because there are many meetings and various topics that need to be discussed (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). If citizens want to participate in a Downtown Creative Reconstruction Committee meeting, but are not invited, they are still able to attend, if they are somehow related to the issues under discussion. Nevertheless, in order to not unnecessarily complicate the complex process of coordinating the people's concerns, it is important to minimize the number of participants per meeting. This is especially relevant for people who only disturb the discussion with unrealistic demands. The wider public is able to review a draft version of the plan and get their opinions included before the plan gets submitted to the city administration (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

After the general reconstruction plan was developed in the first year after the disaster, the Downtown Creative Reconstruction Committee discussed townscape issues and developed according guidelines. The guidelines addressed topics such as "safety and security", "facade of buildings", "height of buildings", which should generally be limited to 3-4 floors in order to preserve the townscape, "management of vacant land" and the "arrangement of parks" and were completed in 2012 (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

In 2013, the Downtown Creative Reconstruction Committee discussed possibilities to activate the central area in order to attract consumers and visitors to return to the area and developed a mid- and long-term reconstruction vision (see illustration 70).

Based on these ideas the Downtown Creative Reconstruction Committee developed an accessibility plan for the central area in 2014, which included considerations regarding Ishinomaki's train station and the relocation of the bus terminal to the city center to improve the access for visitors (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

The plans that are developed by the Downtown Creative Reconstruction Committee are submitted to the Town Building Council's Urban Area Working Group. The working group uses the plan's content that it considers useful for the development of the official reconstruction plans. The working group and the Town Building Council are not required to consider the content from the privately developed plans, but, according to one of the interviews, much of the content is considered (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). This productive cooperation between the public and private sector is specifically based on the committed work of the Urban Area Working Group's chairman Prof. Dr. Michio Ubaura, who coordinates the planning processes between the private and public sector (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

While the cooperation between the private and public sector is going well for some parts of the city, things are more complicated for the overall planning process. The government has problems to translate the citizen's plan into official plans, which is especially problematic when the citizen's plans include important issues that should not be neglected. The fact that a consultant of the city raised his concerns about disregarding the public's opinion for official plans illustrates that there is some room for improvement in this context (Ishinomaki City Consultant, 2015). This opinion is verified by the interviewee from the city administration, who also considers the city's participation approach to be insufficient. Although the city administration tried to involve the citizens from the beginning of the planning process (e.g., through workshops) in order to get their agreement on the reconstruction plans, the standards for a comprehensive participation process were not met (Ishinomaki City Planning Division, Employee, 2015).

9.4.3.2 Social connectedness and neighborhood cohesion

In order to build socio-economic resilience, it is important to create social connectedness and neighborhood cohesion [UN-7.1.3]. Ishinomaki City did not follow a specific aim to keep communities together throughout the reconstruction process. Nevertheless, there are still some interesting approaches, which are presented in the following paragraphs.

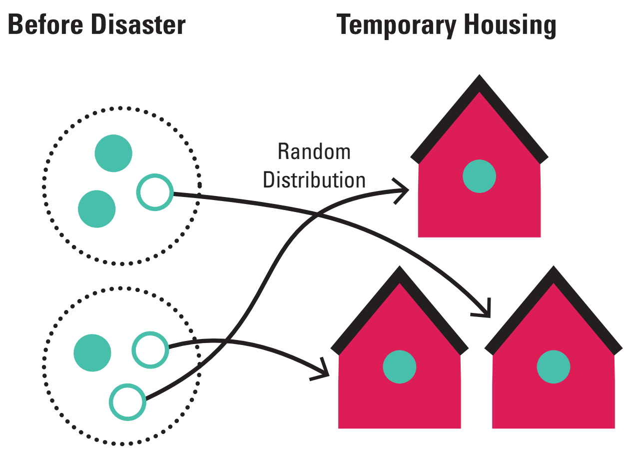


Illustration 71 | Allocation of temporary housing in the urban area of Ishinomaki City | Own illustration based on Toyoshima et al., 2012, p. 11

Temporary Housing

The transfer from evacuation shelters to temporary housing sites differed between the suburban (peninsular) and urban area of Ishinomaki City. The communities in the suburban areas were jointly transferred into temporary housing sites, keeping the communities together. In the urban area, the people had to apply for different temporary housing sites and were picked by the city administration via lottery. However, although this approach might have been fair, it resulted in the dispersion of former communities to multiple housing sites (see illustration 71) (Machizukuri Employee, 2015).

After three years in the temporary housing sites, people were able to build up new communities. The city administration tried to support the community building process in the temporary housing sites, e.g., through the establishment of community meeting rooms, but the situation was still problematic. Now that the new communities are established, the relocation to permanent housing disperses these communities again (Ishinomaki City Planning Division, Employee, 2015; Ishinomaki City Reconstruction Department, 2013).

Permanent Housing

Citizens could either apply individually or as a group for the transition to their permanent housing sites. The citizens were free to choose from housing sites anywhere in the city, there were no restrictions based on their location before the disaster. In the rural part of Ishinomaki City, some communities decided to relocate as a group if they were able to agree on one place for the entire community (Machizukuri Employee, 2015). The permanent housing sites in the city's urban area were distributed via lottery, therefore only a small amount of citizens used the possibility for group relocation. The two main reasons for this are (Ishinomaki City Planning Division, Employee, 2015):

1. The probability to obtain a certain housing lot was the same for the group relocation as it was for individual relocation, since all housing lots were distributed via lottery.

2. The group relocation process requires a high amount of communication between the community members in order to agree on one option. Many citizens did not want to deal with the needs and emotions of each community member and preferred to choose the simpler solution to apply individually.

The high amount of individual households applying and the allocation of housing lots for public housing units through lottery, resulted in anew dispersion of the just established temporary housing communities (Machizukuri Employee, 2015).

Citizen Participation

As discussed in Chapter 9.4.3.1, the more comprehensive citizen participation in Ishinomaki City was organized by grassroots organizations. The discussion of local issues with the citizens and the transfer of the public's ideas and visions into actual plans, temporarily improved the communication between the citizens and resulted in a feeling of ownership (Ishinomaki City Planning Division, Employee, 2015; Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

One module to enable people to meet and exchange their ideas is Machi Café. The community café was established in the city center of Ishinomaki City in June 2012 by the Miyagi branch of the Japan Institute of Architects (JIA) with the intention to offer an information platform for anyone and have a place to organize meetings with residents, volunteers, and experts and proactively develop a reconstruction plan based on the resident's ideas (Sakurai & Kariya, 2013). Today, the café still is an important meeting place for local people as well as visitors to discuss the ongoing issues of the reconstruction process in Ishinomaki City.

Another approach of the citizen's involvement to build community cohesion is Ishinomaki 2.0. The NGO was established in May 2011 by young citizens from Ishinomaki with the intention to use the disaster as a chance to improve the city. The organization pursues a variety of activities including the operation of the Irori business café, Kameshichi community café, and FUKKOU Bar. Furthermore, Ishinomaki 2.0 is responsible for the organization of the Stand Up Week, a yearly summer festival in Ishinomaki City (Ishinomaki 2.0, 2013, 2016).

Considering special requirements of elderly people

Because certain demographic groups, such as elderly citizens, have specific requirements regarding the urban environment, it is important to meet these requirements and enable them an active participation in the local community. In Ishinomaki City, the growing demographic group of elderly people is supposed to be integrated through the development of the city based on the compact city concept. This development should ensure the elderly to have all necessary establishments accessible on foot. Furthermore, the construction of apartments complexes which include age-appropriate apartments and a mixture of daycare services should address the residential needs of the elderly citizens (Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015).

9.4.3.3 Provision of safe shelter

After a disaster, it is important to provide affected people with safe shelter [UN-9.5.2]. The importance of this aspect is reflected in the fact that the provision of housing is one of the three most important aspects of the reconstruction process in Ishinomaki City (Ishinomaki City Planning Division, Employee, 2015). This includes the accommodation in evacuation shelters directly after the disaster, temporary housing and the newly constructed permanent housing.

Directly after the disaster, there were around 70,000 to 80,000 people, who lived in evacuation shelters. All of these people had to be transferred into temporary housing (Ishinomaki City Planning Division, Employee, 2015). Due to the urgency of the situation, the construction of the temporary housing sites had to begin without the previous estimation of the required number. The city administration caught up on this later (Ishinomaki City Consultant, 2015).

In October 2013, there were 7,153 temporary housing units on 134 sites, which were dispersed over the entire area of the city. At that time, 15,377 citizens lived in 6,967 houses, while 186 houses were unoccupied. In addition to this, 12,555 residents lived in 4,788 privately owned apartments, which were used as temporary housing (quasi-temporary housing)(Ishinomaki City Reconstruction Department, 2013). In October 2015, the remaining number of citizens in temporary housing was 10,000. This means, that some people had to move from one temporary housing site to another in order to aggregate them at certain locations. The reason for the aggregation is that the major amount of land, where the temporary housing lots are located, is owned by the public and the land is needed for the implementation of planned reconstruction projects (Ishinomaki City Planning Division, Employee, 2015).

One very important concern of the reconstruction process was the construction of public housing and the implementation of land readjustment projects to enable the affected citizens to move into permanent housing as fast as possible (Ishinomaki City Planning Division, Employee, 2015). In Ishinomaki City, the permanent housing sites were planned based on the surveys that gathered the citizen's intention for reconstruction. Nevertheless, the results of these survey were insufficient to estimate the correct number of required private and public housing. One reason for this was that people changed their mind, e.g., they applied for public housing to have a fallback plan and then decided to rebuild their house in its former location. For this reason, the city constructs more public housing units than needed, which will most likely result in vacancies. There are 3,697 public housing units planned in the city center, 589 additional units are planned in the suburban peninsula area, which amounts to a sum of 4,286 public housing units for the entire city (see table 25). Vacancies are expected to occur in the suburbs because many people consider it as inconvenient to live there. Some apartments in these areas are expected to stay vacant. The public housing sites, which are located close to the city center, on the other hand, are in demand (Ishinomaki City Consultant, 2015).

In addition to the newly constructed public housing, the city also leases about a hundred existing apartments to use them as public housing (Ishinomaki City Reconstruction Department, 2013). This solution is especially useful because of the

		Scheduled year of completion					
	District	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
Urban area	**Hebita**		220	822	1	90	1,133
	Kama-Okaido		150	59	477	44	730
	City center	68		274	160	68	570
	Kadowaki				151		151
	Minato	20	158	67	183		428
	Watanoha	61	165	194	115	44	579
	Kanan-Kahoku		70			36	106
Urban area total		149	763	1,416	1,087	282	3,697
Peninsula	**Peninsula**		3	15	17	3	38
	Ojika		11	34	70	41	156
	Kahoku			2		229	231
	Ogachi		3	39	21	31	94
	Hokujo			3	6	61	70
Peninsula total			17	93	114	365	589
Entire city total		149	780	1,509	1,201	647	4,286

Table 25 | Planned public housing in Ishinomaki City | Own illustration based on Ishinomaki City Reconstruction Department, 2016, p. 39

expected decline of residents in the future. While there is an estimated requirement for 4,600 public housing units at the moment, the number will decline with the decrease of the overall population. This is why the consulting agency suggested to rent existing private housing in order to use it for public housing instead of newly constructing all of the public housing that is currently required. The privately owned public housing units will become completely private again if the need for public housing decreases (Ishinomaki City Consultant, 2015).

9.4.4 Environmental resilience

The preservation or restoration of ecosystem health is the main aspect to build environmental resilience. The following chapter will investigate how spatial planners addressed this aspect throughout the reconstruction process in Ishinomaki City.

9.4.4.1 Ecosystem health

This aspect considers the knowledge about the importance of ecosystem services [UN-5.1.1], aspects in order to maintain or restore the health of ecosystems [UN-5.1.2] and the determination of the impact of planned land-uses on ecosystem services [UN-5.1.3].

The Basic Reconstruction Plan of Ishinomaki City considers the importance of ecosystem health for the people by stating the aim to establish renewable energy sources and to live with nature. Nevertheless, by taking a closer look it becomes noticeable that these measures only intend to get the greatest utility from the sea, river and earth (e.g., through the fishing or forestry industry). The plan does not include actual measures to secure the health of the ecosystem (Ishinomaki City Reconstruction Department, 2013).

This complies with the information from the interviews, which revealed that the environmental aspect is practically not considered in the reconstruction process (Machizukuri Employee, 2015). As one reason for this dissent, the time constraints after the disaster were stated. These constraints limited the possible options to consider environmental aspects to a greater extent. For instance, the need for a speedy construction of housing hampered the use of recycled building material (Machizukuri Employee, 2015). Steps that might be able to increase ecosystem health are the planned distribution of renewable energy sources on the large scale (e.g., the solar power plant in Shin Hebita District) and small scale (e.g., incentives for solar panels on private houses).

In Japan, the impact of spatial plans on ecosystem services are evaluated with the EIA, which is required for all major construction projects. Even though the construction of the seawall can be expected to have significant impacts for the coastal environment, it does not require the implementation of an EIA (see Chapter 4.7.1). This approach can be considered as a neglect of ecosystem health in favor of safety (Bird, 2013).

9.4.5 Spatial planning measures to build resilience

The following chapter summarizes the results from the analysis in the previous chapters. Thereby it examines the spatial planning options that were used to build engineering as well as evolutionary resilience and states which additional options would have been helpful for spatial planners to address these topics.

Which spatial planning options were used to build engineering resilience?

One of the main measures to build engineering resilience in Ishinomaki City was the designation of hazardous areas in accordance with Article 39 of the Building Standards Act in order to enable the relocation of affected citizens and to prevent the development of these areas in the future. The aim of this procedure was to minimize urban land-uses at risk. The relocation sites were prepared through the implementation of group relocation programs or land readjustments projects. In some cases, this required the redetermination of former agricultural land to urban area (e.g., in Shin Hebita District). For other areas, the spatial planners took differentiated land-use decisions: A part of Minamihama District is designed to be a park because any other land-use was considered to be too endangered. The area between the two seawalls in Kama-Okaido District is restricted for residential land-uses, but free for industrial developments.

Spatial planners also increased engineering resilience through the mitigation of the hazard. This was achieved through the construction of a two-tier seawall system and a river embankment along the mouths of Kitakami River. The planning and implementation of this system of protective infrastructure requires a comprehensive collaboration between spatial planners and sectoral planners as well as between the local, prefectural and national level. Parts of the affected area (e.g., in Kama-Okaido District) can be recovered on-site because of these protective measures. In these cases, land readjustment projects were used to reorganize the existing property situation and widen existing roads to ensure a fast and unproblematic evacuation for future hazardous events. This improvement of the city's road network through widening and raising the main evacuation routes is another important aspect to build engineering resilience. In addition to this, the resilience of the social infrastructure was also improved (e.g., through the relocation of the city's hospital and several schools).

The increase of engineering resilience is completed with the application of the building codes and incentives for the installation of solar panels on private houses to increase the building's independence from the local energy network in case of a disaster. These measures intend to build resilience by adapting the building structures. Furthermore, the establishment of various park and the greenway along the river can help to improve the city's climate.

With a combination of all these measures spatial planners were able to build Ishinomaki City's engineering resilience. This especially applies for the planners' main responsibilities like land-use planning and securing the application of building codes. Even though the improvement of the resilience of utility and social infrastructure requires the cooperation with various sectoral planning divisions, spatial planning also played an important role in this context.

Which spatial planning options were used to build evolutionary resilience?

Spatial planners' can contribute their knowledge for the development of hazard maps and thereby help to build political-institutional resilience. To ensure a resilient urban development, it is important that all spatial plans are checked for their accordance with the goal to build a disaster resilient city. At the moment, this is the case because the memories from the GEJE and Tsunami are still fresh. It is important to preserve these memories for the future to ensure that all relevant documents (incl. spatial plans) are continuously assessed for possible risks. After the disaster, the local spatial planners did not have a document prepared that helped them to begin with the reconstruction process. Even though some of the content from the existing city center revitalization plan was adopted into the Basic Reconstruction Plan, the city administration basically had to start from scratch. Two of the interviewees agreed the pre-event developed reconstruction plan would have been a helpful tool to start the reconstruction process after the disaster (Ishinomaki City Consultant, 2015; Ishinomaki City Planning Division, Employee, 2015). The case of Ishinomaki City shows that spatial planners contribution to build political-institutional resilience mainly consists of their ability to contribute to the assessment of risk (e.g., by preparing hazard maps) and their responsibility to review spatial plans for their integrated consideration of disaster risks.

Spatial planners can build socio-economic resilience through the integration of the local population into the planning process. The city administration of Ishinomaki City missed this chance and only informed and consulted the citizens regarding the reconstruction process. Comprehensive participation processes in Ishinomaki City originated from grassroots organizations. The integration of these privately developed ideas for the reconstruction process were only integrated into the official plans because of the personal dedication of individual spatial planners. In some cases the translation of the citizen's expectations into the actual plans, was problematic and resulted in frustration of some people

(Ishinomaki City Consultant, 2015). The relocation process in Ishinomaki City did not consider existing communities. The distribution of people via lottery was selected to be fair, but it also led to a random segmentation of former neighbors. Although the city administration tried to support group relocations, the opportunity was not commonly used. The example of Ishinomaki City shows that it is challenging for spatial planners to build socio-economic resilience, especially if they comply to legal requirements. For this reason, the personal commitment of grassroots organizations or key personalities is an important aspect for the improvement of socio-economic resilience.

As the interviews revealed, the spatial planners in Ishinomaki City did not actually intend to build environmental resilience (Machizukuri Employee, 2015). The continuous implementation of the EIA could help to address this aspect in the future.

Which spatial planning options were able to build resilience? Which additional spatial planning options would have been useful to build resilience?

In Ishinomaki City, the history of spatial planning as an engineering discipline becomes noticeable. While many spatial planning options were successfully applied to build engineering resilience, the existing options struggled to build evolutionary resilience.

The case study of Ishinomaki City helped to identify the following points for improvement in order to build evolutionary resilience:

Political-institutional resilience could be built through an improved cooperation between the three administrative levels (municipal, prefectural and national), which lead to some frictions and problems that are not specific to Ishinomaki City. This concerns spatial planners as well as all other experts involved and is based on the relatively new decentralized administrative system in Japan, which still needs some time to work out. The lessons learned after the GEJE will hopefully help to improve the political-institutional system and help to build resilience.

The spatial planners in Ishinomaki City struggled to use the legally available spatial planning options to build socio-economic resilience. In this context it could be helpful to officially enable comprehensive participation processes after large scale disasters or to simplify the implementation of community relocation projects.

Finally, the implementation of the existing EIA for all projects planned in the aftermath of the disaster (incl. the construction of the seawall) could have helped to build environmental resilience.

9.5 USING THE WINDOW OF OPPORTUNITY

This chapter analyses the window of opportunity in Ishinomaki City after the GEJE and Tsunami. It illustrates how the window of opportunity was constituted, which plans had already been prepared in advance of the disaster and investigates which options would have helped to use the window of opportunity more effectively.

How was the window of opportunity constituted in Ishinomaki City?

The experts in Ishinomaki City, who were interviewed for this research, all agreed on the existence of the window of opportunity after a disaster. However, each of the interviewees sees the characteristic of this windows differently:

- *Financial support:* The financial support from the national government after the GEJE, enabled to plan and implement projects to revitalize Ishinomaki City, which would have never been possible in normal times (Ishinomaki City Planning Division, Employee, 2015; Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). This aspect is especially important for Ishinomaki as a city, which already had to suffer from demographic and economic problems and a tight budget before the disaster. The financial support offered the city administration a new chance to deal with these problems.
- *Human support:* After the GEJE, many experts and volunteers moved to Ishinomaki City. For a city, which had been shrinking for the last 30 years and which was left by many young people in favor of larger cities (Otsuka, 2014), this can be considered as an opportunity for a fresh start. First, the city was able to benefit from the expert knowledge from spatial planners, architects and other professionals who came to the city (Ishinomaki City Consultant, 2015; Ishinomaki City, Downtown Creative Reconstruction Committee Member, 2015). Second, the large amount of young volunteers, who got attached to Ishinomaki City during their stay, offers the chance to improve the city, e.g., with the help of grassroots organizations like Ishinomaki 2.0. Many former volunteers already opened a shop or restaurant in Ishinomaki to revive the city center and help the city to recover.
- *Faster implementation of plans:* The window of opportunity after the disaster helped to get plans implemented faster than in normal times (Machizukuri Employee, 2015). One example for this is Shin Hebita District, where almost 120 landowners reached a conclusion for 46 ha of the district in less than six months (Ishinomaki City Reconstruction Department, 2013). By speeding up the implementation of the plans, the disaster helped to improve engineering resilience (e.g., through the construction of evacuation buildings) and socio-economic resilience (e.g., by increasing the citizen's consciousness for disaster risks) (Ishinomaki City Planning Division, Employee, 2015).

Did Ishinomaki City have any spatial plans for reconstruction prepared before the disaster?

Before the disaster, the city administration did not have any land-use plans – or other plans – for after the disaster prepared (Ishinomaki City Planning Division, Employee, 2015; Machizukuri Employee, 2015). The city administration started to develop the reconstruction plan after the GEJE and Tsunami (Ishinomaki City Planning Division, Employee, 2015). However, the revitalization plan for the city's central area already existed at the time of the disaster. Therefore, the plan could serve as a basis for the reconstruction of the area. The existence of the revitalization plan simplified the work on the reconstruction plan for the city administration. For instance, one aspect of the revitalization plan was the focus on tourism, which was then also integrated into the reconstruction plan (Machizukuri Employee, 2015). This aspect shows that it is very helpful to already have a guiding principle for the development of the city, even if it does not consider the possibility of a disaster. Such a principle can then be used for the development of a reconstruction plan if it becomes necessary.

How can the preparation of spatial plans for reconstruction before a disaster help to use the window of opportunity more effectively?

Planners and experts in Ishinomaki City agree on the statement that having a spatial plan for reconstruction prepared in advance of a disaster would help to accelerate the implementation of the reconstruction process (Ishinomaki City Consultant, 2015; Ishinomaki City Planning Division, Employee, 2015). To be most effective, such a plan should include an assumption of the damage through the hazardous event and the determination of relocation areas for residential land-uses. Furthermore, the plan should determine structural countermeasures to further secure the engineering resilience of the city (Ishinomaki City Planning Division, Employee, 2015). Even though the development of such a plan would be very expensive, it would also be very useful if a disaster occurs (Ishinomaki City Consultant, 2015).

Nevertheless, it must be considered that the preparation of a reconstruction plan prior to a disaster is connected to certain challenges: First, it is complicated and expensive to consider all possible hazards (e.g., tsunami, earthquake, flooding, sand storm) for the preparation of the plan and estimate the required work and budget for the reconstruction process accordingly (Machizukuri Employee, 2015). Second, the citizens were not very interested in participating in the development of a reconstruction plan prior to the GEJE. This is caused by the low frequency of such a disaster, which only occurs once in a thousand years. The people therefore did not expect to experience an event like this in their lifetime (Ishinomaki City Planning Division, Employee, 2015). One idea to resolve this lack of interest could be the concentration on the general improvement in the citizen's urban environment with steps that also get implemented if no disaster occurs (Ishinomaki City Consultant, 2015). In this way, the citizens might get the motivation to get involved into the planning process.

10. CROSS-CASE SYNTHESIS

This chapter compares the analysis results from the case study analysis of Miyako City and Ishinomaki City with each other and develops a cross-case synthesis. The analysis includes the ability of the different spatial planning options to build engineering and evolutionary resilience and the information gathered regarding the window of opportunity. Furthermore, the chapter answers the research questions *How can spatial planning help to build a city's resilience after a disaster?* and *How can spatial planning use the window of opportunity effectively to improve a city's resilience after a disaster?*

10.1 BUILDING ENGINEERING AND EVOLUTIONARY RESILIENCE IN MIYAKO CITY AND ISHINOMAKI CITY

Both case study sites use several spatial planning options to address *engineering resilience*. As a first step to reduce vulnerable land-uses at risk, hazardous land is excluded from future urban development through the designation of hazardous zones. The second step is the relocation of affected people, who used to live in these areas through relocation programs, land readjustment projects or, in case of Miyako City, the implementation of land readjustment and raising programs. In some areas, the spatial planners made differentiated land-use decisions, and designated certain areas with specific land-use zones (e.g., parks or industrial zones). The option to set up new residential areas through land readjustment projects is also used for the improvement of urban design, e.g., by establishing urban parks and greenways.

In both cities, the implementation of existing building codes and the provision of incentives for the installation of solar panels helps to build engineering resilience. The generation of energy through solar power can increase the building's autonomy from the local energy network. In Miyako City, additional building adjustments (e.g., raising the ground floor) are implemented.

To mitigate the hazard, both cities are planning to install protective infrastructure. In many places this involves a two-tier system with a seawall along the coast and a secondary levee, which is either constructed as a concrete seawall, a raised road or a raised green space. In Ishinomaki, both mouths of Kitakami River are planned to be framed by an embankment. The planning and implementation of this system of protective infrastructure requires a comprehensive collaboration between spatial planners and sectoral planners on various administrative levels (i.e., local, prefectural, national).

Miyako City and Ishinomaki City both used the reconstruction process to improve the cities' utility infrastructure. Land readjustment projects were especially useful to enhance the transportation network by readjusting and widening narrow and intricate roads. Furthermore, the relocation of affected social facilities (e.g., the hospital in Miyako City's Taro District and the city hospital and certain schools in Ishinomaki City) increased the disaster resilience of the cities' social infrastructure. These projects also require the cooperation with the sectoral planning departments in charge. Table 26 on the next page gives an overview of the spatial planning options that were used to build engineering resilience.

		Miyako City	Ishinomaki City
Engineering resilience	**Spatial planning options used to build engineering resilience**	**Minimization of exposure of urban areas** › Land-use control in hazardous areas › Relocation through relocation programs or land readjustment projects **Differentiated land-use decisions** › Land-use zoning **Adaptation of building structures** › Building codes › Additional building requirements/ adjustments **Hazard mitigation** › Protective infrastructure › Land readjustment and raising program › Adaptation of urban structure through land readjustment projects	**Minimization of exposure of urban areas** › Land-use control in hazardous areas › Relocation through relocation programs or land readjustment projects **Differentiated land-use decisions** › Land-use zoning **Adaptation of building structures** › Building codes › Additional building adjustments **Hazard mitigation** › Protective infrastructure › Adaptation of urban structure through land readjustment projects
Evolutionary resilience	**Spatial planning options used to build political-institutional resilience**	› Hazard maps and hazard simulations › Resilience evaluation of plans	› Hazard maps and hazard simulations › Resilience evaluation of plans
	Spatial planning options used to build socio-economic resilience	› Citizen participation (information, consultation, active involvement) › Relocation through group relocation program › Provision of public housing	› Citizen participation (information, consultation) › Provision of public housing
	Spatial planning options used to build environmental resilience	› Additional building adjustments	› Additional building adjustments

Table 26 | Cross-case synthesis of engineering and evolutionary resilience | Own illustration

Evolutionary resilience can be built by addressing political-institutional, socio-economic and environmental resilience (see table 26).

Spatial planners in both case study cities helped to build *political-institutional resilience* by supporting the preparation of hazardous maps and simulations for the assessment of risks. Furthermore, both cities currently evaluate their spatial plans regarding disaster resilience. The reason for this, is probably the fresh memory from the GEJE and Tsunami, which results in a high awareness of the need to consider disaster risks for future land-use decisions. If this approach will be maintained in the future is directly connected with the city administration's success to integrate the lessons learned from the disaster into their daily work. The case of Miyako City showed that the consideration of the experience from past disasters (in this case the Great Hanshin-Awaji Earthquake) can help to improve the reconstruction process. Nevertheless, neither Miyako City nor Ishinomaki City prepared a reconstruction plan in advance of the disaster. The lack of such a plan caused insecurities for the local spatial planners in both cities and delayed the start of the reconstruction process.

In Miyako City, *socio-economic resilience* was built through a comprehensive involvement of the local citizens into the reconstruction planning process. In addition, the spatial planners intended to keep communities together throughout the reconstruction process. This citizen focused approach helped to maintain and strengthen the cohesion of communities in Miyako City (Miyako City Planning Division, Employee A, 2015). In Ishinomaki City, the local government only implemented participation processes envisaged by the law (i.e., citizen information and consultation). All of the more comprehensive offers for participation were made by grassroots organizations. Both cases show that meaningful public participation could only be achieved with the personal dedication of individual spatial planners and consultants. The legal framework in Japan does not aim at the implementation of comprehensive participation processes. Miyako City and Ishinomaki City were both able to provide public housing for people who are unable to rebuild their houses on their own or find rental apartments on the regular housing market. In both cities, public housing was constructed to meet the requirements of the growing population group of the elderly.

Besides smaller adaptations regarding the provision of renewable energy on the district or building scale, both case study cities did not build environmental resilience. One evidence for this is the omission to conduct an EIA for the construction of the seawall. This results in a lack of knowledge regarding the environmental impacts that the seawall will cause. The exclusion of environmental aspects from the reconstruction process resulted from the prioritization of other topics that were considered to be more urgent (e.g., safety, provision of housing).

10.2 SPATIAL PLANNING OPTIONS TO BUILD RESILIENCE

The last chapter summarized the results from the case study analyses in Chapter 8 and Chapter 9 and showed, which spatial planning options were used in order to build engineering and evolutionary resilience. This chapter will take an opposite approach and analyze the ability to address the various resilience items for each of the spatial planning options. Table 27 gives an overview of the results from this analysis. In this context, the chapter answers the first research question *How can spatial planning help to build a city's resilience after a disaster?*.

10.2.1 Spatial planning options for risk assessment to build resilience

The spatial planning options for risk assessment – the development of hazard maps and an EIA – are able to build political-institutional resilience. Furthermore, the implementation of an EIA can help to build environmental resilience, even though this option was not used in Miyako City and Ishinomaki City.

› Hazard maps and hazard simulations are valuable tools for risk assessment. Contributing to the development of such maps or simulations (e.g., by providing spatial information), is an important possibility of spatial planners to contribute to political-institutional resilience. Both case study cities in this research developed hazard maps, which served as a basis for the land-use decisions taken. Therefore, this option can be considered as helpful to build political-institutional resilience.

› The EIA undertakes a dual role for risk assessment. If implemented properly, it is useful to evaluate projects for potential risks (and thereby build political-institutional resilience). On the other hand, it is useful to evaluate the possible impact that a project might have on the environment, which can help to build environmental resilience. In the two case studies of this research, neither of the two options was used, which is why the (hypothetical) influence of this resilience item in table 27 was indicated with brackets.

10.2.2 Spatial planning options for risk management to build resilience

The spatial planning options to minimize the exposure of urban areas, make differentiated land-use decisions, adapt building structures and mitigate the hazard are able to build engineering and evolutionary resilience. However, table 27 shows that their emphasis is on the enhancement of engineering resilience.

Minimization of exposure

Exposure of vulnerable land-uses can either be reduced by controlling the future development in hazardous areas or through the relocation of existing land-uses in these areas to safer land.

	Spatial planning options	Engineering resilience items	Evolutionary resilience items
Assessment	**Hazard maps and hazard simulations**	./.	› Risk assessment
	Environmental Impact Assessment (EIA)	./.	› (Proposal evaluation for disaster resilience) › (Ecosystem health)
Management	**Minimization of exposure of urban areas**		
	Land-use control in hazardous areas	› Vulnerable land-uses at risk › Disaster resilience of utility infrastructure › Disaster resilience of social infrastructure	./.
	Relocation through relocation programs or land readjustment projects	› Vulnerable land-uses at risk › Urban Design solutions › Disaster resilience of utility infrastructure › Disaster resilience of social infrastructure	› Social connectedness and neighborhood cohesion (if group relocation program is used)
	Differentiated land-use decisions		
	Land-use zoning	› Vulnerable land-uses at risk	./.
	Adaptation of building structures		
	Building codes	› Building codes	./.
	Additional building requirements	› Building codes › Sustainable building design standards	./.
	Provision of public housing		› Provision of safe shelter
	Hazard Mitigation		
	Protective infrastructure	› Protective infrastructure	./.
	Land readjustment and raising program	› Vulnerable land-uses at risk › Urban Design solutions › Disaster resilience of utility infrastructure › Disaster resilience of social infrastructure	./.
	Adaptation of urban structure through land readjustment projects	› Urban design solutions › Disaster resilience of utility infrastructure	./.
Communication	**Citizen participation**	./.	› Consideration of citizen's needs › Social connectedness and neighborhood cohesion

Table 27 | Spatial planning options to build resilience | Own illustration

- The land-use control in hazardous areas in Miyako City and Ishinomaki City was implemented through the designation of hazardous zones based on Article 39 of the Building Standards Act. The designation was implemented based on the information from hazard maps and builds the basis for all further land-use decisions. Through the designation of hazardous areas, the future land-use in both cities can be controlled, which reduces the amount of (future) vulnerable land-uses at risk. The relocation of existing vulnerable land-uses and utility and social infrastructure away from these areas (also considered in the paragraph below), furthermore helped to build the disaster resilience of the utility and social infrastructure (e.g., through the relocation of schools and hospitals). Accordingly, the spatial planning option land-use control in hazardous areas is able to build engineering resilience.
- Based on the designation of hazardous zones, both case study cities implemented the relocation of vulnerable land-uses as well as utility and social infrastructure away from hazardous areas. The relocation was implemented by means of the group relocation program or land readjustment projects. In accordance with the intention of the relocation, this spatial planning option was able to build engineering resilience. In cases, where the relocation of affected citizens was implemented by means of group relocation projects, which enabled existing communities to relocate as a group, the relocation was also able to build socio-economic resilience by preserving or strengthening the social connectedness and community cohesion.

Differentiated land-use decisions

In Japan, spatial planners are able to make differentiated land-use decisions by means of land-use zoning.

- Land-use zoning was used in Miyako City and Ishinomaki City to designate specific land-uses to areas, which should not be developed as residential areas. One example for this is the designation of industrial zones in Kama-Okaido District in Ishinomaki City. This area was considered to be too dangerous for residential land-uses because it would become inundated in case of a tsunami. Industrial land-uses, on the other hand, were considered to be safe. Land-use zoning is able to build engineering resilience by reducing vulnerable land-uses (esp. residential) at risk.

Adaptation of building structures

Spatial planning options for the adaptation of building structures include the existence and frequent implementation of building codes and the requirement of additional building adaptations where they are considered to be useful. Furthermore, spatial planners are responsible to provide adequate housing options for citizens that are unable to afford safe housing on their own.

- This option directly addresses the engineering resilience item building codes, which includes the existence, continuous implementation and update of building codes. In Japan, the building code is established by the

Building Standards Act. Through the strict application of the frequently updated building codes for the replacement of destroyed houses with new building structures, both case study cities were able to build their engineering resilience.

› In addition to the requirements of the Building Standards Act, Miyako City set additional building requirements, which demand the owners of newly constructed houses in areas that are expected to become inundated up to 2 m by L2-tsunamis to raise the house up to 1.5 m from the street level. Furthermore, both cities encourage landowners to add solar panels to the roof of their houses. A measure which helps to increase the building's autonomy from the local energy network through sustainable building design standards. The combination of the measures of this options also helps to strengthen engineering resilience.

› The provision of public housing is another option to build resilience. In some cases, people cannot afford to find adequate housing on the private housing market. In this case they rely on the provision of public housing. For the construction of public housing, spatial planners should consider the various needs of different population groups. In the case of Miyako City and Ishinomaki City this especially concerns the elderly. In contrast to the other spatial planning options regarding building structures, the provision of adequate and safe public housing can help to build socio-economic resilience, an aim which both case study cities were able to achieve.

Hazard mitigation

To mitigate the hazard, spatial planners in the case study cities are able to plan the construction of protective infrastructure or use the land readjustment and raising program. Furthermore, they can adapt the urban structure for on-site reconstruction through the implementation of land readjustment projects.

› The solution to build protective infrastructure to increase the safety against future tsunamis was widely used in Miyako City and Ishinomaki City. Both cities plan a seawall along the coast, which, in many places is complemented by the construction of a secondary levee. In Ishinomaki City, the construction of a river embankment along the two mouths of Kitakami River is intended to further improve the safety of the cities built structure. The construction of protective infrastructure is able to build engineering resilience.

› In some areas of Miyako City, the hazard is mitigated by raising the land and reconstructing the affected residential area on this artificially lifted land. The spatial planning option to implement these projects is the land readjustment and raising program. The program enables to extricate an area that was formerly exposed to future tsunamis from this exposure through raising it above the expected inundation height. This means, the program is able to reduce the vulnerable land-uses at risk by mitigating the hazards instead of limiting the vulnerable land-uses in hazardous areas. The implementation of the land raising program as part of a land readjustment project also enables the chance to reorganize the area's utility infrastructure (e.g., the road network). If social infrastructure is included in the raised area, the land readjustment and raising program is also able to increase the disaster resilience of social infrastructure. All three of the resilience items that are addressed by this spatial planning option address engineering resilience.

› Some areas can be considered to be safe for on-site reconstruction because the protective infrastructure reduced the exposure to the hazard. For instance, this is the case in Miyako City's Kuwagasaki District and Ishinomaki City's Kama-Okaido District. In these areas, the adaptation of urban structure through land readjustment projects is able to increase the disaster resilience of the area's utility infrastructure (e.g., by adjusting the road network). By this means, the land readjustment projects are able to strengthen the area's engineering resilience.

10.2.3 Spatial planning options for risk communication to build resilience

Finally, spatial planners are able to include the citizens into the planning and decision-making process after a disaster. This is their best option to build socio-economic resilience.

› Citizen participation can help to include the citizens' requirements and needs into the reconstruction process. This is especially important to learn more about the special requirements of vulnerable population groups (e.g., the elderly). The case study cities showed that the Japanese law does not intend a comprehensive participation process. In Miyako City, the city administration decided to use a comprehensive participation concept, which resulted in a strengthened socio-economic resilience. In Ishinomaki City, grassroots organizations took over the task to actively involve the citizens into the planning process. Here, the implementation of the citizens' ideas into official plans experienced difficulties (Ishinomaki City Consultant, 2015). In both cities the dedication of individual spatial planners and consultants was an important aspect for the success of the participation processes. Besides the ability to integrate the people's needs into the plans, the cooperation as a community is also able to build social connectedness and neighborhood cohesion between the affected citizens. In this context, citizen participation is able to build socio-economic resilience.

10.2.4 Spatial planning options to build resilience

Based on the analysis in this chapter, the first research question *How can spatial planning help to build a city's resilience after a disaster?* can be answered. As table 27 shows, the spatial planning options investigated for this research were mainly able to address engineering resilience. This is especially the case for the planning options for risk management. With the exception of the relocation by means of the group relocation program and the provision of public housing, which both address socio-economic resilience, these spatial planning options are only able to build engineering resilience. In comparison to this, the spatial planning options for risk assessment mainly address political-institutional resilience. This is the case because these options are able to enhance the processes that serve as the basis for effective risk management. Furthermore, can the implementation of an EIA help to build environmental resilience (even though this option was not used in the case study cities). Finally, spatial planners are able to build socio-economic resilience by involving the citizens into active participation processes and by taking their ideas and needs seriously. Nevertheless, the experience from the case study sites shows that the Japanese law does not support this option so far.

10.3 THE WINDOW OF OPPORTUNITY

Regarding the window of opportunity, the case study analysis of Miyako City and Ishinomaki City obtained the results presented in table 28 on the next page. The experts agreed on the existence of a window of opportunity after a disaster. Their assessment regarding the constitution of this window, however, differed. In Miyako City, the opportunity for improvement was seen in the enhancement of socio-economic resilience, which could be achieved through the comprehensive participation processes in the ten most affected districts and the preservation of existing communities throughout the entire reconstruction process, which further increased the community cohesion. In Ishinomaki City, the financial support of the national government was regarded as an important chance to implement projects for the revitalization of the city, which would have been impossible to realize with the city's regular budget. In addition to the financial support, Ishinomaki City also gained a large number of young immigrants after the disaster, who came as experts or volunteers to help and, at least partially, decided to stay for the long(er) term. In a city, which suffers from demographic change, this development is considered as a chance for a fresh start. Finally, the situation after the disaster helped to accelerate the implementation of plans, e.g., because the citizens considered the importance of the situation and were willing to compromise.

Neither Miyako City nor Ishinomaki City had reconstruction plans prepared before the GEJE and Tsunami occurred. Both cities followed a similar approach and adopted certain aims from existing spatial plans for their reconstruction plans. In Miyako City the main vision from the city's Master Plan to live in harmony with nature was included into the Post-Disaster Reconstruction Plan. Ishinomaki City adopted some of the content from the revitalization plan for the city center (e.g., the goal to attract more tourists) into the Basic Reconstruction Plan.

Many of the experts in Miyako City and Ishinomaki City agreed on the usefulness to have a reconstruction plan available when a disaster occurs. This opinion is based on the uncertainty of the situation directly after the disaster. Most local planners had never experienced a situation like this and were insecure which steps to take. In a situation like this, a prepared reconstruction plan would have been a helpful tool.

On the other hand, the pre-event development of reconstruction plans is connected with a variety of problems, which were also identified through the case study analysis:

- It is time-consuming and expensive to develop reconstruction plans for each potential hazard.

	Miyako City	Ishinomaki City
The constitution of the window of opportunity	› Window was used to build community cohesion through keeping communities together and comprehensive participation processes (socio-economic resilience)	› Financial support from national government enabled the implementation of a multitude of revitalization projects › Human support from incoming experts and volunteers enabled a fresh start › Accelerated implementation of plans
Pre-event developed plans	› No reconstruction plan developed before the disaster › Main vision from the city's pre-existing Comprehensive Plan was adopted for the reconstruction process	› No reconstruction plan developed before the disaster › Some content from pre-existing plans (e.g., revitalization plan for the city center) was adopted for the reconstruction process
Plans to develop to use the window of opportunity effectively	› Problems: Impossibility to foresee actual impact of disaster, people not interested to discuss options for relocation prior to the disaster › Alternative: Guidelines with steps to take in the aftermath of a disaster	› Problems: Time-consuming and expensive to consider all important hazards, their impact and the required work and budget to recover from them, people not interested to discuss reconstruction issues prior to the disaster › Reconstruction plan should include: assumptions of damages, determination of relocation sites, structural countermeasures

Table 28 | Cross-case synthesis of the window of opportunity | Own illustration

- It is complicated to impossible to foresee the actual impact of the disaster and estimate the required work and budget required for the reconstruction.
- The citizens are not interested to discuss options for relocation or general reconstruction issues prior to the disaster.

Regarding the solution to this problem, the experts in Miyako City and Ishinomaki City had a differing perception. The expert from the Planning Division in Miyako City suggested the development of guidelines that contain general steps to take in the aftermath of a disaster. This could help to overcome the uncertainty directly after the disaster to decide which steps to take first in order to start a successful reconstruction process. The expert from the Planning Division in Ishinomaki City and one of the city's consultants agreed on the need to develop a spatial plan for the reconstruction process after a disaster. This plan should include assumptions of the damages that are expected, the determination of relocation sites and structural countermeasures (e.g., protective infrastructure) to mitigate the hazard. To motivate local citizens to participate in the planning process, the planned projects should improve their residential environment and be scheduled to still get implemented if no disaster occurs.

Coming back to the second research question *How can spatial planning use the window of opportunity effectively to improve a city's resilience after a disaster?*, it can be stated that the existence of a pre-event developed reconstruction plan at the time of the disaster can help to achieve this aim. This opinion was shared by all of the experts interviewed in the context of this research.

A simple design of this plan could include an overview of the main steps to take in the aftermath of the disaster as proposed by an employee of Miyako City's Planning Division (Miyako City Planning Division, Employee A, 2015). Such guidelines could help local spatial planners to prioritize their workforce on the most important things instead of pondering what to do. This could help to accelerate the planning process. The guidelines could be prepared based on the experiences that spatial planners in Tohoku Region gathered during the reconstruction process and then be provided for other cities.

Besides this more general approach, spatial planners could also use the chance to prepare a spatial reconstruction plan in advance of the disaster. A plan like this could include assumptions about the expected damages in case of a hazardous event, information about the location of emergency shelters and possible temporary housing sites, the intended adjustment of the city's structure (e.g., possible relocation projects or the construction of protective infrastructure). This plan would require the consideration of all potential hazards and a frequent update of the information included, which is why some experts considered the development of such plans as unrealistic (Machizukuri Employee, 2015). To avoid the preparation of a plan that ends up in a drawer for the case that no hazardous event occurs, the content of the plan could be integrated into the city's regular land-use plan. By this means, the general vision for the city's development and the vision for the recovered city after the disaster could become one and the goals of the reconstruction plan would still get implemented (albeit in a longer amount of time). One example for this from Ishinomaki City is the hypothetical relocation of people from Minamihama Area onto Hiyoriyama Mountain: Before the GEJE and Tsunami, the people in Minamihama lived in a hazardous area next to Hiyoriyama Mountain. The area of Hiyoriyama Mountain is inhabited by old people, who live in old houses that could have been renovated through re-development projects in order to increase the buildings' capacity. Thereby, the people from Minamihama Area would have been able to move to neighboring Hiyoriyama Mountain and live in safety. However, these plans were not developed before the disaster and because the time after the disaster did not allow the long negotiation process with the various landowners on Hiyoriyama Mountain, this idea was not realized (Ishinomaki City Consultant, 2015). If the relocation of the residents from Minamihama Area would have been included in Ishinomaki's Master Plan, the project could have been developed independently from the occurrence of a disaster while still building the city's overall resilience. If the citizens see the opportunity to improve their everyday living environment, which is intended even if no disaster occurs, this can also solve the problem that many citizens are not interested to discuss relocation options unless a disaster occurred.

11. FINAL CONCLUSION

The research results from Miyako City and Ishinomaki City deliver evidence that it was complicated for spatial planners to build evolutionary resilience. With certain expectations (e.g., strengthening socio-economic resilience through citizen participation, community relocation projects and the provision of public housing), the available spatial planning options mainly addressed engineering resilience. The reason for this rests upon the technocratic tradition of spatial planning in Japan (Hohn, 2000). Japanese people are used to solve their problems with engineering rather than social solutions (Ishinomaki City Planning Division, Employee, 2015). However, as Chapter 3 illustrated, an engineering understanding of resilience is no longer state of the art. Instead, resilience can be understood as a combination of engineering, political-institutional, socio-economic and environmental aspects, which mutually represent the urban system. To build urban disaster resilience, it is therefore important to address all of these aspects.

As the experience from Miyako City and Ishinomaki City suggests, the available spatial planning options were not sufficient to build evolutionary resilience. In order to enable the spatial planners to reach this goal, it is necessary to provide them with sufficient instruments. Examples for this could be the provision of municipalities with the financial opportunity to officially organize active citizen involvement processes for reconstruction planning or the improvement of group relocation projects. On the other hand, municipalities should be urged to use instruments that are already available. This includes the EIA to build environmental resilience. Providing spatial planners with sufficient options to plan for evolutionary resilience would simultaneously help to build the political-institutional resilience of spatial planning itself – it would help to approach resilient urban planning. Another important aspect to strengthen the resilience of spatial planning includes an increased degree of flexibility, an aspect which also became apparent during the reconstruction process after the GEJE and Tsunami.

Even though this research bases on two case study sites in Japan and investigated the reconstruction process after the GEJE and Tsunami, a careful attempt to adapt the research results to a more general context should be made. As described in Chapter 3, the technocratic tradition of spatial planning is not solely a Japanese phenomenon. Instead, an engineering approach to spatial planning is commonly used by practitioners and policy makers (White & O'Hare, 2014). The research results point towards the assumption that White and O'Hare (2014) are right, when they state that the demands on spatial planning to build evolutionary resilience cannot be met if spatial planners are bound to technocratic planning tools (p. 942). This leads to the conclusion that the existing spatial planning options need to be revised in order to meet the current requirements of a changing environment more effectively. However, in order to determine which and how spatial planning needs to be changed in order to be enabled to build evolutionary resilience, further research is required.

Regarding the window of opportunity, the case studies of this research revealed that being prepared in advance of a disaster would help to accelerate the reconstruction process and decrease uncertainties and insecurities of local spatial planners. Experts should decide carefully how this preparation should be formulated.

The spectrum reaches from general guidelines that include basic steps that spatial planners have to take in the aftermath of a disaster to comprehensive reconstruction plans, which include locations for possible reconstruction sites and intended protective infrastructure. In any case, cities should consider their approach to this topic based on a comprehensive risk assessment, local conditions (e.g., available funding and staff) and the citizen's opinion about this topic. Furthermore, spatial planners should be aware of the overall spatial vision that the city wants to achieve over the next years and establish spatial plans accordingly. This vision can serve as a helpful outline for the future urban development independently from the occurrence of a disaster.

To broaden the results from this research additional case study sites in other countries should be investigated for spatial planning's ability to build engineering and evolutionary resilience. The growing database could be used to develop an overview of the spatial planning options that are able to build evolutionary resilience and generate an evidence base to improve spatial planning's competences.

Furthermore, the comprehensiveness of the research topic made it impossible to consider each relevant aspect in detail. For some aspects, further research is needed. For instance, this includes the various levels of uncertainty that spatial planners have to face in the aftermath of a disaster. To observe these processes closer, a thorough analysis of the case study data regarding this topic is planned. The results from this analysis are intended to be published in a scientific article.

To retain the experiences of the local spatial planners, they should be used to develop reconstruction guidelines. These guidelines could collect the most important steps and decisions taken in the aftermath of the GEJE and Tsunami and provide advice how to handle the difficult situation after a disaster. If shared with other cities, these guidelines could help with the preparation for the possible occurrence of a disaster. By this means, the spatial planners from Tohoku Region are able to help their colleagues in other places to build urban disaster resilience and thereby reduce the disaster risk in cities in Japan and abroad.

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ANNEX

TABLE OF CONTENT

ANNEX A: TABLE OF RESILIENCE ITEMS

Table of resilience items sorted by spatial planning's ability to influence them (main sphere of resilience addressed by each item is indicated on the right side of the table) | Own illustration

		Engineering resilience	Environmental resilience			
Influence of Spatial Planning	Items	Engineering	Political-Institutional	Socio-Economic	Economic	Environmental
High	Vulnerable land-uses at risk: agriculture, economic activity, residential [UN-4.1.1, UN-4.1.2, UN-4.1.3]	X				
	Existence, application and update of building codes designed to address risks identified in risk assessment [UN-4.2.1, UN-4.2.2, UN-4.2.3]	X				
	Urban design solutions that increase resilience [UN-4.3.1]	X				
	Sustainable building design standards [UN-4.3.2]	X				
	Impact of land-use and other policies on ecosystem services [UN-5.1.3]					X
	Adequacy of protective infrastructure and effectiveness of maintenance [UN-8.1.1, UN-8.1.2]	X				
	Disaster resilience of utility infrastructure: incl. communication, electricity, water/ sanitation, gas, transportation [UN-8.2.1, UN-8.2.2, UN-8.2.3, UN-8.3.1, UN-8.3.2, UN-8.3.3, UN-8.4.1, UN-8.4.2, UN-8.4.3, UN-8.5.1, UN-8.5.2, UN-8.5.3, UN-8.5.4, UN-8.6.1, UN-8.6.2, UN-8.6.3, UN-8.6.4, UN-8.6.5, UN-8.6.6]	X				
	Disaster resilience of social infrastructure: incl. law and order & first responder, education, healthcare, administration [UN-8.7.1, UN-8.7.2, UN-8.8.1, UN-8.9.1, UN-8.10.1]	X				
Medium	Extent to which any proposal in government is also evaluated for disaster resilience benefits or impairments [UN-1.2.1]		X			
	Knowledge of hazards (also called perils) that the city faces, and their likelihood [UN-2.1.1]		X			
	Knowledge of exposure and vulnerability [UN-2.1.2]		X			
	Understanding of critical assets and the linkages between these [UN-2.1.3]		X			
	Hazard Maps [UN-2.1.4]		X			
	Process ensuring frequent and complete updates of scenarios [UN-2.2.1]		X			
	Awareness of the role that ecosystem services may play in the city's disaster resilience [UN-5.1.1]					X
	Ecosystem health [UN-5.1.2]					X
	Coverage of grassroots organization(s) throughout the city and effectiveness of grassroots networks [UN-7.1.1, UN-7.1.2]			X		
	Social connectedness and neighborhood cohesion [UN-7.1.3]			X		

	Engagement of vulnerable segments of the population [UN-7.1.4]			X		
	Likely ability to meet needs for shelter/ safe places [UN-9.5.2]			X		
	Planning for post event recovery and economic reboot [UN-10.1.1]		X			
	Learning loops [UN-10.1.3]		X			
Low/ None	Co-ordination of all relevant pre-event planning/ preparation activities, all event-response activities and all post-event activities for the city's area, with clarity of roles and accountability across all relevant organizations [UN-1.1.1, UN-1.1.2, UN-1.1.5]		X			
	Participation and coordination of all relevant organizations in the structure(s) defined [UN-1.1.3]		X			
	Co-option of physical contributions by both public and private sectors [UN-1.1.4]		X			
	Extent to which data on the city's resilience position is shared with other organizations involved with the city's resilience, community organizations and the public [UN-1.3.1, UN-1.3.2]		X			
	Adequacy of financial planning for all actions necessary for disaster resilience [UN-3.1.1]		X			
	Capital funding for long run engineering and other works that address scenarios in essential 2 and essential 8 [UN-3.1.2]		X			
	Operating funding to meet all operating costs of disaster resilience activities [UN-3.1.3]		X			
	Contingency fund for post disaster recovery (may be referred to as a "rainy-day fund") [UN-3.2.1]		X			
	Affordability of, and help with achieving safe housing [UN-3.3.1]		X			
	Domestic and non-domestic insurance coverage [UN-3.3.2, UN-3.3.5]		X			
	Incentives to businesses and non-profit organizations to improve disaster resilience – disaster plans, premises etc. [UN-3.3.3, UN-3.3.4]		X			
	Pursuit of all possible methods of financing and funding, as required [UN-3.4.1]		X			
	Availability of skills and experience in disaster resilience – risk identification, mitigation, planning, response and post event response [UN-6.1.1]		X			
	Exposure of public to education and awareness materials/ messaging [UN-6.2.1]			X		
	Validation of effectiveness of education [UN-6.2.2]			X		
	Availability, take-up of training [UN-6.3.1]			X		
	Accessibility of education and training to all linguistic groups in the city [UN-6.4.1]			X		
	Effort taken to learn from what other cities, states and countries (and companies) do to increase resilience [UN-6.5.1]		X			
	Extent to which employers act as a channel with employees [UN-7.2.1]			X		

	Business continuity planning [UN-7.2.2]				X	
	Use of mobile and e-mail “systems of engagement” to enable citizens to receive and give updates before and after a disaster [UN-7.3.1]			X		
	Loss of Education data [UN-8.8.3]			X		
	Health records and data [UN-8.9.2]			X		
	Availability of emergency healthcare including facilities and urgent medical supplies for acute needs [UN-8.9.3]			X		
	Assurance of continuity of all critical administration functions [UN-8.10.1]		X			
	Assurance of continuity of computer systems and data critical to government continuity [UN-8.11.1]		X			
	Assurance of continuity of computer systems and data critical to any of the above infrastructure [UN-8.11.2]		X			
	Existence and effectiveness of early warning systems [UN-9.1.1]		X			
	Existence of emergency response plans that integrate professional responders and grassroots organizations [UN-9.2.1]		X			
	“Surge” capacity of police also to support first responder duties [UN-9.3.1]		X			
	Definition of other first responder and other staffing needs, availability – including fire, ambulance, healthcare, neighborhood support etc. [UN-9.3.2]		X			
	Definition of equipment and supply needs, and availability of equipment [UN-9.4.1]		X			
	Likely ability to continue to feed population [UN-9.5.1]			X		
	Ability to meet likely needs for staple goods [UN-9.5.3]			X		
	Likely availability of fuel [UN-9.5.4]			X	X	
	Interoperability with neighboring cities/ states and other levels of government of critical systems and procedures [UN-9.6.1]		X			
	Emergency operations center [UN-9.6.2]		X			
	Practices and rehearsals – involving both the public and professionals [UN-9.7.1]		X	X		
	Effectiveness of drills and training [UN-9.7.2]		X	X		
	Shadow financial arrangements for processing incoming aid and disbursing funds [UN-10.1.2]		X			

ANNEX B: INTERVIEW GUIDELINES

INTERVIEW WITH MIYAKO CITY PLANNING DIVISION, EMPLOYEE A

Thank you for the opportunity to interview you to learn more about the reconstruction process in Miyako City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

To make the analysis of the interview easier, it would be very helpful to record it. Would this be OK for you?

Introducing questions

First, I would like to ask you to please introduce yourself and tell me what your position in the reconstruction process of Miyako City is?

Could you please tell me about the reconstruction process after 3-11? Feel free to begin wherever you find it appropriate and explain the steps that were most important for you. Take your time; I will not interrupt you until you are finished.

Engineering resilience

The basic goals for the reconstruction process in response to the Great East Japan Earthquake include building infrastructural resilience – can you please explain which tools and approaches of spatial planning you used to approach this goal?

Do you think that the available tools and approaches were sufficient to build up infrastructural resilience? What would you improve if you could?

Socio-ecological resilience

Besides the sufficient infrastructure, resilience is also increased by socio-ecological factors such as community connectedness or participation of vulnerable segments of the population (e.g. the elderly).

In the field of spatial planning, which tools and approaches did you use to increase some of the things I just mentioned, like community connectedness or participation of vulnerable segments of the population or anything else related to this (socio-ecological resilience)?

Did you find these tools and approaches useful to reach the goal to build resilience? Would you like to have additional tools to use? Which are these?

Additional challenges to be considered

The Basic Act on Reconstruction and Response to the Great East Japan Earthquake states in Article 2 that the changing needs of an aging society or global warming (e.g. sea level rise or rising possibility of heat waves) should be considered throughout the reconstruction process. Do you feel enabled to do this in your everyday work? If yes, how do you do this? If no, what would help to improve the current situation?

Do you see the uncertainty of future as a challenge? For example, the fact that you do not know about the height of a possible sea level rise or changes in weather. How do you consider these uncertainties in your work?

Did you take special measures to fulfill the changing needs of an aging society into account throughout the reconstruction process? Did you also consider global warming (e.g. sea level rise or changing temperatures) in your plans?

Window of opportunity

Do you think there is a window of opportunity after a disaster? If yes, did this opportunity help plans to be implemented faster?

Before 3-11, did the administration of Miyako City already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done

INTERVIEW WITH MIYAKO CITY CONSULTANT

Thank you for the opportunity to interview you to learn more about the reconstruction process in Miyako City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

To make the analysis of the interview easier, it would be very helpful to record it. Would this be OK for you?

Introducing questions

First, I would like to ask you to please introduce yourself and tell me what your position in the reconstruction process of Miyako City is?

Could you please tell me about the reconstruction process after 3-11? Feel free to begin wherever you find it appropriate and explain the steps that were most important for you. Take your time; I will not interrupt you until you are finished.

Engineering resilience

The basic goals for the reconstruction process in response to the Great East Japan Earthquake include building infrastructural resilience – can you please explain which tools and approaches of spatial planning you used to approach this goal?

Do you think that the available tools and approaches were sufficient to build up infrastructural resilience? What would you improve if you could?

Socio-ecological resilience

Besides the sufficient infrastructure, resilience is also increased by socio-ecological factors such as community connectedness or participation of vulnerable segments of the population (e.g. the elderly).

In the field of spatial planning, which tools and approaches did you use to increase some of the things I just mentioned, like community connectedness or participation of vulnerable segments of the population or anything else related to this (socio-ecological resilience)?

Did you find these tools and approaches useful to reach the goal to build resilience? Would you like to have additional tools to use? Which are these?

Additional challenges to be considered

The Basic Act on Reconstruction and Response to the Great East Japan Earthquake states in Article 2 that the changing needs of an aging society or global

warming (e.g. sea level rise or rising possibility of heat waves) should be considered throughout the reconstruction process. Do you feel enabled to do this in your everyday work? If yes, how do you do this? If no, what would help to improve the current situation?

Do you see the uncertainty of future as a challenge? For example, the fact that you do not know about the height of a possible sea level rise or changes in weather. How do you consider these uncertainties in your work?

Did you take special measures to fulfill the changing needs of an aging society into account throughout the reconstruction process? Did you also consider global warming (e.g. sea level rise or changing temperatures) in your plans?

Window of opportunity

Do you think there is a window of opportunity after a disaster? If yes, did this opportunity help plans to be implemented faster?

Before 3-11, did the administration of Miyako City already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done.

INTERVIEW WITH TARO DISTRICT CITIZEN A AND B

Thank you for the opportunity to interview you to learn more about the reconstruction process in Miyako City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". This also includes the involvement of the people's needs into the reconstruction process. Therefore, I am very interested in the experiences you gathered over the last four and a half years. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

To make the analysis of the interview easier, it would be very helpful to record it. Would this be OK for you?

Introducing questions

First, I would like to ask you to please introduce yourself.

Could you please tell me about the development of this temporary housing community? Feel free to begin wherever you find it appropriate and explain the steps that you consider as most important. Take your time; I will not interrupt you until you are finished.

When you moved to the temporary houses, was your community moved to live together? Will you be able to relocate as a community when you move from the temporary into permanent houses? Do you think keeping communities together will improve the ability of people to cope with a disaster?

Socio-ecological resilience

To prepare a city for future disasters, it is not only important to build safe infrastructure, but also to build social capacity or community connectedness. This can be reached by considering the people's needs, especially the needs of vulnerable segments of the population (e.g. the elderly).

When spatial planners were planning the reconstruction of the city, did they use approaches that enabled the people to contribute their ideas into the process? If yes, how did this happen? If no, what do you think could be improved?

Additional challenges to be considered

Do you think spatial planners also consider additional challenges like the changing needs of an aging society or global warming (e.g. sea level rise or rising possibility of heat waves) throughout the reconstruction process? If yes, how is this done? If no, what do you think are the reasons for this?

Window of opportunity

Before 3-11, did the administration of Miyako City already have any plans for after the disaster? If yes, were those plans useful? What were the problems?

If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to react faster?

Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done.

INTERVIEW WITH ISHINOMAKI CITY DOWNTOWN CREATIVE RECONSTRUCTION COMMITTEE MEMBER

Thank you for the opportunity to interview you to learn more about the reconstruction process in Ishinomaki City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

To make the analysis of the interview easier, it would be very helpful to record it. Would this be OK for you?

Introduction questions

First, I would like to ask you to please introduce yourself and tell me what your position in the reconstruction process of Ishinomaki City is?

Could you please tell me about the reconstruction process after 3-11? Feel free to begin wherever you find it appropriate and explain the steps that were most important for you. Take your time; I will not interrupt you until you are finished.

Engineering resilience

The basic goals for the reconstruction process in response to the Great East Japan Earthquake include building infrastructural resilience – can you please explain which tools and approaches of spatial planning were used to approach this goal?

Do you think that the available tools and approaches were sufficient to build up infrastructural resilience? What would you improve if you could?

Socio-ecological resilience

Besides the sufficient infrastructure, resilience is also increased by socio-ecological factors such as community connectedness or participation of vulnerable segments of the population (e.g. the elderly).

In the field of spatial planning, which tools and approaches were used to increase some of the things I just mentioned, like community connectedness or participation of vulnerable segments of the population or anything else related to this (socio-ecological resilience)?

Did you find these tools and approaches useful to reach the goal to build resilience? Would you like to have additional tools used? Which are these?

Additional challenges to be considered

The Basic Act on Reconstruction and Response to the Great East Japan Earthquake states in Article 2 that the changing needs of an aging society or global

warming (e.g. sea level rise or rising possibility of heat waves) should be considered throughout the reconstruction process. Do you think these points were integrated into the reconstruction process? If yes, how did this happen? If no, why do you think they were not integrated?

Do you see the uncertainty of future as a challenge for your work? For example, the fact that you do not know about the height of a possible sea level rise or changes in weather. How do you consider these uncertainties in your work?

Were special measures to fulfill the changing needs of an aging society taken into account throughout the reconstruction process? Was global warming (e.g. sea level rise or changing temperatures) considered?

Window of opportunity

Do you think there is a window of opportunity after a disaster? If yes, did this opportunity help plans to be implemented faster?

Before 3-11, did the administration of Ishinomaki City already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done

INTERVIEW WITH ISHINOMAKI CITY MACHIZUKURI EMPLOYEE

Thank you for the opportunity to interview you to learn more about the reconstruction process in Ishinomaki City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

To make the analysis of the interview easier, it would be very helpful to record it. Would this be OK for you?

Introducing questions

First, I would like to ask you to please introduce yourself and tell me what your position in the reconstruction process of Ishinomaki City is?

Could you please tell me about the reconstruction process after 3-11? Feel free to begin wherever you find it appropriate and explain the steps that were most important for you. Take your time; I will not interrupt you until you are finished.

Engineering resilience

The basic goals for the reconstruction process in response to the Great East Japan Earthquake include building infrastructural resilience – what has been done to approach this goal?

Do you think that the available tools and approaches of spatial planning were sufficient to build up infrastructural resilience? What do you think could be improved?

Socio-ecological resilience

Besides the sufficient infrastructure, resilience is also increased by socio-ecological factors such as community connectedness or participation of vulnerable segments of the population (e.g. the elderly).

What tools and approaches did spatial planners in Ishinomaki City use to increase some of the things I just mentioned, like community connectedness or participation of vulnerable segments of the population or anything else related to this (socio-ecological resilience)?

Do you think these things were helpful? What would you like to be different?

Additional challenges to be considered

The Basic Act on Reconstruction and Response to the Great East Japan Earthquake states that the changing needs of an aging society or global warming (e.g.

sea level rise or rising possibility of heat waves) should be considered throughout the reconstruction process. Do you feel like this is happening? If yes, how? If no, what would help to improve the current situation?

Do you see the uncertainty of future as a challenge? For example, the fact that you do not know about the height of a possible sea level rise or changes in weather. How are these uncertainties considered?

Were special measures to fulfill the changing needs of an aging society taken onto account throughout the reconstruction process? Was global warming (e.g. sea level rise or changing temperatures) considered?

Window of opportunity

Do you think there is a window of opportunity after a disaster? If yes, did this opportunity help plans to be implemented faster?

Before 3-11, did the administration of Ishinomaki City already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done.

INTERVIEW WITH ISHINOMAKI CITY PLANNING DIVISION, EMPLOYEE

Thank you for the opportunity to interview you to learn more about the reconstruction process in Ishinomaki City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

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Engineering resilience

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Do you think that the available tools and approaches were sufficient to build up infrastructural resilience? What would you improve if you could?

Socio-ecological resilience

Besides the sufficient infrastructure, resilience is also increased by socio-ecological factors such as community connectedness or participation of vulnerable segments of the population (e.g. the elderly).

In the field of spatial planning, which tools and approaches did you use to increase some of the things I just mentioned, like community connectedness or participation of vulnerable segments of the population or anything else related to this (socio-ecological resilience)?

Did you find these tools and approaches useful to reach the goal to build resilience? Would you like to have additional tools to use? Which are these?

Additional challenges to be considered

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Before 3-11, did the administration of Ishinomaki City already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

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INTERVIEW WITH ISHINOMAKI CITY CONSULTANT

Thank you for the opportunity to interview you to learn more about the reconstruction process in Ishinomaki City. I am a PhD student at TU Dortmund University in Germany. The main research question for my thesis is "How far can spatial planning help to improve a city's resilience after a disaster?". Therefore, I am very interested in the valuable experiences you gathered throughout your work in the reconstruction process. I want to collect lessons learned from you and use them to help spatial planners in other countries to better understand and use their opportunities to create resilience after a disaster. I would like to let you know that I will anonymize the information you give me in this interview when I use it for my thesis.

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Introducing questions

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Before 3-11, did the administration of Ishinomaki City already have any land-use plans for after the disaster? If yes, were those plans useful? What were the problems? If no, do you think it would be helpful to have a recovery plan for the city developed in advance in order to use the window of opportunity better?

Is there anything else you would like to add?

Thank you for your time! After my return to Germany, I am going to use the information you just gave me to understand the possibilities and constraints of spatial planners in the reconstruction process after a disaster. This information will help me to answer my research question. If you are interested, I can send you the results of my research after I am done.