

Cities bouncing forward

A multiple case study on the balance of the resilience dimensions reflected by the policy arrangements in Jakarta and Rotterdam



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Preface

Thank you for reading my Master's thesis, which is the final product of my Master's 'Environment and Society Studies' 'Global Environment and Sustainability' specialisation at the Radboud University in Nijmegen. With pride and relief I can now present my Master's thesis as a result of the past six months of research in the field of climate resilience and six years of studying reflecting various related topics.

Performing this research, I felt very privileged to have the opportunity to work within the Dutch Ministry of Infrastructure and Water Management at the program of International Climate Adaptation and Water Affairs (KAWI) and address the complex and actual topic resilience in urban areas. I would like to thank team KAWI for giving me this opportunity to conduct this Master Thesis and all KAWI colleagues for the pleasant and positive six months. My special thanks goes to Martien Beek for the guidance, the help to narrow down and maintain the thesis focus, and the frequently enjoyable coffee catch-up moments.

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Last but definitely not least, I would like to thank Martine my so-called 'thesis soulmate' for going through the whole thesis process together and providing cups of tea, your intelligence, and motivational support. This has been very helpful and so much more fun. Furthermore, I am very grateful for my family who provided me with moral support, wisdom, proof-reading, trust, words of motivation, and distractions when needed. This has been very valuable to me and helped me with the completion of the full-time study chapter in my life.

I sincerely hope that you will enjoy reading the research and will gain more insight on the climate resilience of the urban areas of Jakarta and Rotterdam.

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Abstract

Cities are major contributors to the accelerating climate change on the other hand also most vulnerable to its effects, especially delta cities. Jakarta and Rotterdam are two of these delta cities facing a diversity of climate change challenges. Climate predictions and other studies show that the worst case scenarios are more severe. The ability of a city to bounce back will not be enough to protect the city, its inhabitants, its nature and its economic assets. In order to ensure that urban areas can cope with climate change challenges, there is an urgent need to build social-ecological resilience, which means that the cities are able to bounce forward in regards to these challenges. This includes a balance among the three following dimensions:

- 1) Robustness, the ability to reduce climate hazards probability;
- 2) Adaptability, the ability reduce the consequences of climate hazard;
- 3) Transformability, the ability to foster societal change into a new equilibrium to preserve the stability of the social-ecological system.

Literature has identified governance and instructional systems as one of the import aspects of resilience in urban areas. Therefore, this study looks into the social-ecological resilience of both cities and the balance of the dimensions reflecting the policy arrangements according to the Policy Arrangement Approach. This has led to the following research question: *How are the climate resilience dimensions integrated in the governance of Jakarta and Rotterdam reflecting the policy arrangements, in order to identify the resilience balance?*

The data on both case studies to answer the research question was collected through the qualitative research methods of semi-structured expert interviews, data analysis, and observations. This has led to the findings that both cases have a different balance of the resilience and show that a balanced equilibrium of the dimensions of resilience is difficult to achieve due to cross-overs and trade-off among these dimensions. The resilience balance in Jakarta bends towards a dominance of the adaptability dimension. The centre of attention of climate hazards are efforts made to reduce the consequences. This focus has arisen out of necessity and a trade-off with the robustness. The strong capacity to adapt and recover is facilitated by the Jakartans themselves. Simultaneously, plans are currently made to enhance the transformability and relocate the capital city. Rotterdam shows the opposite and the resilience balance bends towards the robustness dimension, which focusses on the perseverance of the social-ecological system. Due to history, the Dutch focus on a robust system of flood defences which is fully accounted for by the government. The dominance of the robustness creates trade-offs regarding the adaptability and transformability dimensions in which other actors do have a significant role being experienced as additional or as a back-up plan towards the robust system. Moreover, both cases show that by tradition the focus within the resilience dimensions mostly on flood related hazards as showed by the policy arrangements, while there is a need for a more broad type of resilience due to the upcoming climate challenges.



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1. Introduction

1.1. Problem statement

The climate is changing and global warming will continue to rise during the 21st century if no radical changes are made. The effects of climate change are an increasing threat to the global environment and society. Mitigation is the best adaptation to climate change. However, due to past greenhouse gas emissions, certain irreversible changes are already locked in, making some risks unavoidable (IPCC, 2021). There is growing consensus on the cause of climate change and therewith the fact that the world is currently moving into the era of the Anthropocene. This indicates that human activities contribute to climate change and mankind has become a global geological force on its own (Steffen, Grinevald, Crutzen & McNeill, 2011).

Cities are major contributors to climate change since urban activities are globally responsible for the largest amount of greenhouse gas emissions (UN Environment Programme, n.d.). Nevertheless, cities are most vulnerable to the climate change effects and in the frontline of facing the increasing amount of challenges such as floods, droughts, storms and heat waves (UN Environment Programme, n.d.). This is amplified by the fact that over two thirds of the world's largest cities are located in delta areas, making them extra vulnerable to climate change effects (C40 Cities, 2016). The high risk and vulnerability to climate change of cities is also due to their prominent socio-economic role in the world. Urban areas are the home to approximately 55% of the world's population, which is expected to grow with accelerating numbers due to population growth and urbanisation (United Nations, 2018). In addition, cities are accountable for more than 80% of the global gross domestic product (The World Bank, 2020). Most of the urban climate threats are water related which are seriously affecting cities and its service, infrastructure, housing and human livelihoods and health (The Global Centre on Adaptation, 2021). At the same time, water is one of the most vital sources for the primary needs of life (i.e., providing food, drinking water and energy). Moreover, water also plays a pivotal role in managing the environment and creating jobs and recreation. Besides these vital functions, water can also work as leverage in order to adapt to different climate challenge and building resilience in urban areas (The Global Centre on Adaptation, 2021).

Jakarta and Rotterdam are two delta cities with a prominent socio-economic role in their respective countries, but with very different macro characteristics. However, they both are located below sea level and face in a certain degree many of the same water related climate change challenges. The cities have to manage the challenges of the diversity of all increasing climate change challenges.

Jakarta has experienced many natural disasters, caused by a combination of the climate change and anthropogenic forces. The city faces an increasing threat of pluvial flooding from the thirteen major rivers flowing through it, floods due to extreme rainfall and coastal flooding because of sea level rise which is even strength by land subsidence. The floods have an intertwined cause by climate change and



anthropogenic driven forces, such as ground water pumping, and paving urban surfaces (Putri, Rostika, Adadi, Rakhmatika, 2021; Savirani, 2021). Currently, Jakarta is sinking by extreme rates, therefore has the nickname ‘the sinking city’ (Savirani, 2021; The World Bank, 2016). The city is also named a ‘bathtub’, since the urban surface has become the drain location for water instead of the sea. Together with its naturally flood-prone position this has resulted in a long history and increasing frequency of coastal and fluvial flooding while also dealing with a growing occurrence of other extreme weather events or extended drought periods (Savirani, 2021). Jakarta its situation has become so critical that the national government is even planning to move the capital towards a new city (Savirani, 2021). More in-depth elaboration about the climate change challenges for Jakarta is provided in the case description in section 4.1.

Rotterdam was not harmed during the major floods that occurred in the Dutch history (Ward, Pauw, van Buuren & Marfai, 2012). However, the city has a naturally flood-prone location and due to the relative sea level rise there is an increasing risk of coastal flooding, besides the risk of fluvial flooding from the Meuse river. In addition, there is a growing challenge of pluvial flooding due to the increase of more extreme precipitation patterns in the dense paved urban area of Rotterdam (Rotterdams WeerWoord, 2020; Ward et al., 2012). The city of Rotterdam is clearly facing serious increasing flood risks. However, climate change is also forming growing threats in less visible forms such as heat stresses and droughts, causing damage and impacting health of the environment and the society (Rotterdams WeerWoord, 2020) Further elaboration on the climate change challenges for Rotterdam is provided in the case description in paragraph 5.1.

This manifests that both cities are facing these significant growing multi-sided climate change challenges. Climate predictions and other studies show that the worst case scenarios are more severe. The ability of a city to bounce-back solely by its robustness will not be enough to protect the city, its inhabitants, its nature and its economic assets (IPCC, 2021; Restemeyer, Woltjer & van den Brink, 2015). In order to ensure that urban areas can cope with climate change challenges, there is an urgent need to build social-ecological resilience, which means that the cities are able to bounce forward in regards to these challenges, including the dimensions robustness, adaptability, and transformability. Therefore, this study looks into the social-ecological resilience of urban areas focussing on Rotterdam and Jakarta as a way to become resilient towards climate challenges and enhancing the vitality of urban life.

1.2. Research aim and questions

The aim of this research is to gain a comprehensive understanding of the different conceptual meanings of resilience. In addition, the aim is to find out how these different resilience dimensions are currently integrated into the policy arrangements of the contrasting urban areas of Jakarta and Rotterdam. This is to identify the current balance of the resilience dimensions and map out the cross-overs and trade-offs, in order to find the cities their weaknesses and strengths.

Research question

How are the climate resilience dimensions integrated in the governance of Jakarta and Rotterdam reflecting the policy arrangements, in order to identify the resilience balance?

- What are the different types of resilience and its dimensions?
- How is resilience currently integrated into Jakarta's policy arrangements (PA)?
 - To what extent is robustness integrated into the PA of Jakarta?
 - To what extent is adaptability integrated into the PA of Jakarta?
 - To what extent is transformability integrated into the PA of Jakarta?
 - How is the balance of the resilience dimensions in Jakarta?
- How is resilience currently integrated into Rotterdam's policy arrangements?
 - To what extent is robustness integrated into the PA of Rotterdam?
 - To what extent is adaptability integrated into the PA of Rotterdam?
 - To what extent is transformability integrated into the PA of Rotterdam?
 - How is the balance of the resilience dimensions in Rotterdam?

1.3. Relevance

Scientific relevance

Over the last two decades there has been an explosion on resilience research. The amount of publication on resilience related to the environment has increased massively (Folke, 2016). Many scholars have also recognised the evolution of the resilience concept into social-ecological resilience and its importance due to complexity of social-ecological systems and its challenges (Armitage, Béne, Charles, Jonson & Allison., 2012; Bahadur, Ibrahim & Tanner, 2013; Bollettino, Alcayna, Dy & Vinck, 2017). This line of resilience thinking has already been applied to different empirical case studies including different focus areas such as the social and governance domain (e.g. Khan, Korac-Kakabadse & Skouloudis, 2021; Komugabe-Dixson, de Ville, Trundle & McEvoy, 2019; Paolisso et al., 2019). However, prior research mainly focused on the study of resilience dimension regarding flood related challenges (Kaufmann, Van Doorn-Hoekveld, Gilissen & Van Rijswijk, 2015; Restemeyer et al., 2015; Wiering, Green, van Rijswijk, Priest, & Keessen, 2014; Zevenbergen, Gersonius, & Radhakrishan, 2020). This thesis therefore contributes to the existing theory by researching the resilience of two empirical cases in a holistic way due to its broader focus than water, including the different climate change challenges, which are characterized through the arrangements of governance domains.

Societal relevance

Cities are vulnerable to the climate change effects of which many are water related (UN Environment Programme, n.d). Building social-ecological resilience and thus bouncing forward, can help urban areas to cope with these effects and help creating more adaptability and flexibility facing uncertainties, change and disruptions (Folke, 2016; Meerow, Newell & Stults, 2016). This research examines the lessons learned regarding the integration of social-ecological resilience into the policy arrangements. The



research outcome offers relevance due to insights into social-ecological resilience and the policy arrangements for different scales of governance institutions across the globe but especially for Indonesia and the Netherlands (e.g. national government, municipalities & water authorities). This is relevant since governance and institutional systems are one of the important aspects regarding resilience in urban areas (Ribeiro & Gonçalves, 2019). In the light of the research outcomes, knowledge about the current situation is provided which will provide insides on the current resilience balance. The current balance offers insight into the strengths and challenges of the cities and their social-ecological resilience. These lessons can be used in future resilience strategies, related policies, and its implementation. Therefore, this indirectly helps to cope with climate change challenges. The broad urban scope of the research is also useful as an example showing how to integrate different elements and dynamics into climate adaptation strategies. Furthermore, the findings can be useful for creating connections among different (international) actors.

1.4. Outline of the paper

In continuation of this master thesis, the theoretical framework is provided. This includes a review of the existing literature on social-ecological systems, resilience and its governance followed with an elaboration on the theoretical concept of social-ecological resilience and the policy arrangement approach which are being operationalised into a conceptual model. This is followed by the methodology chapter which elaborates on the research strategy, methods and data analysis. Afterwards, a results chapter for the case of Jakarta and the case op Rotterdam is written, in which the three resilience dimension are elaborated in the light of the four elements of the policy arrangement approach. This subsequently leads to the conclusion, discussion and recommendations.



2. Theoretical Framework

This chapter starts with a literature review on the concepts of social-ecological systems, resilience, and complementary governance strategies, followed by a review of the policy context of Indonesia and the Netherlands. Thereafter, an elaboration on the theoretical framework including resilience and the policy arrangement approach is presented, which are then developed into a conceptual model.

2.1. Literature review

Social and ecological systems used to be studied solely separate, however, in recent years a shift occurred in which both systems are coupled and studied in an integrated way (e.g. Bourceret, Amblard & Mathias, 2021; Folke, Biggs, Norström, Reyers & Rockström, 2016; Schoon & Van der Leeuw, 2015). The integration of social and ecological studies is required in order to deal with the complexity and change in Social-ecological Systems (SES) (Armitage et al., 2012).

This relates to the increasing concerns about, for example pollution, biodiversity loss, deforestation, and sea-level rise (Bourceret et al., 2021). SES refers to the interdependency of society and nature. This can be explained by the fact that on the one hand, the human dimension in its broad facets (i.e. communities, economies, cultures, governance, and institutions) is embedded in the biosphere while being able to extensively shape it at different scales. On the other hand these societal facets are naturally shaped by and evolving with the biosphere (Folke et al., 2016; Schoon & Van der Leeuw, 2015).

The evaluation of resilience thinking is also formed by the bridge between natural and social studies. The notion of social-ecological resilience has grown importance for both scholars as well as practitioners and policy makers regarding the topics of climate change adaptation and disaster risk reduction (Armitage et al., 2012; Bahadur et al., 2013; Bollettino et al., 2017). This evaluated form of resilience is focussing and encouraging adaptive capacity, transformation, learning, innovation and moving beyond material assets (Armitage et al., 2012). This line of resilient thinking goes beyond the narrowed traditional concept of resilience which is focussing bouncing-back and resisting change by the control of technical and infrastructure domain preventing disasters and change (Folke, 2016; Holling, 1973; Zevenbergen et al., 2020). The traditional concept includes a system and society which is not designed for failure, lacking social-ecological thinking, with possible extreme consequences. In many parts of the world major disasters have functioned as catalysts for evaluating their approach from a more controlled and preventative way towards preparedness by acknowledging, adapting, and recovering from uncertainties. However, many countries are still behind in this resilience evaluation and steps forward have to be taken (Klijn, Mens & Asselman, 2015; Zevenbergen et al., 2020). Many of these disasters and uncertainties are water related, which forms one of the world's largest impacts and risks shaped by social and environmental interactions. However, water can also contribute to the resilience due to its inherently intertwined role with all process of a social-ecological system (Falkenmark, Wang-Erlandsson & Rockström, 2019)



The shift from the traditional concept of resilience towards the social-ecological resilience thinking requires governance institutions to evaluate their perspective into a system of strategic alternatives, such as adaptive pathways to prevent any lock-ins in future scenarios. This can help decision makers including long-term considerations, since governance institutions are a central component in linking social and ecological resilience with direct and indirect impacts on these systems (Bourceret et al., 2021; Zevenbergen et al., 2020). Ribeiro and Gonçalves (2019), have identified governance and institutional systems as one of the important dimensions regarding resilience in urban areas, to absorb and reduce the impact from disturbance and adapt to change. Bahadur et al. (2013) state, that there is a need for a polycentric and multi-layered governance with decentralised organisational structures and policy in order to achieve resilience. This is considered flexible, adaptive and closer to the needs of communities and local lives, improving the fit between knowledge and action and the context in which societies can respond more adaptively. Polycentric governance is a way to achieve adaptive governance which includes shared learning and trust building. Adaptive governance is suggested as more likely to lead to social-ecological resilience since it is well suited toward change, complexity and uncertainties (Salomon, Quinlan, Pang, Okamoto & Vazquez-Vera, 2019).

2.2. Review of policy context

As mentioned earlier, governance plays a key role within the transition to climate resilience and is the focus of this research (Ribeiro and Gonçalves, 2019; Ward et al, 2012). In order to be able to answer the research question which focusses on governing, it is necessary to identify the policy context of Jakarta and Rotterdam. The governmental structures of countries are usually structured into different layers. Decentralisation of governance has been a trend that spread globally about two decades ago (Faguet, 2014). This reforming trend has influenced the division of governmental tasks and responsibilities essentially everywhere in the world.

The Netherlands is described as a decentralised unitary state, in which unitary implies that the national government creates legislation and policies and its supervision and enforcement (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021-a). However, due to the decentralisation task, responsibility, and powers are shared with three other regional government institutions, namely provinces, municipalities and water authorities. The Dutch national government remains responsible for the development of national legislation and policies. This is prepared by twelve different ministries which all hold their own portfolio. Water and climate adaptation is endorsed within the Ministry of Infrastructure and Water Management, but it is also partially embedded within other ministries, such as the Ministry of Economic Affairs and Climate Policy (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2018). The Dutch national policies are directly and indirectly influenced by European Union (EU) legislation because all EU regulations, directives and decisions are binding for its Member States (Rijksdienst voor Ondernemend Nederland, n.d.). An example of a resilience related directive is the EU Floods Directive which is integrated in the Dutch national Delta Program (Ward et

al., 2012). Since the decentralisation, the twelve provinces in the Netherlands are responsible for the implementation of national and European policy on nature, recreation, soil, air, and water. Besides the implementation of (inter)national policies, provinces also develop and realize their own policy regarding spatial planning and provincial infrastructure. Furthermore, they supervise municipalities and waterboards (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021-b). Within those twelve Dutch provinces there are 355 municipalities. A municipality is the government layer closest to the

Dutch citizens and local livelihoods. They execute social-, service- and maintenance tasks, while also developing and realizing their own policies on municipal environment and spatial planning which needs to be in line with the provincial and national policies (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021-a). The Dutch waterboards are the most deviating government institutions

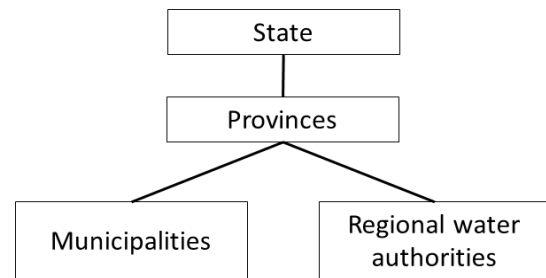


Figure 1: Administrative structure of the Netherlands (Kaufmann, 2015)

compared to the others, forming a unique functional governance layer. There are 21 waterboards in the Netherlands, all having a specific water management portfolio. They are responsible for water safety, quality, and quantity and implementing and incorporating national and provincial policies on these topics into their own policies (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021-a).

Indonesia is also described as an unitary state with a three-tier government system that exists out of three main layers which are the national government, provinces, and municipalities (Kota). However, the municipalities are further divided into administrative districts (Kabupaten), which are divided into subdistricts (Kecamatan) and these exists out of village or neighbourhood divisions (Kelurahan) (Ward et al., 2012). Since the trend of decentralisation this multi-level structure has become more prominent (Van Voorst 2015; Ward et al., 2012). The Indonesian national government remains the one responsible for the development of national legislation and policies. This is prepared by 31 different ministries which all hold their own portfolio. The Ministry of Public Works is responsible for water and climate adaption, however, that is also partially embedded within other ministries, such as the Ministry of Agrarian and Spatial planning. The Ministry of Public Works mainly a executive organisation which is steered by the coordination ministries (Ward et al., 2012). Several offices of the ministries are also integrated within the other two government tiers. For example, the provincial and municipal government levels also have Public Works offices that have delegated authority over water resources and climate adaption (Ward et al., 2012). The city of Jakarta is not identified as a municipality but as a province named the Province of Special

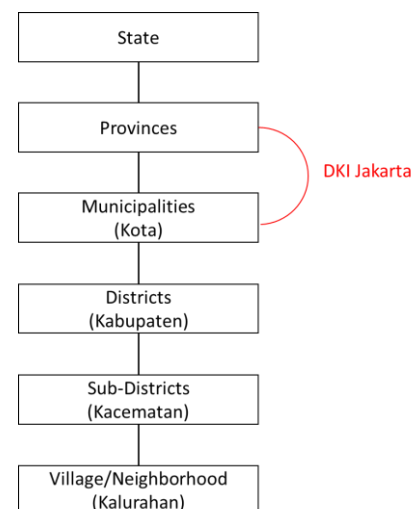


Figure 2: Administrative structure of Indonesia & Jakarta (created by author with content of Ward et al., 2012)

Capital Region Jakarta, therefore it is having a governor instead of a mayor. Within this province the Coordinating Body for Jakarta Metropolitan Region Development is tasked with monitoring, planning and coordinating developments in Jakarta, also the ones related to climate resilience. However, this coordinating body needs to comply with the national made policies (Ward et al., 2012).

2.3. Theoretical concepts

2.3.1. Resilience

The concept of resilience has a long history in different studies, however resilience thinking in ecological studies and systems originates from the 1970s (Alexander, 2013; Meerow et al., 2016). The ecologist Holling is seen as the founder of the resilience theory used in natural sciences. Holling (1973) describes the term resilience as the ability of a system to absorb, preserve or bounce-back after disturbance and change, in order to conserve a stable and consistent system. This description of the resilience concept is referred to as ‘engineering resilience’ (Folke, 2006). Overtime, the concept resilience has evolved due to the fact that resilience of complex systems is broader than only the conservation of the system. The main characteristics of resilience remained on stability, persistence, and the buffer capacity of a robust system, however, it also initiates ideas on utilizing the opportunities and new paths that emerge from disturbances (Folke, 2006). This evaluated concept of resilience is referred to as ‘ecological resilience’. Also, sometimes as ‘social resilience’, since this concept of resilience was introduced into social studies due to the interlinkage between the social and ecological systems (Adger, 2000). Due to this interdependency the concept of resilience continued to develop as ‘social-ecological resilience’. This means that a social-ecological system should be flexible and even more open to emergence instead of maintaining stability of the system. This concept incorporates the focus on adaptation, transformation, and learning while remaining the general ability to persist in response to disturbance (Folke, 2006). An overview of the different concepts of resilience is displayed in Table 1 and visualised in Figure 3.

Table 1: Overview of resilience concepts (Folke, 2006)

Resilience concepts	Characteristics	Focus on	Context
Engineering resilience	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological/ecosystem resilience social resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscapes
Social-ecological resilience	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions



Figure 3: Frameworks of Resilience: The valleys in the surface represent equilibrium or stability domains, the ball represents the system, and arrows represent disturbances. (Layboyl & Fannon, 2016)



Social-ecological resilience

This research will focus on the concept of social-ecological resilience, since this evolved form is most suitable due to the complexity of a city, a social-ecological system. This new lens of resilience provides holistic view of complex systems such as a city in which societies interact with the environment, while setting people, planet and profit at the same level of importance at least conceptually (Bollettino et al., 2017; Sterk, Leemput & Peeters, 2017). It offers an opportunity to focus on the social ability to prepare and adapt to the challenges and threats posed by climate change (Bollettino et al., 2017). Simultaneously, contributing to the resilience of the biosphere, while conserving the ecosystem and its biodiversity and possibly using the environment, its blue-green infrastructures, and their ecosystem services (Adger, 2000; Folke et al., 2016). There is not one definition of this resilience concept carved in stone. However, Folke (2006) defines three main fundamentals of social-ecological resilience:

- 1) *“the amount of disturbance that a system can absorb and still remain within a domain of attraction,*
- 2) *the degree to which the system is capable of self-organisation, and*
- 3) *the degree to which the system can build and increase the capacity for learning and adaptation”* (p. 259-260).

The description of these three elements can be translated into the elements of ‘robustness’, ‘transformability’, and ‘adaptability’ (Restemeyer et al., 2015). Robustness indicates the ability of the social-ecological system to persist the disturbance for climate challenges and threats (Restemeyer et al., 2015). Adaptability is about the human actions that contribute by on the one hand sustaining while also innovating and improving the development of current pathways (Folke et al., 2016). The transformability refers to shifting development into new pathways by means of knowledge, learning and creating windows of opportunity (Folke et al., 2016). The operationalisation of these three elements is provided in section 2.5.1. Almost all social-ecological resilience definitions include these three main elements and are alike in their main message about the ability to ‘bounce forward’ instead of ‘bouncing back’ (Folke, 2016; Keessen, Hamer, Rijswick & Wiering, 2013; Meerow et al., 2016). For example, Biggs, Schlüter & Schoon (2015, as cited in Folke, 2016) define resilience as *“the capacity of a social-ecological system to sustain in the face of change, by persisting and adapting or transforming in response to change.”* (p.44).

2.3.2. Policy Arrangements

A policy arrangement (PA) can be defined as *“the way in which a certain policy domain is shaped in terms of organisation and substance”* in the case of multi-level governance (Wiering & Arts, 2006, p. 328). According to Arts and Leroy (2006), PA is an intuitional concept in which they refer to institutions as *“the phenomenon whereby over time day to day actors’ behaviour solidifies into patterns and structures, whereas these patterns in turn structure day to day actors’ behaviour”* and *“the gradual sedimentation of meanings into rules of behaviour and organisational structures, that in turn reproduce*

and recreate these meanings.” (p.7). Besides the notice of PAA as an intuitional concept it also pays attention to discursive aspects of policy making alike. The main goal of the PAA is to describe the arrangements and to understand their relative stability or change (Arts & Leroy, 2006).

In order to enable this aim and analyse the climate resilience governance of Jakarta and Rotterdam, the PAA offers four equal analytical elements.

- 1) The ‘actors’ which are involved in the researched policy domain, and their coalitions and oppositions;
- 2) the division of ‘resources’ between these actors, which lead to differences in power and influences among these actors;
- 3) the ‘rules of the game’ within the PA, which can be either in terms of formal or informal rules; and
- 4) the policy ‘discourses’, where discourses entail the views and values of the actors involved (Leroy & Arts, 2006; Liefferink, 2006).

The operationalisation of these four elements is provided in section 2.5.2. As described within the definition of PA, it is shaped in terms of organisational and substantive aspects. The elements of actors, resources and partly the rules of the game characterize as organisational aspects, while the discourses and the other part of rules of the games identify as substantive aspects (Wiering & Arts, 2006). The PAA links up all four relevant elements of a policy domain within the tetrahedron, which are all interrelated and have implications on each other. Hence it enables to study the PA as a whole (Arts & Leroy 2006; Liefferink, 2006).

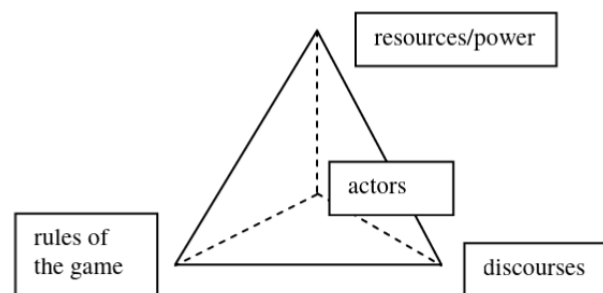


Figure 4: The tetrahedron, symbolising the interconnectedness of the four dimensions of a policy arrangement (Liefferink, 2006)

As defined PA is about the shaping of a certain policy domain (Wiering & Arts, 2006). It could be stated that due to the challenges of climate change new policy domains emerge, such as the climate adaption policy domain (Carmin, Anguelovski & Roberts, 2012). However, reality shows that despite the emergence of the climate specific policy domains, climate resilience and therewith adaption is also convened into more than one certain policy domains. In other words, climate resilience is divided over several policy domains. Kaufmann et al. (2015), identified water system management, urban water management, spatial planning, crisis management, and compensation as the policy domains for flood resilience. Since climate resilience is broader than flood resilience the policy domains of for example mobility and housing are also involved.

As described the PAA is often applied to analyse and map the patterns of change and stability within policy domains in environmental studies. However, this research will use the PAA theory to provide a research outline of the most important factors impacting climate resilience policy. Thus, the

PAA is used as an analytic tool that helps to map and describe the four elements of the PA among the three resilience dimensions for the city of Jakarta and Rotterdam.

2.4. Conceptual model

The conceptual model visualised in Figure 5 represents the research process of this thesis based on the theoretical concepts, which are elaborated on previously in this chapter. In this paragraph the conceptual model will be explained phase by phase, and are denoted by the letters A to D. The first phase of the model (A) is the disruptions of climate change. These are the main driver for this research because they affect the city of Jakarta and Rotterdam, its assets, and all citizens. In the second phase of the model (B) relates to the social-ecological resilience. If the cities want to address these climate change disruptions, they need to become social-ecological resilient. The third phase (C) characterizes the theoretical concept of social-ecological resilience into the three dimensions ‘robustness’, ‘adaptability’, and ‘transformability’ (Folke, 2006). For each city all three dimensions are researched considering the four elements of the PAA ‘actors’, ‘resources’, ‘rules’, and ‘discourse’(Lieverink, 2006). This research examines the PAA of the three resilience dimensions in order to find out to what extent the resilience dimensions are integrated for the specific cities and how they relate to each other. Based on the two separate analyses of the resilience of both cities, the last phase (D) provides an overview of the balance of the three resilience dimensions in the cities and identifies their interlinked relationships leading to cross-overs and trade-offs.

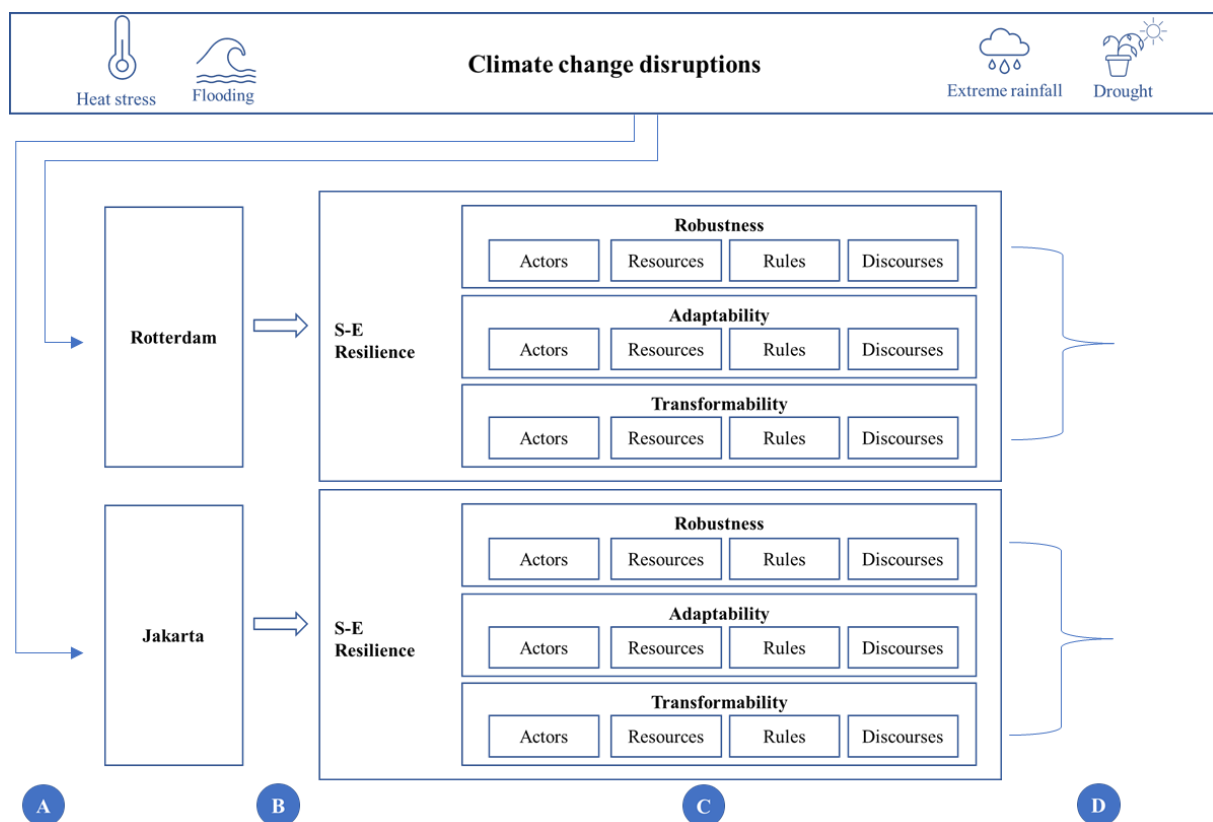


Figure 5: Conceptual model (created by author with content of Folke, 2006; Liefferink, 2006)

2.5. Operationalisation

In order to study the theoretical concepts of the conceptual model, an operationalisation step is needed. The operationalisation is the transition from the theory into the empirical research abilities. In essence, a process which will translate the abstract theoretical concepts into researchable variables. This enables data collection and analysis on the concepts that are not directly observable (Van Thiel, 2014). According to Van Thiel (2014), the first step of operationalisation is formulating a definition of the theoretical concepts. This is already provided in the previous sections of this chapter. Therefore, this section will focus on the determination and visualization of the operationalisation of the theoretical concepts into measurable variables (Van Thiel, 2014).

2.5.1. Social-ecological resilience

As discussed earlier on in this chapter, social-ecological resilience can be defined regarding the three dimensions robustness, adaptability and transformability. These three dimensions are operationalised into evaluable variables of which a complete overview is visualised in Figure 6.

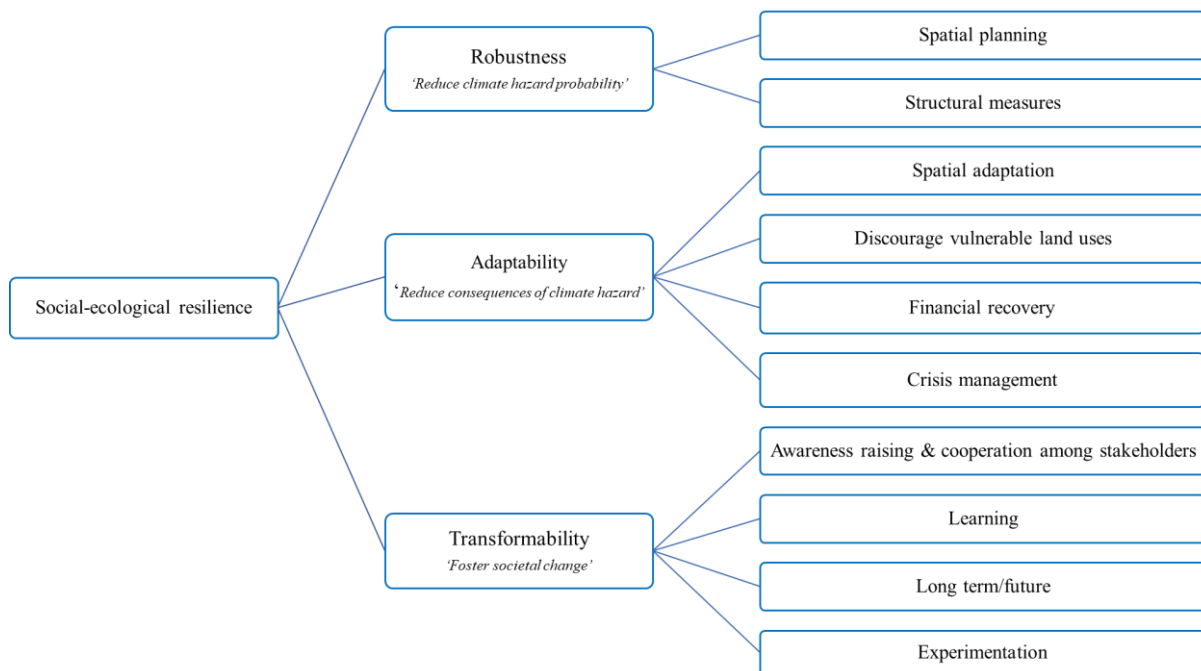


Figure 6: Operationalisation social-ecological resilience (created by author with content of Torabi, Dedekorkut-Howes & Howes, 2021; Restemeyer, Woltjer & van den Brink, 2015)

Robustness

The Robustness of a city is based on its ability to resist climate hazards. Therefore, the robustness measures aim to reduce the climate hazards probability. For this research, measures contributing to a city's robustness are divided into two variables. Firstly, building and maintaining structural measures such as, dikes, sluices, storm surge barriers, and sand nourishment (Restemeyer et al, 2015; Torabi, Dedekorkut-Howes & Howes, 2021). Secondly, spatial planning can add to a city its robustness through, for example, making room for the river by planning measures such as river widening. The structural



infrastructural works and spatial planning can prevent climate hazards such as floods and droughts from happening (Restemeyer et al, 2015; Torabi et al., 2021).

Adaptability

Due to the accelerating impact of climate change, just being robust to combat climate hazards is not enough anymore. Eventually there will always be events that overtop the first line of robust protection, therefore, adaptability is crucial in becoming climate resilient (Restemeyer et al., 2015). The adaptability of a city is based on its capacity to reduce the consequences of climate hazards. This means that the city should be adjusted to a state in which climate hazards may occur without leaving substantial damage to the city (Restemeyer et al., 2015). For this purpose, four adaptability variables are defined within this research. First, spatial adaption in a form of climate proofing existing and new infrastructure and buildings. This can be achieved, for example, greenery in private and public spaces, reducing impervious surfaces, and elevating houses and vital infrastructure (Restemeyer et al., 2015; Torabi et al., 2021). Second, discouraging vulnerable land uses, which means that it can be made unattractive to practice land use or settle at spots that are more vulnerable. This can especially be taken into account considering new housing or other land uses (Restemeyer et al., 2015; Torabi et al., 2021). Third, crisis management measures, such as warning systems and evacuation schemes, can reduce the consequences of the climate hazard. If a cities inhabitants are warned early for the different climate hazards and provided with information on what to do so the impact can be reduced (Restemeyer et al., 2015). Lastly, financial recovery resources in form of for instance, climate hazard insurances and recovery funds can help with a quick recovery and reduce the financial consequences of climate hazards (Restemeyer et al., 2015).

Transformability

Adapting to climate hazards will ‘allow’ these hazards to occur without leaving significant damage. When possible climate hazards do occur, also a societal change is needed. Therefore, transformability is a crucial factor in becoming a climate resilient city (Restemeyer et al., 2015). A cities transformability can be interpreted as the capacity of a city to foster societal change. This implies a societal shift in people their behaviour and mind-set regarding climate hazards. This is a necessary precondition for the physical transformation of a city to become social-ecological resilient. An example of the desirable shift in mind-set is from ‘fighting the climate hazards’ to ‘living with climate hazards’ (Restemeyer et al., 2015). For this research four variables are identified to operationalise the transformability. The first variable is the awareness on the climate hazards and cooperation on combating this among stakeholders, including citizens and the vulnerable groups. Through this, stakeholders can be empowered to share the responsibility and tasks regarding climate hazard management instead of a purely public task. Moreover, citizens that are well aware are less likely to be affected by a climate hazard. This can be achieved through measures such as public campaigns and education in schools (Restemeyer et al., 2015). Secondly, the ability to foster change includes learning. Learning for example can be done through looking at different areas or looking back into past years of climate events. The third variable, experimentation, adds to the ability of learning since this can create new insights (Restemeyer et al.,

2015). The last variable of transformability is long term and future thinking, including for example, room for uncertainties into decision making (Torabi et al., 2021).

2.5.2. Policy Arrangement Approach

The PAA is, as mentioned before, based on the four elements actors, resources, rules and discourses, which can be divided according to substantive and organisational aspects. These four elements will be operationalised into variables which are elaborated on below and displayed in a complete overview in Figure 7.

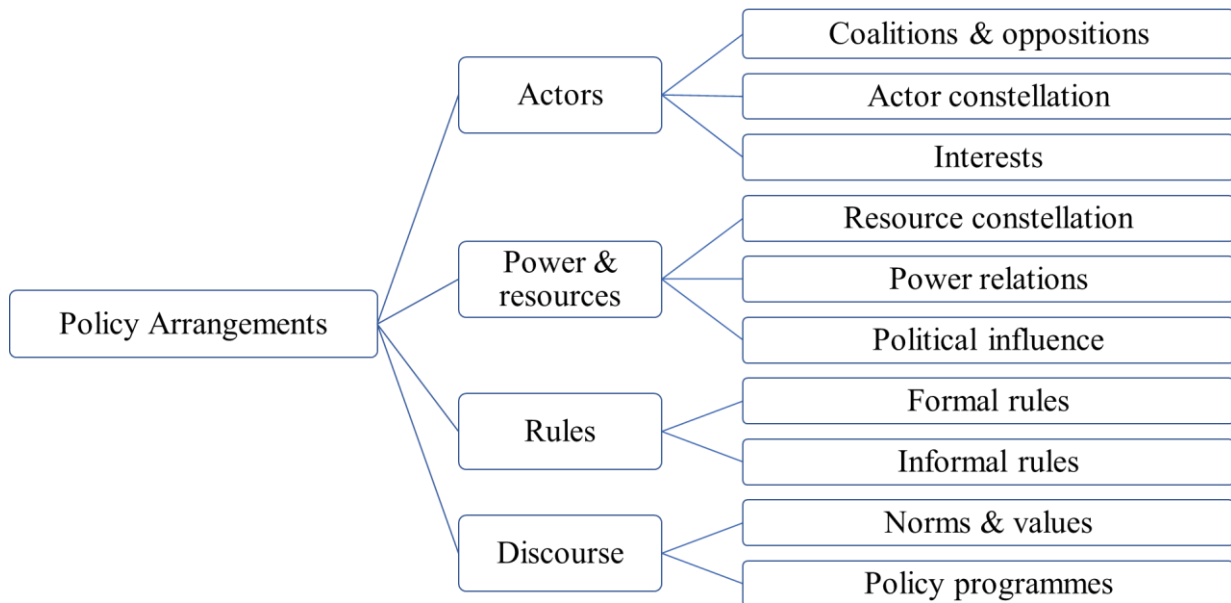


Figure 7: Operationalisation policy arrangements approach elements (created by author with content of Kaufmann, 2017; Liefferink, 2006; Wiering & Arts, 2006)

Actors & coalitions

The dimension on actors and their coalitions is the central dimension in the PAA. It is only through the actors that the other three dimensions can exist (Liefferink, 2006). The actors, including state, market and civil society actors, work with each other in a day-to-day basis either a form of ‘allies’ like coalitions or in the form of ‘enemies’ by having oppositions. Therefore not only actors but also their coalitions are central within this dimension (Liefferink, 2006; Wiering & Arts, 2006). For this research, coalitions regarding the different resilience dimensions are taken into account that cooperate for policy development and implementation works. The actors dimension is often a starting point of many studies looking into policy arrangements to determine who is involved in the specific policy area in the different stages such as agenda-setting, decision making, and execution, which is named the actors constellation (Liefferink, 2006; Wiering & Arts, 2006). Furthermore, the actor interests and the relations with each other within the coalitions can be observed (Liefferink, 2006; Wiering & Arts, 2006). Taken all the above mentioned into consideration the following variables are addressed in the actor dimension for this research: coalitions & oppositions, actor constellation and interaction patterns (Wiering & Arts, 2006)



Resources and power

The policy arrangement division of resources and power has a starting point of the division of resources among the actors. The division of resources will provide insight and will lead to differences in the power and influence position of actors (Lieverink, 2006). According to Liefferink (2006) power refers to the mobilisation and distribution of the available assets of actors. For this research that includes resources such as finances, knowledge, expertise, and land. Influence refers to who determines policy outcomes and how, which is related to the resource constellation and can be determined by for example the power relations and the political influence, for example, including the dynamics of the national and local politics (Kaufmann, 2017; Liefferink, 2006; Wiering & Arts, 2006). Taken all this into account, the variables for the resource dimension are resource constellation, power relations, and political influence

Rules of the game

The third dimension of the policy arrangements is the dimension of rules. Liefferink (2006, p.56) defines rules as “*the mutually agreed formal procedures and informal routines of interaction within institutions*”. The formal procedures are referring to legislation and regulations which can for example be about decision making and implementation, being substantive in nature. Regarding this research, formal rules include for instance, the resilience related laws, regulations, and standards, as well as the different resilience plans and approaches developed on the different administrative levels. The informal rules of the game include the ‘routines’ of interaction and the political culture within institutions, being organisational of nature. For this research this includes for example the maintenance routines and the culture towards this (Kaufmann, 2017; Liefferink, 2006; Wiering & Arts, 2006). Therefore, the dimension of rules of the game is operationalised into two variables: the formal and the informal rules.

Discourse

The discourse dimension is referring to the substantial aspects of policies. According to Liefferink (2006), discourses entail the views and narratives of the actors involved. The discourses of actors can be divided into two different levels. First, the discourses are influenced by the general and normative ideas that actors have about society, their fundamental values, and ideals, that may have an impact on specific other policy arrangements such as the rules. For instance, in this research this includes the acceptance of the occurrence of climate hazards. This level of discourse can be translated into a variable of norms and values (Lieverink, 2006). Second, the discourses dimension concerns ideas and what we conceive as desirable and feasible about the concrete policy topic at stake and its problems and solutions, which can be translated into the viable policy programmes, and for example indicates the vision on how to act regards climate hazards. Discourses at this level imply a substantive strategic position of actors in the policy arrangement. These two levels of discourses can be summarized through the variables norms and values, and policy programmes (Wiering & Arts, 2006).

3. Methodology

This chapter provides the research philosophy and an elaboration on overall research strategy, followed by a description of the case selection for the research. Hereafter, the research methods for data collection and the data analysis are presented. Finally, this chapter provides the research validity and reliability.

3.1. Research philosophy

The research philosophy is about the beliefs on how the research data is obtained and used and also it determines and guides the actions of the researcher (Saunders, Lewis & Thornhill, 2019). According to Moon and Blackman (2014), the philosophy provides general principles of theoretical thinking which is used to obtain the knowledge of reality. They identify three fundamental elements of a research philosophy, which are the ontology, epistemology, and philosophy paradigms.

Ontology is described as “*what exists in the human world that we can acquire knowledge about*” (Moon & Blackman, 2014, p. 1169), varying from one existing reality, known as realism, to the existence of multiple realities, named relativism (Moon & Blackman, 2014). This research has a ‘critical realism’ ontology, meaning that there is one reality assumed to exist. However, the reality might change, is based on assumptions, and is too complex, therefore can never be understood perfectly (Guba & Lincoln, 1994). This applies to this research on building resilience towards climate change since resilience, as well as climate change, are considered to have one reality. Nonetheless, the one reality of these phenomena is critical since the ability to fully understand the complexity of the changing climate and all its uncertainties in the future is imperfect (Guba & Lincoln, 1994).

Epistemology refers to the question of how knowledge is created, providing a spectrum from meaning derived from the object, the subject, or the interplay between those (Moon and Blackman, 2014). A modified dualist ‘objectivist’ epistemology is applicable for this research, because knowledge is acquired without subjectivity of the researcher (Guba & Lincoln, 1994; Moon & Blackman, 2014). The data gathering and analysis from the research methods is accomplished in a neutral way. The objectivist view allows to generalize the findings of the case of Jakarta and Rotterdam and enables the exchange of lessons to become more resilient (Guba & Lincoln, 1994). However, objectivity is difficult to guarantee in reality. The findings are therefore based on probability, which is supported by the broad and diverse data collection through triangulation.

The philosophical paradigm of the researcher guides their actions forming the research due to a set of assumptions. Guba and Lincoln (1994) have identified four paradigms identified based on the ontological and epistemological views of the researcher. The four philosophical paradigms are positivism, post-positivism, critical theory and constructivism. The critical realism ontology and the objectivist epistemology have led this research to a ‘post-positivism’ philosophy paradigm. This paradigm has resulted in the conduction of multiple methods in order to create valid and objective outcomes on the cases providing one assumed reality (Moon and Blackman, 2014).



3.2. Research strategy

The research strategy is a central element in designing the research and provides a logical overview of the procedure used in order to answer the research question (Van Thiel, 2014). The research question: *How are the climate resilience dimensions integrated in the governance of Jakarta and Rotterdam reflecting the policy arrangements, in order to identify the resilience balance?* was answered by using a deductive research approach. A deductive approach means that the research is guided by the prior theory. Existing general theory is the starting point of a research and applied to a specific phenomenon in order to create a conclusion (Creswell & Poth, 2018; Ritchie & Lewis, 2003). This research moves from the theory on resilience and the PAA to the particular cases of Jakarta and Rotterdam. Besides a deductive approach, the research strategy is based on the methodological choice of qualitative research. A qualitative approach is concerned with understanding and meaning while creating in-depth contextual interpretive analysis (Ritchie & Lewis, 2003). This approach is most suitable for this case study research since an in depth understanding of the specific cases was needed to find an answer to the research question.

To further specify the research procedure, a specific research strategy was selected. Van Thiel (2014), distinguishes the four main strategies of experiment, survey, case study and desk research, all having their own characteristics. For this research the case study strategy was chosen as the best fit. A case study is an empirical research that investigates a phenomenon in depth and within its real-life context (Yin, 2014). A case study is suitable for this research due to the ‘how’ research question focussing on social-ecological resilience in cities and its policy arrangements, a phenomenon in real-life context. To be more precise a multiple case study is most appropriate for this research studying two cases, because two cases can still be studied in-depth while also making the findings more robust and general applicable (Yin, 2014). It is important to notice that it is not a comparable case study in which the results are compared. This study has two separate cases of which only the conclusions are placed side by side.

3.3. Case selection

Van Thiel (2014) describes two options to select cases for a multiple case study research. It is either possible to select heterogenous cases, i.e., contrasting characteristics of the cases, or choose homogenous cases, i.e., equivalent types of cases. For this research the city of Rotterdam located in the Netherlands and the city of Jakarta located in Indonesia were selected. A heterogenous design is the basis, since this research aims to provide the learnings on resilience of the cities under different urban macro conditions, such as the political, economic, social, and legal elements. However, the cases selected for this research also contain the homogenous element based on the environmental context, in which both cases have to a certain extent similar climate change challenges.

Besides the theoretical arguments for the selection of these cases, practical issues also plea for the selected cases. The involvement of practical issues such as the sufficient access to data within the case



selections nearly always play a role due to different reasons (Van Thiel, 2014; Yin, 2014). By selecting Rotterdam and Jakarta as cases for the research, respondents were within the network of the hosting research organisation, the Ministry of Infrastructure and Water Management.

3.4. Research methods for data collection

Case study research relies on multiple sources for data collection in order to provide in-depth findings on the cases. To provide in-dept findings, qualitative research methods are most suitable (Yin, 2014). The primary methods used in this research were semi-structured interviews and document analysis, which were strengthened by observations. The application of these research methods is discussed in the paragraphs below.

3.4.1. Semi-structured interviews

Interviews in qualitative research can be categorised into unstructured and semi-structured interviews (Bryman, 2012). This research conducted semi-structured interviews, which are interviews that are guided by a prepared interview guide, including specific topics. However, the interview guide is not a script but a roadmap to lead the conversation with flexibility for the interviewee as well the interviewer. The flexibility within the interview helps to obtain more in-depth information, while still discussing predetermined research topics. This is an advantage of this form of data collection and fits this research (Van Thiel, 2014). In order to select interviewees for the research, different sampling strategies can be applied. The strategy sample used to determine the interviewees for this research is maximum variation. The strategy of maximum variation is based on a wide range of different respondents being interviewed (Creswell & Poth 2018). This creates a broad perspective of in-depth information on the cases and is therefore most suitable for this case study. The respondent selection based on their valuable relation to the research topic are displayed in Appendix 1. The interviews were conducted either face-to-face or online and recorded if permission was granted. Two interviews were not recorded due to practical or privacy matters. During these interviews detailed notes were made.

3.4.2. Document analysis

Desk research was conducted in order to enable a document analysis, which is the other main method of data collection for this research. This method extracts the information from existing data sources that have been produced for a different purpose than research (e.g. policy documents, media output, annual reports) (Van Thiel, 2014). The developed knowledge of the interviews is supplemented by documents in order to generate a cross-check of the findings. The use of multiple methods to gain qualitative data helps to create a comprehensive in-dept understanding and is named triangulation (Bryman, 2012). Furthermore, a document analysis was necessary for this research due to its interest in the cases their resilience and its policy arrangement. The main documents that were analysed are shown in Table 2.

Table 2: Overview of documents analysed for research

Jakarta
<ul style="list-style-type: none">• Jakarta Climate Action plan• Draft report trilateral working group: Integrated Flood Safety Plan• Presentation slides New Capital Authority: Sustainable Smart Forest City• Tebet eco garden: Connecting People with Nature
Rotterdam
<ul style="list-style-type: none">• Nationale klimaatadaptatie strategy (2016)• Delta programma 2022• Weerkrachtig Zuid-Holland• Resilience strategy Rotterdam• Klimaatopgaven in Kaart Rotterdams WeerWoord

3.4.3. Observations

Observations are a convenient research method for a case study, because a real-world setting of the cases is being researched. Data collection through observations is useful in gathering additional information about the research topic (Yin, 2014). Observations are divided into two types, which are direct and participating observations. Within direct observations the researcher has merely a passive observing role towards the real-world situation, whereas with participating observations the researcher has a role in the real-world situation and may actually participate in it (Yin, 2014). This research applied a direct observation in a formal setting for the case of Rotterdam. The symposium of the ‘Rotterdam’s WeerWoord’, the climate adaptation organization of the Municipality of Rotterdam, was observed. During this symposium there were presentations and a panel discussion on the climate proofing of the city of Rotterdam. In order to collect data from the symposium detailed notes were made during the panel discussion, because it was not possible to record the discussion due to practical reasons and the lack of opportunity to ask for permission. These detailed notes are as close to a transcript as possible, meaning that the minutes made were noted as verbatim as possible including referring to the person that made the comment. Additionally, a direct observation in the form of a field visit by the researcher was done to visit certain resilience dimensions examples in the city. For instance the Rotterdamse Rooftop Walk during the ‘Daken Dagen’ which guides its visitors over rooftops while sharing knowledge on, among other things, resilient options. In order to capture the data notes and pictures were taken. Furthermore, this research applied participating observations in a less formal setting thought field visit in Jakarta. In Jakarta three observation in the form of a field trip were done: field trip along the coastline of Jakarta, a field trip through the Tangerang river basin which has the same challenges but less traffic, and a field trip to the Eco Tebet Park a river naturalization project. The field trips were guided by experts in the field and the researcher had the opportunity to ask questions. The data collected for these observation were recorded through photographs at the field sites and notes made in a preorganized scheme according to the operationalization. The photograph helped to convey important case characteristics (Yin, 2014). These photographs were made either without people in them or with permission to conduct ethical research.

3.5. Data analysis

3.5.1. Semi-structured interviews

In order to analyse the information from the conducted semi-structured interviews, the recordings were transcribed. The transcribing was done in a verbatim way, meaning that the transcripts are completely the same as the recording, including moments of silence, stuttering, and grammar mistakes. Due to this type of transcribing the chance to miss important emphasises is minimized (Hebburn & Bolden, 2017).

The transcripts or notes of the interviews were coded in a programme named Atlas.ti. An abductive coding strategy was applied, which is a combination of inductive and deductive coding. This strategy was chosen because the theories stay included while remaining open to surprises (Linneberg & Korsgaard, 2019; Saldaña, 2021). Deductive coding was the basis of the coding strategy, using a preconceived list of codes based on the concepts of the theory, to label the transcripts and be able to link the data to the theory (Linneberg & Korsgaard, 2019). However, to not miss out on any important information, the deductive coding was supplemented with inductive coding. Inductive coding implies that codes will emerge during the coding process based on information in the transcript (Linneberg & Korsgaard, 2019). The inductive coding process was divided into two cycles. The first cycle, also known as open-coding was based on descriptive or in-vivo coding in order to filter segments of data, besides the deductive coded text. The second cycle of coding was meant to group the first cycle codes into categories or themes and used a focused coding strategy which aims to find thematic and conceptual similarity. The codes of the second cycle of coding were diffused or added to the deductive coding list (Linneberg & Korsgaard, 2019).

3.5.2. Document & observation analysis

The documents consulted for this research were first briefly scanned, while highlighting the relevant sections in order to easily find the relevant data in the document. To be able to further analyse the relevant highlighted sections of documents and the observation notes, a deductive coding approach was used in the Atlas.ti program. This deductive coding is similar to the coding list used for the semi-structured interviews, which enabled to link the collected data with the existing theory (Linneberg & Korsgaard, 2019).

3.6. Research Validity and Reliability

In order to ensure the validity and reliability of the research and its data, several decisions were made through the research process. The validity can be divided into internal and external validity of the research (Bryman, 2012; Van Thiel, 2014). Internal validity is based on the fact that the obtained data is objective and reflects reality. For this research, internal validity is strengthened by data triangulation. (Van Thiel, 2014; Yin, 2014). According to Van Thiel (2014), a high internal validity is common with case study research due to the wealth of information that will be collected from different sources. The external validity can be described as the generalization of the research, which is the aim of a post-positivism case study research. In order to be able to generalize the specific research cases, comparable



literature was analysed to find out how the case fit in the existing knowledge domain guided by theories which creates analytical generalisation. However, statistical generalisation is known as difficulty for case study research due to its specific design and findings (Van Thiel, 2014; Yin, 2013). To strengthen the external validity a clear and detailed method chapter is described and research information such as the interview guide is added in Appendix 2, in order for others to reproduce the research.

The reliability of the research is related to the ‘trustworthiness’ of the research, which is dependent on the appropriate design and conduction of the study by the researcher (Ritchie & Lewis, 2003). To improve the reliability, the whole research process has been documented, so that every step is traceable and can be reviewed (Van Thiel, 2014). This includes recordings and transcripts of the interviews and overviews of the coding files. The documenting is accessible for the reviewer of the research and all participants in order to create transparency.

4. Results Jakarta

This chapter provides the research results for the Jakarta case, starting with the case description. This is followed by three sections on the resilience dimensions: robustness, adaptability, and transformability. In these sections, each dimension is explained and then elaborated on through the PAA elements: actors, resources, rules and discourse.

4.1. Case description

City characteristics

Jakarta is the capital and largest city of Indonesia, an archipelago with more than 13.000 islands. Jakarta is labelled largest city and has a province level status officially which is official named ‘Daerah Khusus Ibukota Jakarta’, which is Bahasa Indonesian for Special Capital Region of Jakarta, and is mostly abbreviated for DKI Jakarta. The city is located on Northwest of the island of Java where it is positioned in a delta area with thirteen rivers, which discharge into the Jakarta Bay (Savirani, 2021). This sea is bordering Northern Jakarta, of which large parts are situated below sea level (DKI Jakarta, 2022-a). The Jakarta metropolis is one of world’s largest megacities. The high population numbers are the results of rapid urbanisation over the last two decades and cause an extreme high density of Jakartans per square kilometre (DKI Jakarta, 2022-a). This causes a housing challenge, which leads to large amounts of slum areas (Savirani, 2021). The city is also the economic and political heart of Indonesia. The economy is in recovery following the Covid-19 pandemic (BPS-Statistics of DKI Jakarta Province, 2022). The largest Jakarta economy contributors are the sectors wholesale and retail trade, repair of motor vehicles and motorcycles, construction, and manufacturing industry. Also Jakarta has many natural wealth sources due to the geographical conditions in the form of minerals and marine products (BPS-Statistics of DKI Jakarta Province, 2022; DKI Jakarta, 2022-a).

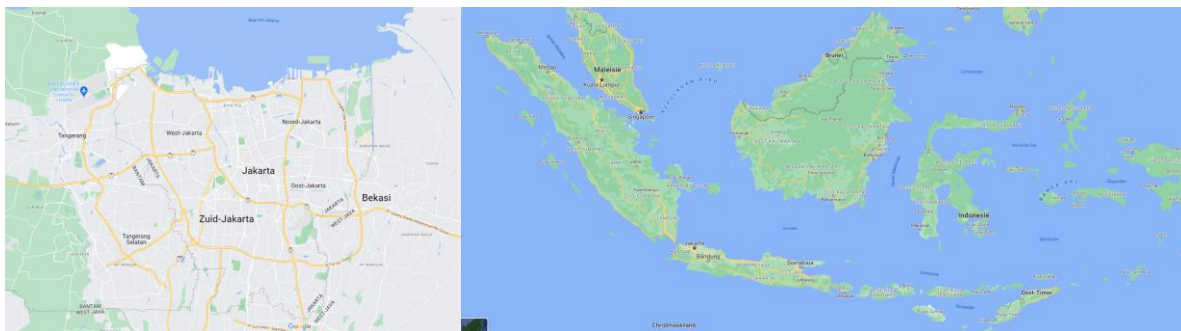


Figure 8: Location Jakarta (Google maps, 2022)

Table 2: City characteristics Jakarta (DKI Jakarta, 2022-a; BPS-Statistics of DKI Jakarta Province, 2022; The World Bank, 2021)

Physical	
Coastline	35 km
Total land surface	660 sq km
Social	
Population	10,5 million citizens
Population density	15.900 citizens per sq km
Economic	
GDP	120.7 billion euro's
GDP per capita	11,50 euro
Gini ratio	37,3

Climate challenges and impacts

Jakarta has a tropical monsoon climate, which means it is hot throughout the year during day and night, and having drier season and wet season. The wet season is from November to May with high peaks of precipitation and high air humidity (DKI Jakarta, 2022-a). However, the climate is changing and under business-as-usual scenarios, the impact on Jakarta's inhabitants and environment will be disastrous. On top of the tropical heat, an increase in average temperatures and peak temperatures are expected, contributing to the urban heat island effect. This will negatively influence the air and water quality and affect the health of the vulnerable inhabitants (DKI Jakarta, 2021; Green climate fund, 2021). Furthermore, the precipitation patterns are changing, resulting in increasing periods of droughts. Extended periods of drought will also negatively affect the water quality but the quantity as well. It will have a major impact on the already stressed fresh water supply in Jakarta, contributing to the dropping ground water levels and therewith land subsidence. This will cause damage to infrastructure and buildings (DKI Jakarta, 2021; Ministry of National Development Planning, 2019). Another effect of the changing precipitation patterns is the increase in the intensity and frequency of extreme of rainfall, which is also expected in the coming years. The current Jakarta drainage system is not able to cope with these events, causing pluvial floods. To make things worse, it will lead to higher water levels in the rivers, resulting into to more frequent fluvial floods including all the associated damaging consequences (DKI Jakarta, 2021; Green climate fund, 2021). Additionally, there is an increasing threat of coastal flooding due to sea level rise. Jakarta is expected to face a sea level rise of 1 centimetre per year. The threats of climate change in Jakarta are strengthened by anthropogenic drivers. Excessive groundwater extraction leading to land subsidence that ranges along the coastline from 1-20 centimetre per year causing an even larger relative sea level rise (DKI Jakarta, 2021). By the year 2050, an even bigger part of DKI Jakarta will be situated below sea level and without coastal flood defences, the city will flood more frequently. Without further development, some areas will even become permanently flooded. Due to the relative sea level rise, the discharge of the rivers into the sea will become more difficult and can lead to more

fluvial floods (DKI Jakarta, 2021; Savirani, 2021). The different types of flood cause damage to houses, infrastructure and assets, while also putting the economy on halt. In addition, the water quality and public health will decrease while the transmission of water and vector borne diseases will increase. The coastal floods will cause more saline intrusion affecting the food availability. Climate change impacts will affect vulnerable Jakartans the most, recognizing that they are often located in slum areas which mostly are in flood prone areas, causing climate injustice (DKI Jakarta, 2021; Van Voorst, 2015).

Administrative structure

The administrative structure of Indonesia is a three-tier system. The three-tier government generally consist of: national government, provinces, and municipalities. In addition, there are also several regional administrative bodies. Due to the size of Jakarta, the city has a provincial status. After decentralisation different tasks and responsibilities also the climate resilience have been divided among the governmental bodies. Currently this division remains unclear (Ward et al., 2012). The division in responsibilities and its obstructions will be elaborated on during this chapter.

4.2. Robustness

The ability of Jakarta to reduce the probability of climate hazards is often described as “critical”, “bad quality” or “not present” by many interviewees. Frequent floods proof that the current system in place is not capable of keeping the water away and prevent flooding. The current system is designed to discharge the water as fast as possible which causes problems downstream (Interview Wierix, 2022). Efforts made are often as response to previous flood events and there is no structural or fundamental approach at all (Interview Coenen, 2022). However, efforts regarding a robust system in different forms are in place or in process, since there is an increasing consciousness about the need.

Structural measures

There are flood defence infrastructures located along the coast and rivers. Nevertheless, observations have shown that coastal and river dikes are inconsistent in many ways, which does not benefit the robustness of the system. Different heights, designs and non-contiguous locations of concrete dikes are located, including seepage, broken or no dike structure at all (Observation coastline Jakarta, 2022). Also, in one dike section five different heights can occur easily, since the calculations were performed by different people with different principles. There are some safety standards, which are not very high due to the focus on cost-benefit analysis (Interview Coenen, 2022). There is an awareness about the need for a robust flood defence system, hence efforts are ongoing to design a plan to build a robust system. The most recent project for coastal protection was the National Capital Integrated Coastal Development II (NCICD II), by a trilateral working group of Indonesia, Korea, and the Netherlands that prepared a Integrated Flood Safety Plan (IFSP) to reduce flood vulnerability and increase the robustness (Minkman, Letitre & van Buuren, 2018). The plan consists of three stages, of which the first focusses on the reinforcement of approximately 62.6 kilometre of coastal and 57,6 river estuary dikes. In recent years, progress has been booked along certain dike sections. However, 46,2 kilometres of dike sections remain

critical of which 33,2 kilometres are not constructed yet. Visual impressions of the coastal defence are provided in Appendix 3. An agreement has been made to finalize these unconstructed sections in public area before 2025 (Trilateral working group NCICD II, 2021; Observation coastline Jakarta, 2022). When dike areas are newly constructed, maintenance is lacking, especially in the first few years it is neglected. The vertical walls constructed dikes have to be as budget friendly and functional as possible. Additional functions are not included in the design. This results in coastal communities adjusting the dikes themselves by adding stairs and scaffolding (Interview Coenen, 2022; Observation coastline Jakarta, 2022).

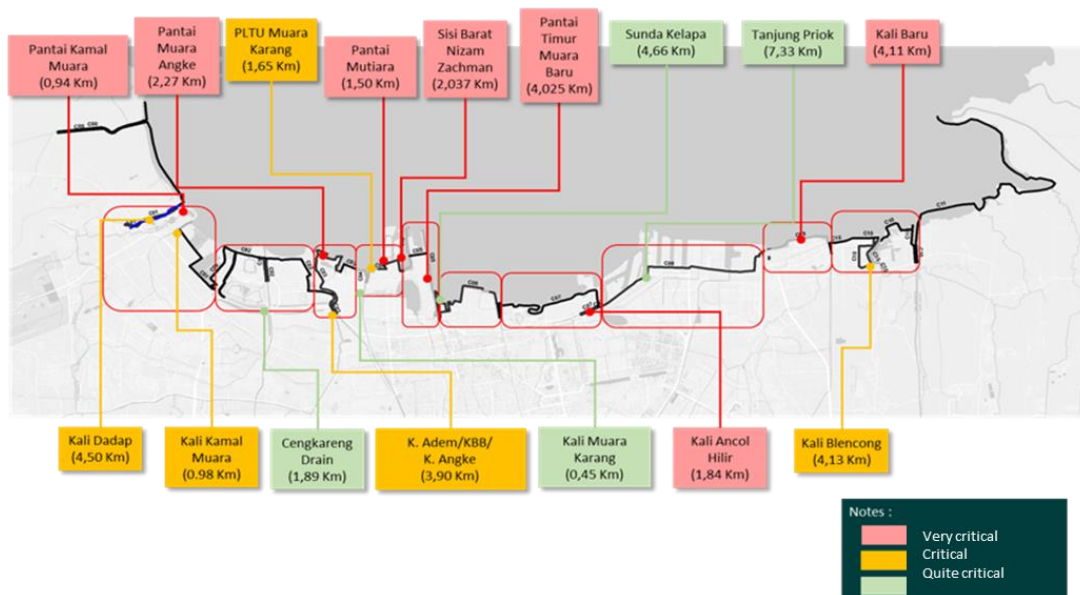


Figure 9: Status coastal dike infrastructure Jakarta (trilateral working group NCICD, personal communication, 2022)

Currently, the IFSP remains a draft and waits for the nomination to an official status, due to political reasons. Recently, no large floods occurred which does not provide a sense of urgency for the plan (Interview Ahmad, 2022; Interview Coenen, 2022; Interview Letitre, 2022; Interview van der Wiele, 2022). In this process, the history of the former plans remains a challenge, making it a very sensitive topic (Interview Ahmad, 2022; Interview Wierix, 2022). Therefore, the integrative plan is important and needs to include social and ecological aspects (Observation coastline Jakarta, 2022). In addition to the dike system, there are polder systems with pumping units in place. The polders and its water drainage system are needed in Northern Jakarta to prevent floods from rainfall since the area is located below sea level. Currently, there are some pump systems with reservoirs in place, for example, at 'Waduk Pluit' (Observation coastline

NCICD II flood safety strategy consists out of three stages. Stage A) aims at immediate strengthening of the current coastal and river mouth protection as no-regret short term measures. Stage B) consist of an open outer sea dike protecting the West region of Jakarta against flooding from storm and high sea levels. Stage C) consist of an outer sea dike protection the East region of Jakarta Bay. NCICD II is also linked to the controversial construction of seventeen artificial island in Jakarta Bay, known as land reclamation project (Trilateral working group NCICD II, 2021).

Jakarta, 2022). Nevertheless, the current pumping, retention basins and drainage capacity is not sufficient to prevent floods at times of extreme rainfall events. Therefore, stage A of the NCICDII strategy also suggests installing additional pumping stations (Trilateral working group NCICD II, 2021). In addition to the coastal flood defence structures, the thirteen rivers also have their own flood defence system. However, only one third of the system is developed and works properly (green area in Figure 10), another one third of the system is developed but remains having some flood threats (yellow area in Figure 10), and the last one third of the river system is not developed yet (red area in Figure 10) (Interview Ningrum, 2022).



Figure 10: Development river system Jakarta (DSDA-DKI Jakarta, personal communication, 2022)

The drainage capacity in form of a sewage system is also very limited. About 90% of domestic wastewater flows directly into surface waterbodies and groundwater (Trilateral working group NCICD II, 2021). In order for a robust system to work as planned there are certain preconditions. First of all, the land subsidence needs to slow down and thus, water supply by deep groundwater extraction needs to be stopped. Efforts are ongoing for an improvement of water quality and piped water supply (Interview Tarigan, 2022). This is essential to prevent subsidence of dike structures and an increase of the flood risk for more areas (Trilateral working group NCICD II, 2021). However, stopping ground water extraction is very challenging (Interview Ahmad, 2022). Furthermore, maintenance of the current dike structures as well as retention basins is needed. The basins and rivers need to be dredged and kept at the right water level in order to maintain the storage capacity before the rain season. Despite the positive efforts, the outcome is not enough for the large and highly populated system (Interview Wierix, 2022; Observation coastline Jakarta, 2022; Observation river basin Tangerang, 2022). In terms of river normalisation, the Jakarta government dredged and installed sheet piles along parts of one of their rivers in 2016. This had large social consequences, since large numbers of poor communities along the river

banks were forced into evictions and relocating for example, to low-cost rental apartment buildings. This caused fierce resistance in many areas since the relocation in many cases was too far away from their earlier homes, forcing them into new livelihoods (Savirani, 2021). Despite the consequences and resistance the river normalisation was preserved. However, the current Governor has promised to discontinue in order to prevent social unrest (Interview Coenen, 2022). The urban drainage system in Jakarta is in urgent need of maintenance since it is currently suffering blockage caused by waste and backwater issues from subsidence and sea level rise (DKI Jakarta, 2021).

Spatial planning

In terms of river naturalisation, the first examples are arising to control the floods. Especially upstream of the river basins, where more nature-based solutions are being integrated, instead of hard infrastructure (Interview Ningrum, 2022). An example is the ‘Eco Tebet Park’ which is recently developed at the river banks. The concrete embankments along the river have been replaced with nature-based and water permeable materials. Also the park can be used flooded at times of heavy rainfall or during high river discharge. (Observation Eco Tebet Park, 2022; Interview Tarigan, 2022; DKI Jakarta, 2022-b). Approximately 140 nature-based storage systems along the rivers will be developed, starting this year. These are some first efforts that change the system from just fast discharge, into delaying discharge by water retention. The need for this approach has been initiated however, the completion remains challenging (Interview Wierix, 2022) Similarly to river normalisation these developments will lead to forced evictions of poor communities, with all that entails. (Interview Nigrum, 2022). Another nature-based approach to build a robust system is mangroves, which are native species. However, mangroves cannot provide a solution for the coastal problems of Jakarta due to major height difference of the coast, and the sea and the dense population along the coast. The mangroves in place are mostly for tourism and ecological purposes (Interview Coenen, 2022; Interview Wierix; Observation river basin Tangerang, 2022). Although, environmental preservation including mangrove forests is provided as one of the directions of the coastal development (Observation coastline Jakarta, 2022). All measures taken towards a robust system are with regards to ‘keep the water away’ and do not include any other climate threats.



Figure 11: Eco Tebet Park (by author, 2022)



Figure 12: Illegal housing along the riverbanks of Jakarta (Trilateral working group NCICD, personal communication, 2022)

4.2.1. Policy arrangements robustness

The policy arrangement elements regarding the dimension of robustness are shown in Table 4 and further elaborated per element in the text below.

Table 4: Overview policy arrangements robustness Jakarta (based on in text sources)

PA	What	Elaboration
Actors	• Ministry of PUPR	• Responsible for part of the coastal defence structures
	• Other ministries	• Consolation partners for coastal defence structures
	• DKI Jakarta	• Responsible for part of the coastal defence structures & robust river basin
Resources	• Private actors	• Responsible for part of the coastal defence structures
	• International consortiums	• Involved for strategy and designing of coastal defence
	• Financing	• Large amounts of funding needed to create robust system which is not available directly
	• Available land	• Acquiring available land is very challenging due to scarcity
Rules	• Political power	• Political leaders have a great power to influence the robustness developments
	• Knowledge & expertise	• Capacity building has increased over years but remains needed
	• Limit rules for robust system	• Rules are based on national and provincial policy framework but limited amount of rules directly involving robustness
	• Flood standards	• Legally established standards are relative low
Discourse	• Groundwater extraction legalisation	• Development of legalisation to restrict groundwater exploitation
	• Focus of policy programmes is to keep the water out	
	• Discourse is not dominant in bigger picture	

Actors

The accountability of a robust coastal system is allocated to three main actors. The first actor is at the level of the national government, the ministry of PUPR, which is responsible for parts of the coastal dike structures. Other parts of the coastal dike structures are the responsibility of DKI Jakarta and private actors located at the coastline. These responsibilities include the construction and maintenance of the dikes (Interview Ahmad, 2022; Interview Coenen, 2022; Interview Letitre 2022; Trilateral working group NCICD II, 2021). Private actors often have their responsibilities in order to provide their clients with flood safety and damage prevention. However, an important saying in flood management is “*it is as weak as the weakest link*” (Interview de Groot, 2022). International consortiums are often deployed for the determination of strategy and design of the coastal flood defence, such as the Korean and Dutch for NCICD II. Also, coastal development is in consultation with the coordinating ministry of Maritime Affairs and Investments (Menko Maritim), the coordinating ministry of Economic Affairs (Menko Perekonomian), and the ministry of National Development Planning (Bappenas) (Trilateral working group NCICD II, 2021). The responsibilities of robust river basin in Jakarta are mainly assigned to DKI Jakarta (Interview Nigrum, 2022; Observation Eco Tebet Park, 2022). However, after the decentralisation there is still indistinctness about the responsibilities (Interview Wierix, 2022)



The divided responsibilities for the robust coastal defence system results in challenges forming coalitions among actors. Many interviewees state that the consultation and coordination can be classified as “*terrible*” and is challenging and complex due to the different political interest of the President and the Governor of Jakarta. The actors often only take actions for their own dike sections without coordination (Interview Coenen, 2022).

Resources

For a robust system, some main critical resources are essential. Firstly, a significant amount of structural funding is needed, which is not available and remains a challenge as stated by many interviewees. The first stage of the NCICD II strategy demands a large budget. There are financial streams coming from private actors, state budget and the local government budget. DKI Jakarta has entered into a loan agreement with an agency that offers multi-finance services for infrastructure sectors, in order to finance the coastal defence sections. However, due to the Covid-19 pandemic, financial resources are minimized and funding has become uncertain (Interview, Nigrum, 2022). Another way to secure funding is through climate or green finance sources and funds and investments of investors or foreign governments which are less depending on annual budget allocation. Suggestions for the funding of the additional stages of NCICD II, are based on generating new revenue streams, which remains challenging (Trilateral working group NCICD II, 2021). Secondly, available land is necessary to build a robust system, however, land in Jakarta is not available (Interview Booister, 2022). Acquiring land can be very complex and challenging and can have large social consequences for the poor communities and their livelihoods. Due to all complexities and challenges, political power is of extreme importance and influence in Jakarta on the topic of floods. Political power can withhold and overcomplicate developments. The Jakarta Governor is the leader of the opposition of the President (interview Coenen, 2022). The political minefield hinders the decision-making (Interview Wierix, 2022). For instance, in Semarang, with a good political relationship, a comparable study was completed and funding is available. Nevertheless, when there is political support, Jakarta can have a large realization power (Interview Letitre, 2022). Despite the minimal physical progress, after years of complex discussions, strategy thinking and designing a robust system there are merits gained in form of capacity building and knowledge and expertise development among the actors (Interview van der Wiele, 2022). However, it is also argued that policymakers often switch position within the government, which is not beneficial for knowledge and experience gained and results in lack of continuity within the organisations (Interview Coenen, 2022).

Rules

The rules in Jakarta are formed by a national and provincial policy framework, including laws, regulations and Governor and Presidential Decree’s. However, policies for a robust system are limited. There are legally established flood standards set in the Governor Decree of DKI Jakarta. Translated into international standards, the coastal dikes are accepted to flood once every 1000 years, the river dikes are allowed to flood once every 100 years, and the polder areas are accepted to flood once every 25 years. Nevertheless, the current actual safety levels do not comply with these standards (Trilateral working



group NCICD II, 2021). In addition, these standards can only be achieved when accurate and consequent calculation models are used, which did not happen for all the dikes in Jakarta in the past (Observation field visit coast Jakarta, 2022; Interview Coenen, 2022). Also, groundwater legislation is important for a robust system. Currently, many regulations are in development to limit the exploitation of groundwater, and in some areas it is completely restricted (Interview, Tarigan, 2022). However, the enforcement is problematic, which leads to illegal continuation of ground water extraction (Interview Wierix, 2022).

Discourse

The discourse on robustness in the policy programmes is focussing on keeping the water out. However, this discourse is not dominant in the bigger pictures. It lacks a ‘water culture’, due to the focus on other challenges such as traffic congestion, pollution and slum areas/informal settlements which are currently considered as more primary problems, as well as the administrative culture and organisation (Interview Booisters, 2022; Interview Coenen, 2022; Interview Wierix, 2022). The policy discourse is a response to flood events and will be acted upon after an event (Interview Coenen, 2022). The reduction of the probability of climate hazards and especially floods are part of Jakarta’s new climate strategy. However, this is classified as track three, after the crisis management and reduction of the exposure (DKI Jakarta, 2021). Furthermore, due to the scarcity of certain resources and the complexity of different (political) interests, the policy discourse is not reflected in reality. The government struggles with making this policy discourse dominant, since there is a high acceptance on flooding among the communities (Interview Nigrum, 2022). However, due to the growing prosperity, a future big flood event could boost this discourse (interview Coenen, 2022). In the coastal communities, the discourse to ‘keep the water out’ is not dominant in their values. In some cases robustness by keeping the water away is even not preferred, since this disconnects the communities in a visual and physical way from their livelihoods. Despite that, in some cases people do get a feeling of safety due to a robust system (Observation coastline Jakarta, 2022).

4.3. Adaptability

The main goal of the different adaptability forms in Jakarta is to limit the consequences of climate hazards on the economy or health and livelihoods of the people in Jakarta.

Crisis management

The first track of the climate adaption strategy focusses on crisis management in the form of preparing responses for climate hazards. Like robustness, this is focussing on the water related threats. Jakarta has and will further develop emergency response plans for before, during and after a climate disasters (DKI Jakarta, 2021). Early warning system systems are in place for the different coastal floods as well high water levels on the rivers to warn before a climate disaster. Part of this early warning system is an online system that shows live footage and water levels at different locations (Interview Nigrum, 2022). However, past floods have shown that the early warning system does not work optimally (Interview

Wierix, 2022). In addition, social media has a significant role in the warning of floods, forming its own informal warning networks. People living upstream of the rivers use their social media to inform and warn the citizens downstream about the flood risks (Interview Coenen, 2022; Interview Letitre, 2022; Interview Wierix, 2022). The crisis management in Jakarta before the disaster also includes a team of DKI Jakarta that applies last-minute no regret measures 6 hours before the expected flooding, for instance mobile pumping stations and sand bags (Interview Nigrum, 2022). Furthermore, the inhabitants themselves take the last minute no regret measures and move their furniture to a higher level (Interview Coenen, 2022). In addition, the government has a special team appointed for evacuation during a disaster that will guide people to shelters with the basic needs of life for during and after the climate disaster (DKI Jakarta, 2021). The recovery in form of evacuation is classified by interviewees as “*well organised*”, people know what to do and several locations are created for help. People have their own social network, which contributes to a good evacuation. Moreover, there are good units and with suited equipment (Interview Coenen, 2022; Interview Wierix, 2022).

Spatial adaptation

The second track of the climate adaptation strategy are spatial adaptation measures. Currently an important effort for this dimension is spatial greening, since this contributes to the impacts of the urban heat island effect and water related challenges as well as other challenges such as air quality and the liveability. Currently, only 10% of the city is green, while the city aims to increase this towards 30% (Interview Irzal, 2022). Examples such as green roofs and the ‘Eco Tebet Park’ are planned to expand on larger scale over the city due to great success (Observation field visit Eco Tebet Park). The current 10% of green in the city is barely positioned in the most flood-prone area of the city, Northern Jakarta (Interview de Groot, 2022; Observation coastline Jakarta, 2022). In these areas, different spatial adaptation examples can be found. For instance the redevelopment of ‘Kampung Aquarium’, a former slum area in a highly flood-prone area transformed into vertical housing of which the first two floors can be flooded without consequences (Interview Tarigan, 2022; Observation coastline Jakarta, 2022).



Figure 13 & 14: Kampung Aquarium before and after development (Mahadi, 2018; Sihite, 2021)

There are more examples of social vertical housing to prevent damage by floods and relocate the poor communities who were forced into eviction by robustness measures. (Interview de Groot, 2022; Observation coastline Jakarta, 2022). Also some people live in houses on stilts, floating homes, or



adjusted homes by, for instance, moving the electricity upwards in order to limit the impact of flood events (Observation coastline Jakarta, 2022). However, it is questionable if this is a result of new spatial climate adaption, since often these styles of ‘houses’ can also be described based on traditional experience. Furthermore, heat stress related housing design is integrated by tradition, there are no houses with a gabled roof (Interview Wieirx, 2022; Observation river basin Tangerang, 2022). Moreover, first developments of local water storage facilities combined with housing and vertical drainage are arising. (interview Coenen, 2022; Interview Wierix, 2022). These developments contribute to the consequences of extreme rainfall as well as periods of drought, in case the water quality is ensured (DKI Jakarta, 2021; Interview Irzal, 2022). Additional spatial adaption measures regarding drought are not happening yet (Observation Eco Tebet Park, 2022). For the heat stress, the adaption measures besides urban greening are the use of shade cloths between the streets to create shade and more comfortable wind chill. The use of air conditioning is very common to cool the tropical temperatures inside building. However, air conditioning does limit heat inside buildings but on the other hand it strengthens the effects of heat stress outside (DKI Jakarta, 2021; Interview Booisters, 2022). Many good contributions and examples in the form of spatial adaption are developing. However, to the Jakarta expansion these examples are still drops in an ocean. On top of that, the efforts are labelled as “*symbolic*” by interviewees, since the upstream areas continue building that worsens the problem (Interview Coenen, 2022; Interview de Groot, 2022; Observation river basin Tangerang, 2022).

Discouraging vulnerable land use.

Other spatial adaption decisions such as discouraging vulnerable land use are limited. As some examples already showed, at some very flood-prone areas, such as river banks, vulnerable communities have been forced into eviction, due to the decision that those areas should give room to the water and therefore are not available for housing anymore (Interview Wierix, 2022; Savirani, 2021). Continuing these actions are suggestions by the Jakarta Climate Action Plan. The plan recommends that updating of the Spatial Master plan should prevent new development areas likely to be impacted by climate hazards, as well as further relocate existing buildings and infrastructure in high risk areas (DKI Jakarta, 2021). However, the current Jakarta Governor has made an election promise not to do this (Interview Coenen, 2022). Reality shows that there are many extremely flood prone area settlements already and that the amount is increasing due to the growing urbanisation, the lack of available space and the increase of flood-prone areas (Observation coastline Jakarta, 2022; Observation river basin Tangerang, 2022).

Financial recovery

Limiting the consequences of climate hazard by the means of financial recovery are not or hardly available. Inhabitants and entrepreneurs in flood-prone areas have arranged their houses and businesses in a way that at times of a flood their financial damage is as small as possible. Often the houses that are affected by the floods do not have significant financial damage due to the low monetary value in and of their homes (Interview Coenen, 2022). However, this is becoming more difficult since the general prosperity in Jakarta is increasing and flood perspectives show that also the houses of other social classes

will become affected (Interview de Groot, 2022; Interview Wierix, 2022). Due to the frequent occurrence of floods there will be limited insurance actors that are willing to insure the risks. The government does also not provide any financial compensation (Interview Letitre, 2022).

4.3.1. Policy arrangements adaptability

The policy arrangement elements regarding the adaptability dimension are shown in Table 5 and further elaborated per element in the text below.

Table 5: Overview policy arrangements adaptability Jakarta (based on in text sources)

PA	What	Elaboration
Actors	• DKI Jakarta	• Leading in crisis management & spatial adaption in public areas
	• Regional Disaster Management Agency	• Crisis management agency within DKI Jakarta
	• Water Resource Agency	• Supporting agency for crisis management and spatial adaption
Resources	• National Disaster Management Agency	• National crisis management agency consulting regional agency
	• National government	• Different ministries and agencies consultation and cooperating regarding spatial adaption
	• Local governments	• Consultation and cooperating regarding spatial adaption
	• Citizens	• Very active regarding crisis management and spatial adaption
	• Human capital	• Large amount of personnel for crisis management activities
	• Equipment	• Good equipment available for crisis management activities
	• Finances	• Governmental annual budget for infrastructure and spatial adaption & investments of private parties & grants
	• Available land	• Scarce but needed for spatial adaption measures
	• Political power	• Governor has power to make or break adaptability efforts and allocate other resource
	• Knowledge & expertise	• Need for capacity building
Rules	• National policy framework	• Overarching and influencing regional policies on adaptability
	• Provincial policy framework	• Regional policies on spatial adaption
	• Climate Action Plan	• National guideline for climate adaption
	• Disaster Risk Appraisal 2016	• National guideline for crisis management
	• Crisis management response plans	• Local plans with procedures during crisis situations
	• Detailed Spatial Masterplan	• Regional plan guiding for spatial adaption
	• Regional Long-Term Development Plan & Regional Medium-Term Development Plan	• Regional plans guiding spatial adaption on long and mid-term development
Discourse	• Adaptability is the dominant discourse	
	• Limit impact of climate hazard due to actions during the hazards	
	• Tolerance of occurrence of climate hazards	
	• Adaptability based on abilities of citizens	

Actors

Due to the broad range of different adaptability facets, many different actors are involved. Regarding the different stages of crisis management, the government of DKI Jakarta is in the lead. Within the DKI Jakarta the Regional Disaster Management Agency (BPBD) is prominent, supported by different provincial agencies such as the Water Resource Agency (DSDA), and in consultation with the National Disaster Management Agency (BNPB) (DKI Jakarta, 2021; Interview Nigrum, 2022). Social media does also have an important influence on the early warning of climate disasters. Therefore, citizens posting on social media also have a significant role (Interview Coenen, 2022; Interview Wierix, 2022). For the



spatial adaption responsibilities a broader division among actors exists. There are many ministries and departments involved in climate related topics and actions (Interview Wierix, 2022). The greening, vertical housing and land use planning is accounted for at different provincial government bodies, such as planning, water and city parks. This is also in consultation and cooperation with national government bodies and more local governments, such as the Jakarta districts (Kecamatan) (DKI Jakarta, 2021; DKI Jakarta, 2022-b; Interview Irzal, 2022; Observation Eco Tebet Park, 2022). Regarding other spatial adaptation measures on building level, the citizens and private actors are leading. All interviewees describe the *citizens* of Jakarta as very adaptive, due to their climate hazards preparations, their calm continuing acting at time of the climate hazard and quick recovery after a climate hazard, to remain thriving in their livelihoods, without large reliance and expectations by the government.

Coalitions among the actors remains a challenge, especially among the different levels of actors, similar as with the robustness actors. In addition to this, a certain coordination from the national government is lacking to get effective results in the whole river basin (Interview Coenen, 2022). However, there are some successful examples of multi-government agencies projects such as the ‘Eco Tebet Park’. The integrated approach of this park including educational, ecological and recreational purposes resulted in the involvement of multi-governmental agencies (DKI Jakarta, 2022-b; Observation Eco Tebet Park, 2022). Overall it was stated that “*there are only a few actors who get something done, and many actors who can hinder*” (Interview Coenen, 2022).

Resources

In order to mobilize adaptability in Jakarta, various resources are important. Human capacity is essential to execute actions needed for crises management. For example, DSDA of DKI Jakarta has 3.000 personnel to implement the last-minutes no regret measures before flood events occur. Furthermore, the BNPB of DKI Jakarta has more than 1.000 personnel for evacuation measures. In addition to human capacity, the suitable equipment for crisis management is a required resource, which is available at DSDA (DKI Jakarta, 2021; Interview Nigrum, 2022). For the crisis management as well as the spatial planning and discouraging vulnerable land use financial resources are essential. Funding for adaptability is acquired by governmental means such as the provincial annual budget and the national state revenue and expenditure budget which are for large scale infrastructures that are considered of strategic national importance. Besides public funding streams, some large scale progresses could be financed by private parties, multilaterals or NGO’s, for instance in the form of funds, grants, or loans (DKI Jakarta, 2021; Observation Eco Tebet Park, 2022). Furthermore, land is a highly required resource for many spatial adaptation measures and the discouraging of vulnerable land use. However, land surface in Jakarta is not available and acquiring land can be complex, expensive and have social consequences (Interview Booister, 2022; Interview Coenen; Observation Eco Tebet Park, 2022). Due to his political power, the Jakarta Governor is also of essence to make or break adaptability efforts and make resources available (Interview Letitre, 2022). It is stated that “*the production power is limited and the obstruction power enormous*” (Interview Coenen, 2022) Moreover, human resources are of urgent need, also in form of



expertise and knowledge. Therefore, capacity building in the different parts of the provincial government is of urgency (DKI Jakarta, 2021). An example of this is the exchange program on water and climate adaptation with the municipality of Rotterdam, named ‘DUTEP’ (Interview Irzal, 2022; Interview Ningrum, 2022).

Rules

Rules on adaptability are formed by a national and provincial policy framework, including laws, regulations and Governor and Presidential Decree’s. Also the adaptability of Jakarta is guided by important national documents such as the national guideline for developing a Climate Action Plan for climate adaptation (RAN-API 2013) and the National Disaster Risk Appraisal 2016 (DKI Jakarta, 2021). The rules for crisis management are further directed by the response plans, which include the roles, responsibilities and procedures to be followed by organisations and inhabitants (DKI Jakarta, 2021). Regarding the spatial adaption, there is a Detailed Spatial Masterplan (RDTR) for Jakarta as well as Regional Long-Term Development Plan and a Regional Medium-Term Development Plan (DKI Jakarta, 2021; Interview Irzal, 2022). However, this masterplan needs an update to create meaningful impact on Jakarta with adaptability measures (DKI Jakarta, 2021). Besides this, there are also policies in place to steer the measures. Examples are the regulations on ‘Green building’, making green buildings permitted for government buildings and new constructed houses. The current policies are being updated to cover all building typologies. The policy incorporates spatial adaptation aspects such as green roofs, natural ventilation, rainwater harvesting and sustainable drainage systems (DKI Jakarta, 2021; Interview Irzal, 2022). Green building policy is stated a very important since by this measure, mitigation can be applied while not being challenged by the land scarcity (Interview Irzal, 2022). Similarly to the rules of robustness, enforcement of the policies remains challenging in Jakarta, leading to a discrepancy of the different documents and the reality (Interview Coenen, 2022; Interview Wierix, 2022).

Discourse

The adaptability discourse is to limit the impact of climate hazards due to adequate preparation and actions before, during and after climate hazards. This discourse is very dominant, due to the high acceptance rate of the occurrence of climate hazards in Jakarta (Interview Nigrum, 2022). The occurrence of a flood is experienced as annoying but not earthshattering. However, this tolerance is slightly changing due to the increase in general prosperity and therewith the increase in damage (Interview Coenen, 2022; Interview de Groot, 2022). Furthermore, the Jakarta citizens do have a high ability of limiting the impacts of the climate hazards on their own livelihoods without interference of the government (Interview Coenen, 2022). However, it could be stated that the dominance of this discourse has arisen due to the lack of robustness (Interview Coenen, 2022; Interview van der Wiele, 2022; Interview Wierix, 2022). The discourse is mainly focussing on the threats by water and only slightly the impact of heat stress and drought. However, this is steadily increasing due to growing awareness on the impact of heat stress and drought (Observation Eco Tebet Park, 2022).

4.4. Transformability

The ability of Jakarta to foster change into a new equilibrium to create stability regarding its climate challenges is at centre of discussion. The national government of Indonesia is planning to relocate the capital. In 2019, President Joko Widodo announced his plan to relocate the capital city from Jakarta to East Kalimantan



Figure15: Geographical locations of Jakarta and New capital city (Shimamura & Mizunoya, 2020)

(Savirani, 2021). By 2024, the new capital has to form a new centre of gravity and is a response to the social-ecological issues. The relocation releases pressure from the sinking city Jakarta and its high vulnerability to the climate hazards as well as many other environmental, mobility and social challenges it faces (Shimamura & Mizunoya, 2020). East Kalimantan has a rich forest area and is considered as a biodiversity hotspot. Concerns are shared on the damaging burdens that the new capital city could possibly bring along (Van de Vuurst & Escobar, 2020). However, the national government is planning to make the new capital city a sustainable smart forest city, which should be developed by a resilient core before 2035 (Susantono, 2022).

Due to the Covid-19 pandemic the plan has been halted temporarily, since the government needed to focus on the pandemic and reallocate the budget (Savirani, 2021). The capital relocation brings questions to the table about what this means for the transformability of Jakarta. Theoretically speaking, it does releases some pressure of Jakarta and creates necessary space (Interview Letitre, 2022). However, Jakarta will remain the economic centre of Indonesia and the home to millions of people facing the threats of climate hazards. Nevertheless, the change that arises in society as well as the administrative bodies regarding the line of thought on the essence of the capital city to be sustainable and resilient could positively backlash on Jakarta as well (Observation fieldtrip river basin Tangerang, 2022).

The new capital city should represent the nation's identity, be social, economic and environmentally sustainable and be a smart, modern and international city. It should built with concepts 'Forest City' and 'Sponge City' in order to have an integrated and absorbent city that contributes food flood resilience and efficiency ecology preservation resource system. This should be enhanced by 75% of green area (Susantono, 2022)

Despite this, many interviewees state that the current ability of Jakarta to transform regarding a new equilibrium is "not present". However, the digital transformation that has taken place in Jakarta shows that they do have a certain ability to transform. Subsequently, this digital transformation does contribute to the transformability of Jakarta regarding climate hazards (Interview Coenen, 2022; Interview Wierix, 2022).



Awareness

Awareness about the urgency of climate resilience among the Jakartans benefits from the digital transformation among all different prosperity levels. The extremely wide reach of social media contributes to an increase in awareness and therefore also actively deployed by departments such as DSDA to inform citizens (Interview Nigrum, 2022). Nevertheless, it is difficult to formulate the current state of awareness due to different experiences of the interviewees. Due to frequent events of climate hazards, awareness of the hazards itself cannot be ignored (Interview Ningrum, 2022). However, on the causal relation of these climate hazards such as land subsidence more awareness is needed among the general public (Interview Letitre, 2022). The awareness at the government officials has significantly increased and is present (Interview Coenen, 2022).

Long-term thinking

Long term planning and future thinking is found to be challenging in Jakarta. Interviewee de Groot (2022) states, “*we ask them to solve the problems for a hundred years from now, while they are still working to solve the problems of today*”. Indonesia did commit to international long term agreements on the climate such as the 2015 Paris agreement with goals for 2050 (DKI Jakarta, 2021). However, the long term development plans that were revert to before are only going forward twenty years (Board of Regional Development Planning, 2021; Interview Irzal, 2022). In contrast, with many activities and plans the NCICD II did incorporate future options (Trilateral working group NCICD II, 2021). There is also no plan by the Jakarta provincial government about the city its future continuation after the relocation of the capital (Observation field visit river basin Tangerang, 2022). The plans for the new capital city however, do include long term strategies to 2045 and onwards (Susantono, 2022). Many interviewees agree that there is a lack of long term planning and future thinking in Jakarta.

Cooperation

To incorporate transformation, cooperation between the different actors is required. As noted in previous actor sections, cooperation among different actors is challenging. The national government and DKI Jakarta are not aligned and even intersectoral coordination within the different authorities is considered to be weak. After the decentralisation coordination, aligned interests, and a vision is missing, nourished by political arguments (Interview Coenen, 2022; Interview Letitre, 2022). Possibly, this can be strengthened by the relocation of the capital and a shift in interests, which can further align them (Interview Coenen, 2022). Cooperation with citizens in form of participation is limited and mostly a formal check in the box. However, when a local community is being disadvantaged and shout aloud can influence large scale projects (Interview Booisters, 2022). Furthermore, through legal processes local communities have the opportunities to exert influence (Interview de Groot, 2022).

Learning

The new capital plan shows the ability to learn from the situation in Jakarta, as one of the directions is effective and efficient governance. Not only based on the governance directions but also regarding spatial planning for a climate resilient city. However, this is also questionable as the geographical

location of new capital city is also a coastal flood prone area (Interview Letitre, 2022). Furthermore, Jakarta is connected with international resilience platforms such as C40 (DKI Jakarta, 2021). According to interviewee Ovink (2022), international multilateral coalitions contribute to the learning of each other's best practises. Jakarta could learn on the organisation and financing of a robust system and the preserving of this (Interview Letitre, 2022).

Experimentation

Learning through experimentations in form of pilots are also popular in Jakarta, especially when provided by international actors. The pilots are often presented on a big platform to show the efforts (Interview Coenen, 2022). However, multiple interviewees agree that some pilots do not form a transformation. Interviewee Ovink (2022) states, “a pilot is something different than transformation. A pilot is good, but then it has to be done again, again and again to scale up in order to transform”. Closing the gap between pilots and a transition towards a new equilibrium remains difficult (Interview Coenen, 2022).

4.4.1. Policy arrangements transformability

The policy arrangement elements regarding the dimension of transformability are shown in Table 6 and further elaborated per element in the text below.

Table 6: Overview policy arrangements transformability Jakarta (based on in text sources)

PA	What	Elaboration
Actors	• National government	• In the lead of capital relocation
	• President Jokowi	• Announced capital relocation
	• Prince of Abu Dhabi	• Leading capital relocation project
	• Panel of high-levels and investors	• Supervising capital relocation project
	• Private actors in Jakarta	• Contribute to resilience efforts in Jakarta
Resources	• Leadership	• Presidents effort to relocate the capital city
	• Finances	• Extremely large budget needed for capital relocation funded by government means and investors
	• Knowledge & experience	• Lessons on new capital city utilizing for Jakarta
	• Political power & influence	• Needed for allocation of resources – transformation shifts political power balance and interests
	• Available land	• Unavailable but needed for future climate uncertainties - Transformation should provide space.
Rules	• No additional rules than mentioned in previous dimensions	
	• No formal or informal rules for Jakarta after capital relocation	
	• New capital city has various targets	
Discourse	• Release pressure from Jakarta to make the city less vulnerable	
	• Integration of resilient city concepts	
	• Change in mindset	

Actors

To foster change towards a new equilibrium in order to create stability all actors have a role to a certain extend. When specifically discussing the transformation by relocation of the capital, the national government is in the lead. Within the national government, the president has a special decisive status



(Savirani, 2021). According to Interviewee de Groot (2022), President Jokowi has been elected and re-elected partly due to his promise to serve the whole country and not only be Jakarta minded. Another special actor is the prince of Abu Dhabi, Sheikh Mohammed bin Zayed Al Nahyan, who had committed to lead the relocation project, supervised by a high-levels and investing internationals (Savirani, 2021). DKI Jakarta does not have a role in the relocation of the capital itself. However, they do have a role in this transformation since the pressure on the city will be decreasing and space has to arise. Therefore, DKI Jakarta has a role to give substance to this and learn from the resilient and sustainable city efforts in the new capital city. In this there is also a role for all other actors located in Jakarta since awareness and cooperation are essential to achieve this transformation in Jakarta (Observation Tangerang, 2022).

Resources

The resources needed to empower a transformation in general is described as “*the million dollar question*” (Interview Ovink, 2022). One of the mentioned resources needed for a transformation is leadership (Interview Ovink, 2022). Interviewee Letitre (2022) stated “*If the president wants or says something than it will happen, it shows that the highest decision-making level is needed to get a transformation started*”. This is also accurate in terms of the new capital city. Furthermore financial resources are of great importance since the relocation of the capital requires will be extremely expensive, for which the national government will allocate 27 billion euros (Savirani, 2021). These cost need to be financed through, among other things, private sector investments and international investors (Savirani, 2021; Susantono, 2022) Resources are also needed in Jakarta in order to be able to benefit from this transformation. The knowledge and experience gained through the resilient developments in the new capital city are resources which potentially can be utilized for Jakarta (Observation river basin Tangerang, 2022). Currently, many resources are mainly available for pilots minded developments. There is a challenge to establish resources in order to scale up these efforts in Jakarta, which is fed by political processes and interests and a lack of interests in Jakarta due to the new capital city (Interview Coenen, 2022). However, to enable transformation resources for the long term are essential (Interview Ovink, 2022). At this moment long term financing in Jakarta for the climate topic is classified as “*unimaginable*” (Interview Wierix, 2022) Theoretically, the transformation of the capital relocation should make some space available. *Available land* is a crucial resource to prepare for future climate uncertainties, which is in the current state of Jakarta not present (Interview Booisters, 2022).

Rules

The rules regarding the transformability of Jakarta itself towards the climate hazards are as described at the rules section of the other dimension. Additional rules are not developed regarding the transformability. The city Jakarta does not have a plan or strategy yet, for when the capital is relocated (Observation river basin Tangerang, 2022). For the relocation of the capital, a strategy is in place, including its motivations and directions that lead to the nation’s capital vision with eight development principles and 24 key indicators. For instance one of the principles is ‘designing with nature’ including the target ‘75% of the area for green space’ (Susantono, 2022).



Discourse

The discourse on the transformability is that the relocation of the *capital should release different forms of pressure from Jakarta. Since it is foreseen to make Jakarta less vulnerable to the climate disaster risk, it will relieve land subsidence caused by ground water extraction, it will slow down environmental degradation and it will create space due to the mitigation of economic and population concentration* (Shimamura & Mizunoya, 2020). However, many interviewees find the reality of this discourse questionable. Sometimes, the actual relocation is even questioned to happen (Interview Coenen, 2022; Interview Wierix, 2022). The discourse of the policy program for the new capital city dominantly based on concepts such as ‘forest city’ and ‘sponge city’ which show a transformation in mindset, can create awareness, and possibly backlash in a beneficial way to Jakarta and its policy programmes and its implementation on long term (Susantono, 2022; Observation river basin Tangerang, 2022).

4.5. Balance among resilience dimensions

The resilience balance of the three dimensions should facilitate change in order to preserve stability of the social-ecological system. This balance weighs towards the adaptability dimension in Jakarta. The centre of attention is on the limitation of the impact and consequences of the climate hazards, which mostly includes flood threats and slightly heat stress and drought. Partly, the spatial adaptation measures are included by tradition. Also, there are effective evacuation and informal warning systems in place to limit the consequences. In all adaptability efforts the private actors and citizens are facilitating themselves and have a high adaption and recovery ability. This originated as a result of a trade-off by the robustness dimension. In other words, dominance in adaptability has arisen in a response to the lack of a robust system and large scale effective responsibilities taken by the government, leading to a high frequency of climate hazards, in history and today. The transformability dimension based on the capital relocation, can in theory contribute the adaptability and the robustness dimension and provide a cross-over, since this will create room for expansion of these other dimensions. However, reality has to show if this will not flip into a trade-off, since the transformation could also lead to lack of interests, investment and development of the other two dimension in Jakarta. This can lead to an even larger dependence on the adaptability of the Jakartans.

5. Results Rotterdam

This chapter provides the Rotterdam research results. Starting with the case description, followed by three sections on the resilience dimensions: robustness, adaptability, and transformability. In these sections, each dimension is explained and then elaborated on through the PAA elements: actors, resources, rules and discourses.

5.1. Case description

City Characteristics

Rotterdam is the second largest urbanised area of the Netherlands, located in the province of Zuid-Holland. The city is situated in the delta area of the downstream Rhine and Meuse river basins. There are two rivers, ‘Nieuwe Maas’ and ‘Rotte’ entering the city from the East. The West side of the city borders to the North Sea. Large proportions of land are below sea level. This geographical positioning is also the basis for the city's name, since Rotterdam owes its name to a dam built in the Rotte river. Furthermore, Rotterdam is located within the Dutch economic centre ‘the Randstad’ and is one of the premier economic hubs of Europe, mainly due to its major port (Centre for Liveable Cities and Urban Land Institute, 2020; Rotterdams Weerwoord, 2021). However, the port of Rotterdam and its resilience strategy are not in the scope of this research, since this research focuses on the city as a whole and not its specific activities. Further city characteristics are provided in the Table 7 below.

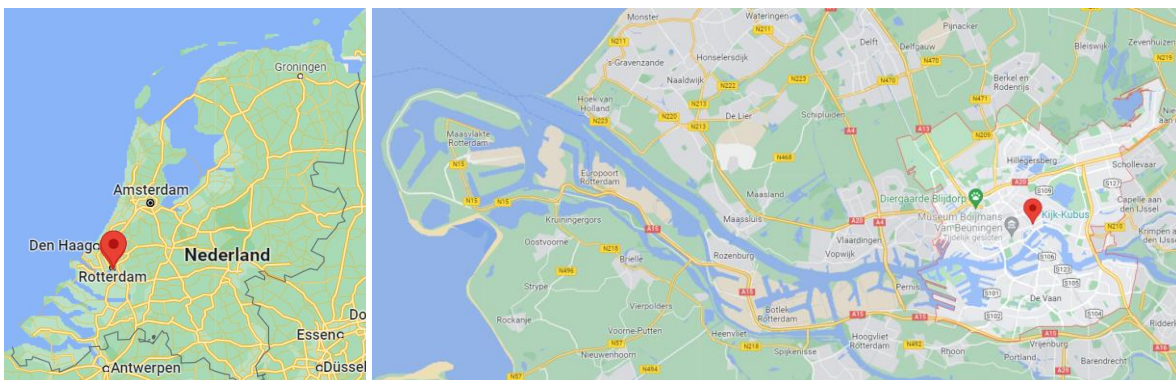


Figure 16: Location Rotterdam (Google Maps, 2022)

Table 7: City characteristics Rotterdam (Centre for Liveable Cities and Urban Land Institute, 2020; Rotterdams Weerwoord, 2021)

Physical	
Coastline	30 km
Total land surface	206,44 sq km
Percentage of publicly-owned land	40%
Outer dike area	10%
Social	
Population	0,64 million citizens
Population density	3.060 per sq km
Economic	
GDP	170 billion euro
GDP per capita	270.010 euro



Climate challenges and impacts

The climate in the Netherlands is classified as a moderate sea climate. This implicates relatively mild winters and summers and rainfall throughout the entire year. However, the climate has been changing, summers are becoming hotter and drier. A temperature increase of 1.4 °C is expected by the year of 2050 (Centre for Liveable Cities and Urban Land Institute, 2020; Klimaateffectatlas, n.d.). In addition, the urban heat island effect is a threat to large urban areas, such as Rotterdam, causing health challenges (Rotterdams WeerWoord, 2021). The increasing periods of heat in combination with decreased amounts of rainfall, causes dry summer periods. The precipitation shortage is expected to increase with 25% by 2050, impacting the water quality, the foundations of buildings, the groundwater level, and therewith land subsidence (Rotterdams WeerWoord, 2021).

In contrast to the drought periods, extensive amounts of water coming from multiple sources have always been a challenge for Rotterdam as a delta city and will continue to be, due to climate change (Centre for Liveable Cities and Urban Land Institute, 2020). During the history of Rotterdam, areas of the low-lying delta city has been flooded some times. But during the major floods in the Netherlands, the city has ‘dodged the bullet’ . Yet, this long history of flooding threats and events have contributed to the flood defence system and organisation in Rotterdam as it is today (Centre for Liveable Cities and Urban Land Institute, 2020; Rotterdams WeerWoord, 2021). The sea level rise at the coast of Rotterdam is predicted to increase one meter by 2100 compared to the year 1990, not including the most recent insights of the IPCC. This is especially a hazard to the outer dike areas, since floods are expected to occur more frequently (Centre for Liveable Cities and Urban Land Institute, 2020; Klimaateffectatlas, n.d.; Rotterdams WeerWoord, 2021).

Over the last century, the annual amount of precipitation has already increased to 850 mm, a growth of 27%, and is expected to continue to increase to 1000 mm in 2050. This increasing amount of rain is expected to fall more often during extreme weather events, instead of spread out over the year. Heavy precipitation events are expected to occur twice as much with major peaks of possibly 170 mm (Klimaateffectatlas, n.d.). The spatial planning and sewage system of the city are not prepared for this. Over 16.000 properties and even 2000 vulnerable objects, such as healthcare institutions, will become at risk of flooding. The danger of pluvial floods can lead to large financial damage, let alone the environmental damage which occurs when the sewage systems will flood into the surface water (Centre for Liveable Cities and Urban Land Institute, 2020; Rotterdams WeerWoord, 2021).

Administrative structure

The Netherlands is part of the European Union and has a decentralised administrative structure that consist of three layers of administrative bodies, as mentioned in the theoretical framework chapter. For Rotterdam these three bodies are the national government, the province of Zuid-Holland and the municipality of Rotterdam. In addition, there are regional water authorities named waterboards that are characterised by the functional decentralisation. Rotterdam has three different waterboards active in their area (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021-a; Kaufmann et al., 2015).

All the different bodies have their own task regarding the climate resilience, which will be elaborated on throughout this chapter.

5.2. Robustness

The ability of Rotterdam to reduce climate hazards probability is often described as “*in order and there is enough attention to remain in order*” (Interview de Wit, 2022). Most interviewees state that due to history, the robustness of Rotterdam is focussed on the water threats. This remains a priority and the flood safety strategy will be scaled up considering the climate change challenges such as sea level rise (Staf Deltacommissaris, 2022).

Structural measures

Rotterdam its robust system, which is in place to prevent flooding, is based on structural measures in a form of primary flood defence infrastructure. The city is protected by eighty kilometres of primary dikes along the rivers and dunes at the coast. Furthermore, storm surge barriers protect the city from coastal floods by high tides at sea (Rotterdams WeerWoord, 2021). There are three storm surge barriers which are part of the Deltaworks, and were built as a result of the devastating flood in the Netherlands in 1953 (Centre for Liveable Cities and Urban Land Institute, 2020). The primary structural flood defence provides a robust system at this moment for Rotterdam (Interview Bals, 2022; Interview Verlinde, 2022), However, it is questionable to what extent the system is robust enough for the extreme future sea level rise (Interview Wolters, 2022). In addition, Rotterdam has outer dike neighbourhoods, which are not protected by a strong flood defence system (Rotterdams WeerWoord, 2021). In addition to the primary defence system, there is a regional dike system in place. The regional dikes are an essential part of the polder system behind the primary dikes. The regional dikes are a barrier between the land surface in the polders and the drainage water system, that helps to regulate the water level in the polders and need to prevent floods in the polders (Rotterdams WeerWoord, 2021). However, the capacity of the water drainage system and its pumps is relatively small, since the pump and drainage capacity are limited (Interview Hoogvliet, 2022).



Figure 17: Structural flood defence system Rotterdam (Municipality of Rotterdam, n.d.-c)



In addition to the flood defence system, Rotterdam has a large mixed sewage system. This means there is one sewage system that drains both wastewater and rainwater towards the wastewater treatment plant. There the water is purified and thereafter discharged in to the Nieuwe Maas river. The drainage of rainwater into the sewage system contributes in preventing pluvial floods to a certain extent. However, in case of extreme precipitation, the sewage system cannot capture all the rainwater and will overflow the mixed water into streets or surface waters (Rotterdams WeerWoord, 2021).

Spatial planning

Rotterdam aims to capture water and reduce the flood probability also in the form of spatial planning measures. Spatial planning measures create more room for the river, which contributes to a smaller probability of floods. In Rotterdam there are few examples of this due to the highly urbanised area, and therefore limited options to create room for the rivers or the sea (Interview Hoogvliet, 2022). An example is the water storage at the ‘Eendragtspolder’. As soon as the water level in the Rotte river threatens to become too high, the natural recreation area will be flooded to create room for the water and temporary storage. This will prevent the area near the Rotte river, including Rotterdam, from flooding (Hoogheemraadschap van Schieland en de Krimenerwaard, 2022-a). Water storage is also important in times of drought (Rotterdams WeerWoord, 2021). Interviewee Verlinde (2022), stated the precipitation and drought challenges should be connected in a robust system. However, a robust system for drought is classified as a distribution issue (Interview Hoogvliet, 2022). Also the tidal parks of Rotterdam contribute to the robustness of the system since it also has the function of a wave braker during high water levels and are allowed to fully flood when necessary. For example, the outer dike island of Brienoord with its nature friendly river banks of the Nieuwe Maas river (Gemeente Rotterdam, 2019; Interview Gerbraad, 2022). Besides river naturalisation efforts, river normalisation efforts also contribute to more room for water. The water bodies and its assets are maintained, for instance by dredging, to ensure a good water flow. This is also an essential contribution to a robust system (Hoogheemraadschap Schieland en de Krimpenerwaard, 2022-b; Interview Bals, 2022)

In contrast to water related climate disruption, it is not possible to reduce the probability of heat stress by creating a robust system. Therefore, the robust system in Rotterdam is only related to floods and slightly to droughts. All interviewed experts confirm that the robust system is fully focused on the discharge of water and coastal protection. Interviewee Wolters (2022) states, “*it’s a water story*”. In addition interviewee Raadgever (2022), questions the possibility of having a robust system regarding heat stress, not considering mitigation.

5.2.1. Policy arrangements robustness

The policy arrangement elements regarding the robustness dimension are provided in Table 8 and further elaborated per element in the text below.

Table 8: Overview policy arrangements robustness (based on in text sources)

PA	What	Elaboration
Actors	<ul style="list-style-type: none"> Ministry of I&W Rijkswaterstaat 	<ul style="list-style-type: none"> National flood management Flood protection & water quality of coastal and main water system
	<ul style="list-style-type: none"> Staff Delta program Province of Zuid-Holland 	<ul style="list-style-type: none"> Strategy for future water safety and availability Contribute on to rainwater facilities
	<ul style="list-style-type: none"> Waterboard Schieland en Krimpenerwaard, Hollandse Delta & Delfland 	<ul style="list-style-type: none"> Regional flood protection, water quantity and quality
	<ul style="list-style-type: none"> Knowledge & expertise Human capacity Delta Fund Regional and local taxes 	<ul style="list-style-type: none"> Largely available at mentioned actors Largely available at mentioned actors Long term financing measures related to Delta program Financing regional and local measures related to water challenges
Rules	<ul style="list-style-type: none"> Land EU legislation Water Act 	<ul style="list-style-type: none"> Scarce but needed for robustness measures Overarching and influencing national legislation Regulates holistic management of water system
	<ul style="list-style-type: none"> Delta program Flood defence standards Waterboard legislation 	<ul style="list-style-type: none"> Directions for local and regional water and flood management National standards for basic flood protection level Regional water management legislation
	<ul style="list-style-type: none"> Prevention of climate hazards is the primary discourse Flood focussed: Keep the water out & drain the water as fast as possible Government responsibility to protect against floods 	
Discourse		

Actors

The robust water system in Rotterdam is a government responsibility, and is divided into the different layers of the decentralised government. At the national government the Ministry of Infrastructure and Water Management (I&W) is responsible for a reduced probability of floods. Rijkswaterstaat the national executive body, is performing tasks of flood protection and water quality of the Dutch coastal and main water systems (Centre for Liveable Cities and Urban Land Institute, 2020; Kaufmann et al., 2015). There is also a staff on the Delta program, a special program established after the destructive flood in 1953 in parts of the Netherlands. The Delta program aims for a robust system in 2050 and sets the course for the future on the Dutch water safety and fresh water availability. There is a separate chapter in the Delta program for the Rijnmond-Drechtsteden area of which Rotterdam is part (Staf Deltacommissaris, 2022). The three waterboards in Rotterdam are responsible for the regional flood protection, water quantity, and water quality. The municipality of Rotterdam itself is responsible for the collection of rainwaters by means of construction, management, maintenance of the sewerage system as well as spatial planning measures. The municipality and waterboards cooperate with the province of Zuid-Holland on the facilities to discharge rainwater and manage water in public areas (Centre for Liveable Cities and Urban Land Institute, 2020).

To maintain and improve this robust water system of Rotterdam, the different actors all form a coalition, starting off in the Delta program (Staf deltacommissaris, 2022). The actors work together to have a robust water system. Multiple interviewees (2022) state that this is a shared responsibility in which they cooperate, while each having their own responsibilities, tasks and management areas due to



their shared interest on reducing floods probability and other climate disruptions (Hoogheemraadschap Schieland en de Krimpenerwaard, 2022-b).

Resources

Due to the long history, building a water robust system in the Netherlands there is a lot of knowledge, expertise and experience available. Within organizations of the different actors there are relatively a lot of human capacity to work on this topic (Hoogheemraadschap Schieland en de Krimpenerwaard, 2022-b; Interview Verlinde, 2022). The Dutch have also created a Delta fund, which is a long term available budget independent from the political coalition in place. This fund finances the Delta program measures (Interview Wolters, 2022; Staf Deltacommissaris, 2022). A second important source financing source are taxes incomes. The municipality has a local tax in form of a sewage levy. The waterboards as well as the province of Zuid-Holland have budget through its regional taxes (Centre for Liveable Cities and Urban Land Institute, 2020). It is important to notice, that through these budgets only water related measures can be financed (Interview Wolters, 2022). Furthermore, land is a critical resource for a robust water system in a highly urbanised area as Rotterdam (Interview de Wit, 2022). In order to take measures that contribute to a robust system, available space is needed. For example, strengthening of a dike is at the expense of housing and living space. When an existing dike is heightened by one metre, the dike will become six metres wider (Rotterdams WeerWoord, 2021).

Rules

Influenced by European legislation the Dutch have a national Water Act, which regulates holistic management of the water system, including the flood defence structures (Kaufman et al., 2015). Under this act, the Dutch developed the Delta program which provides guidance and directions for regional and local government bodies on the adequate water and flood management. They can translate these directions towards a customized plan for their own management area (Centre for Liveable Cities and Urban Land Institute, 2020; Staf Deltacommissaris, 2022). Another nationwide legislation is the standards set for the primary flood defence infrastructures. These standards are based on a basic protection level and an indicator based on economic value and risk. Under the Delta program there is a large execution program named 'Hoogwaterbeschermingsprogramma 2', which works on strengthening the dikes to ensure a robust system considering the growing risks up to 2050. However, these standards have not been achieved everywhere yet (Staf Deltacommissaris; Hoogheemraadschap Schieland en de Krimpenerwaard, 2022-b, 2022). Furthermore, the waterboards have their own legalisation for their management area described in the 'keur' which is elaborated in more specific thematic documents named 'leggers' (Hoogheemraadschap Schieland en de Krimpenerwaard, 2022-b).

Discourse

The dominant discourse regarding robustness within the policy arrangements is the focus on the threats of flooding. Within this focus the discourse and priority is to protect the city from floods and keep the water out by having a robust flood defence system and a system that is focussed on draining the water as fast as possible (Interview Bals, 2022; Staf Deltacommissaris, 2022). Especially in Rotterdam this

remains important due to the limited space available to live with water (Interview Hoogvliet, 2022; Interview Bals, 2022). A robust water system will also continue to be a priority, in order to remain the Triple A status of international credit rating agencies (Deltacommissaris Peter Glas, cited in Gemeente Rotterdam, 2022). Interviewee Ovink (2022), states *“the whole Dutch system is focussed on water safety and water drainage and not to retain it”*. This is supported by Interviewee Gebraad (2022), *“the core of the resilience is our robust system, which has been pretty strong for already a long time”*. The other dimensions of resilience are considered as an extra layer of protection, except for the outer dikes areas (Interview Gebraad, 2022). The robust system is a government responsibility to protect the city and its citizens. The robust system in Rotterdam organised by the government creates a feeling of complete safety with the citizens.

5.3. Adaptability

For the adaptability of Rotterdam, a major acceleration track has started and is growing in importance.

Spatial adaption

The adaptability of Rotterdam is currently nearly fully committed to the implementation of climate proofing measures. In contrast to the robustness dimension, adaptation efforts made are merely focussing on the consequences extreme precipitation events. Also, heat stress and drought are becoming more important (Interview Verlinde, 2022; Interview de Wit, 2022). Except for the outer dikes areas, for this areas the adaptability focus is on flooding. Currently a strategy is being developed to also make the outer dike areas resilient in which adaption is most important (Interview Gebraad, 2022). The climate adaptability execution tracks in Rotterdam focus on the adaptation of new and existing real estate, infrastructure and the public space (Interview Verlinde, 2022; Rotterdams WeerWoord, 2022). Measures are taken that contribute to the sponge capacity of the city, such as increasing of the local infiltration and storage capacity (Rotterdams WeerWoord, 2022). Examples are the urban water buffers and water squares which installed at multiple locations and store the water in times of extreme rainfall in the city.



Figure 18&19: Water square Rotterdam Bentheplein during dry and wet conditions (De Urbanisten, 2015)

There are also many small scale examples such as rain barrels at houses that contribute to the storage capacity of the city (Interview Bals, 2022; Interview Verlinde, 2022; Rotterdams WeerWoord, 2022). Many small scale adapting measures together make a big whole which contributes to the challenges (Interview Hoogvliet, 2022). Water storage measures also contribute as drought adaption measures.



Adaptability measures regarding heat stress are also becoming more important and more frequently applied in Rotterdam.

Important climate proofing measures which are in progress to reduce the consequences of heat stress are the reduction the pavement and increasing greening of the urban area. The ‘NK tegelwippen’ is an example which promotes and enables these actions (Interview Wolters, 2022; Rotterdams WeerWoord, 2022). In 2021, Rotterdam added 21,5 extra hectares green area, compared to 2018 (Municipality of Rotterdam, 2022-b). These measures also contribute to adaptability for extreme rainfall and add to ecology as well as the liveability of the city, making it a holistic solution, which is also one of the aims of Rotterdam. At the time, all the climate threat analyses were done by theme, while many of the challenges are integrated with each other, which is often the same for the solutions (Interview Gebraad, 2022). Integral coordination is becoming the norm nowadays, for instance the climate squares are being developed with more ecological elements, instead of using pavement as before (Interview Bals, 2022; Interview Verlinde, 2022). However, in some situations there is a risk of maladaptation which need to be taken to mind. Implementation of green adaption measures is complex. On one hand, it could contribute to all challenges of the climate disruptions. One the other hand, it could add up to the droughts since it could have high water demand, especially during hot summers. Therefore, it is of great importance that adaption measures are selected thoroughly (Interview Bals, 2022; Rotterdams WeerWoord, 2022). Moreover, real estate and public space can be adjusted with sustainable cooling measures, such as isolation, shadow, and ventilation (Rotterdams WeerWoord, 2022). Furthermore, risk assessments are being made to find the vulnerable spots of the vital infrastructure in order to make it more heat stress resistant or cool them when necessary (Interview Hemmen, 2022; Interview de Wit, 2022; Rotterdams WeerWoord, 2022).

A neighbourhood approach is used to make the adaptation measures custom fit and work as effective as possible (Interview Bals, 2022; Interview Verlinde, 2022). Moreover, holistic and multidisciplinary solutions for different climate hazards are aimed for. Also integrating other urban transitions, such as the energy and mobility transition, often entailing some challenges (Interview Verlinde, 2022; Gemeente Rotterdam, 2022-a).

Crisis management

Traditionally, crisis management and warning and evacuation schemes in place focus on flood hazards. For flooding different crisis and evacuation protocols are in place, as directed by the Delta program (Staf Deltacommissaris, 2022). At times of flooding, most of Rotterdam, is not possible to evacuate out of the area. Therefore, evacuation within the area is needed in forms of vertical evacuation and shelters (Rotterdams WeerWoord, 2022; Provincie Zuid-Holland, 2018). Due to the Covid-19 pandemic the development of crisis management strategies were delayed (Staf Deltacommissaris, 2022). During a threat of high water, citizens are being actively warned using different channels and last minute no regret measures will be taken (Gemeente Rotterdam, n.d.-c). Currently, steps are also being made on crisis management of heat stress. A protocol is being developed and active warning communication messages



are being spread at times of heat stress (Gemeente Rotterdam, 2022-a; Interview Verlinde, 2022; Interview de Wit, 2022;). Interviewee Verlinde (2022) states that the heat stress protocol is not ready yet. However, they do use their website and social media to communicate with advice what to do during extremely hot days. Also at times of drought, warning messages are being shared, in order to limit the water demand (Rotterdams WeerWoord, 2022).

Discouraging vulnerable land use

The adaptability of Rotterdam using the discouragement of vulnerable land use is barely in place but is at the centre of discussion currently (Observation Rotterdams WeerWoord symposium, 2022). The consideration to build in highly flood prone areas is one that comes up for discussion more often with different parties (interview Wolters, 2022). Interviewee de Wit (2022) implies that decisions regarding this topic need to be made for the future. However, due to mainly extreme housing shortage this is not happening yet. In fact, the opposite is happening, for example at the outer dike areas approximately 17.500 housing will be built. Therefore interviewee Gebraad (2022) states, *“It is not a matter of whether you build, but how you build.”*

Financial Recovery

Financial adaptability is arranged via the national Calamities Compensation Act, which is paid when the national government declares a climate hazard as a disaster. Other financial adaptability in form of insurances for different many climate hazards is limited and market penetration is slow (Kaufmann et al., 2015). However, the involved actors are exploring the possibilities and conditions for this. Insurances could possibly be stimulated by other resilience elements, since insurance companies also benefit from climate resilient city and possibility set adaptation standards as a condition to insurances, which is seen as a benefit by many interviewees.

5.3.1. Policy arrangements adaptability

The policy arrangement elements regarding the adaptability dimension are provided in Table 9 and further elaborated per element in the text below.

Table 9: Overview policy arrangements adaptability dimension Rotterdam (based on in text sources)

PA	What	Elaboration
Actors	• Ministry of I&W	• National directions for the different adaptabilities variables
	• Staff Delta program	• National strategy for future water related spatial adaptation
	• Province of Zuid-Holland	• Regional responsibilities for directing and facilitating adaptability efforts
	• Rotterdams WeerWoord; a coalition with the municipality of Rotterdam, three Rotterdam waterboards and water company Evides	• Local responsibility regarding directing, facilitating, and supporting of adaptability efforts
	• Private parties including citizens	• Responsible for adaption efforts at private surface
Resources	• Safety region Rotterdam-Rijnmond	• Crisis management water hazards
	• GGD	• Crisis management heat stress
	• Insurance companies	• Financial compensation being discussed
	• Delta fund	• Long term financing measures related to Delta program
	• Impulse budget	• Financing climate adaptation measures
	• National disaster fund	• Financing recovery of damage of climate disasters
	• Regional and local taxes	• Financing regional and local adaptation measures related to water
	• Subsidies	• Financial incentives for private actors for adaptation measures available at government actors
Rules	• Knowledge, expertise & experience	• Available at mentioned government actors
	• Human capital	• Available at different actors
	• European legislation	• Overarching and influencing national legislation
	• Spatial Planning Act	• Regulates holistic management of spatial planning
	• Water Act	• Regulates holistic management of water system
	• Delta program spatial addition	• Guides all government layers to apply the Delta approach
	• National Adaption Strategy	• Strategy guiding towards adaption on all climate challenges
	• Regional and local adaptation strategies	• Strategy guiding towards climate adaption
	• Climate adaptive covenants	• Voluntary agreements between government and housing corporation and construction sector for climate adaptation
	• Municipal spatial legislation	• Local spatial planning legislation
Discourse	• Crisis plans	• Manual providing risks, scenarios and guidelines for climate hazards
	• A robust system merely is not enough any more	
	• Adaptability dominant discourse in outer dike areas	
	• Adaptability dominant discourse for pluvial flood, heat stress and drought	

Actors

Adaptability includes a broad variety of variables; therefore, many different actors are involved. All interviewees agree that adaptability is a responsibility of all. This is essential since only 40% of the Rotterdam land surface is public space and owned by the municipality. The other 60% is owned by private parties, such as businesses, citizens and housing corporations. Enhancing Rotterdam its adaptability, especially regarding spatial adaption, is led by the municipal program Rotterdams WeerWoord. They are responsible for providing directions, stimulation and support regarding adaptation efforts (Interview Verlinde, 2022; Observation Rotterdams WeerWoord symposium, 2022). Also, the national and provincial government including the Delta program, provide directions regarding adaptability, help to enable, and gain knowledge and act regarding their own assets (Interview Wolters, 2022; Ministerie van Infrastructuur en Waterstaat, 2016; Staf Deltacommissaris, 2022). Future decisions about discouraging of vulnerable land use is also a responsibility of local and provincial

governments. However, guidance of the national government is desired (Interview Bals, 2022; Interview van der Knaap; Interview Wolters, 2022). Regarding the crisis management of the water related threats, the safety region is the important actor, while for heat stress it is the GGD. However, there are also national coordination centres active on this topic. The municipality and the waterboards also have their own roles and tasks contributing to warning, evacuation other crisis measures. The housing corporation are open to playing their role if needed (Hoogheemraadschap Schieland en de Krimpenerwaard, 2022-b; Interview van der Knaap, 2022; Kaufmann et al., 2015; Rotterdams WeerWoord, 2021). The financial adaptability important actors are the national government and insurance companies. The insurance companies can provide financial compensation regarding damage by water to a certain degree. Flood disasters financial compensation is only offered by the national government.

The cooperation between all the different climate adaptability actors in regional or thematic coalitions appears as a great strength of adaptability for Rotterdam. It is even mentioned as “*unique*” (Interview Bals; Interview Verlinde, 2022). Rotterdam is a very welcomed party in the development of regional and national adaptation strategies (Interview Wolters, 2022). Verlinde (2022), also provides the example that in order to stimulate the adaptability of the city, an employee of the municipality is stationed in the housing corporation one day a week, to translate the challenges in specific actions to work on for the corporations. Furthermore, cooperation within different departments of the municipality of Rotterdam happens related to climate adaptation measures (Interview Verlinde, 2022). Moreover, they also cooperate with active citizens and businesses. The latter also applies for the province of Zuid-Holland, they even get actively approach by business parks (Interview de Wit, 2022).

Resources

For the large acceleration track that is deployed regarding the adaptability of Rotterdam many resources are needed. Spatial water related adaption measures are funded through the similar sources as mentioned at the robustness section (Staf Deltacommissaris, 2022). This funding excludes measures merely for heat stress (Interview Wolters, 2022) The national government also has launched an impulse budget together with the regional government, which helps to finance climate adaption measures, in order to accelerate (Interview Wolters, 2022; Ministerie van Infrastructuur en Waterstaat, 2018). In order not to be limited by the option of the tax incomes, the Rotterdam municipality also has its own climate adaptation budget . In contrast to the Delta fund this budget is negotiated every four years at the start of a new coalition of the municipal politics. This causes a hinderance in the implementation and long term planning for the city (Interview Verlinde, 2022).

Furthermore, municipality and the waterboards also provide resources. They provide different sorts of subsidies for citizens to provide incentives for climate adaption measures at private properties (Gemeente Rotterdam, n.d.-b; Interview Bals, 2022; Interview Verlinde, 2022). Besides the financial support, regional and local government institutions can provide knowledge, expertise and experience for measures at private properties (Interview de Wit, 2022). Likewise, citizens sometimes provide their human capital in form of coordination, construction or maintenance of the measures. Rotterdam itself



has the luxury of a large department with many employees to work on the adaptability of the city (Interview Verlinde, 2022). In contrast to the safety region and GGD which had limited resources available last years for climate disruptions crisis management , due to the Covid-19 pandemic (Staf Deltacommissaris, 2022). For the financial recovery the most important resource remains the national disaster fund. This becomes available when the national government has declared the climate disruption as a disaster and will fund the recovery of the damage (Interview Wolters, 2022).

Rules

Influenced by European legislation the Dutch have a Spatial Planning Act, which determines how spatial plans come about at the different government layers. Under this act, together with the Water Act, the Dutch established the Delta program with a theme on spatial adaptation as essential to become climate resisting in 2050. (Centre for Liveable Cities and Urban Land Institute, 2020). The Delta program spatial adaptation coordinates and stimulates all government layers to analyse their climate vulnerabilities in their own area using stress tests. This is followed by risk dialogues with relevant partners, in which a translation towards adaption strategies with concrete goals is developed and elaborated in an execution agenda. This cycle is called the Dutch Delta approach and needs to be repeatedly executed every six years (Staf Deltacommissaris, 2022). This approach is also being stimulated through the National Adaption Strategy. This strategy is more inclusive since they include all climate challenges, rather than only a focus on water threats. Yet the two national programmes are much aligned (Ministerie van Infrastructuur en Waterstaat, 2016 ;Wolters, 2022). The province of Zuid-Holland has arranged a *covenant* on ‘climate adaptive construction’ together with the construction industry and a covenant on ‘climate adaptative housing’ with housing corporations (Interview de Wit, 2022; Provincie Zuid-Holland, 2018). The regional and local governments also have their own adaption strategies. Additionally, the Rotterdam municipality even has a resilience strategy and its own spatial legislation. Within the legal possibilities, they try to stimulate adaption measures. For example there is no permit needed for the creation of façade gardens (Gemeente Rotterdam, n.d.-a; Interview Verlinde, 2022).

Discourse

The discourse for the adaptability of Rotterdam is to prepare the city by adapting for future climate risk and impacts, in order to avoid damage (Rotterdams WeerWoord, 2022). Interviewee Gebraad (2022) states: that nowadays the message is *“a robust system merely is not enough anymore. We need to create more space to absorb the impacts, which is exactly what we do with the adaptation measures”*. Interviewee Verlinde (2022) states *“you can’t get around it, you have to do it” “the focus is on adapting”*. This is especially the dominant discourse for the policy programs of the *outer dike areas*. Particularly in combination with the housing shortage on short and midterm (Gemeente Rotterdam 2022-a; Interview Gerbaard, 2022; Interview Bals, 2022). Besides the outer dike areas, this discourse is dominant regarding the challenges of extreme rainfall and increasing for heat stress and drought. The balance among these three will become equal in this policy discourse and also in investments made (Interview Verlinde, 2022). Furthermore, the discourse for climate adaptations is to explicitly utilize its

advantage for social resilience within the neighbourhoods and increase the liveability and attractiveness of the city (Gemeente Rotterdam, 2022-a; Interview van der Knaap, 2022; Interview Verlinde, 2022).

5.4. Transformability

The transformability is one of the four resilience characteristics in the resilience strategy of Rotterdam. They define it as “*transformability is having the courage and the expertise to change the system in order to become more resilient*” (Gemeente Rotterdam, 2022-a, p.23). Transformability is indeed changing towards a new equilibrium in order to preserve stability. During the WeerWoord symposium (2022) different scenarios for future Rotterdam and its climate hazards were presented. One of the possible transformations of Rotterdam into a new equilibrium, could mean a shift in acceptance of the climate hazard occurrence. Including a change in governance regarding the actions and preparations towards the climate hazards occurrence (Observation Rotterdams WeerWoord symposium, 2022). According to Interviewee Wolters (2022) this discussion on consideration of the balance between preventing and acceptance of climate hazards is one that should be held at policy level. Another new equilibrium for Rotterdam could possibly be the abandoning and/or moving parts of Rotterdam as new equilibrium in order to create stability among climate hazards (Interview van der Knaap, 2022; Observation Rotterdams WeerWoord symposium, 2022). However, interviewees agree that at this moment these transformations are not realistic and will not happen due to the high socio-economic value of Rotterdam. Nevertheless, parts of these transformations are not fully excluded for the future. The change in the system that is currently aimed for in Rotterdam is a governance transformation. The objective is to make resilience governance adaptive regarding the future, integrative, and inclusive. This is due to the aim to integrate climate resilience into the structural thinking of the cities and regions policies and actions. In addition, a change regarding the responsibilities of actors is the objective. Climate adaptation is something of all and the ambition is that all actors will perform climate adaptive to make it inclusive. A shift is needed from full governmental responsibility, towards a new standard in which all actors in the city collectively combat the challenges of climate change. In this new aimed standard the municipality and other government institutions can facilitate, stimulate and guide the other actors in Rotterdam to act climate adaptive (Interview Verlinde, 2022; Rotterdams WeerWoord, 2021) In reality the transformability is described as ‘*upcoming*’, ‘*super difficult*’, and ‘*we haven’t got there yet*’ (Interview Gebraad, 2022; Interview Ovink, 2022; Interview de Wit, 2022;).

Interviewee de Wit (2022) stated “*my highest goal is reached when the climate adaption program I run has become unnecessary*”.

Awareness

The Rotterdams WeerWoord invests a lot in the climate awareness and motivation to act towards this societal as well as administrative (Interviewee Bals, 2022; Rotterdams WeerWoord, 2022-a). This is also stimulated and identified as the important part of the approach in the national documents (Ministerie



van Infrastructuur en Waterstaat, 2016). An increase in awareness contributes to the integrative and inclusive governance transformation, since other stakeholders gain knowledge about the need of their own responsibilities and the need to integrate adaptation in all other policy topics. Awareness is raised in Rotterdam by using a neighbourhood approach, to interact with and inform the citizens in a way that suits the neighbourhood best (Interview Verlinde, 2022; Observation Daken dagen; Rotterdams WeerWoord, 2022). Most government interviewees notice that awareness is increasing, and state that private parties and citizens are becoming aware of the climate consequences when living in a delta city as Rotterdam. However, van der Knaap (2022) questions the awareness of the residents of the housing corporation and states that actions are often motivated by an increase in the attractiveness and liveability of the area, making the contribution to climate adaptation a beneficial side effect. This motivation is recognized by the other interviewees and depend on the characteristics of the neighbourhood. The efforts taken on climate adaption are strongly linked with the social challenges and aim to also increase the social resilience (Gemeente Rotterdam, 2022-a; Interview Ovink, 2022). Furthermore, the awareness differs among the various climate disruptions. For instance, the threats of drought are less visible to most actors than extreme rainfall events (Interview Bals; Interview, Gerbraad, 2022).

Experimentation

Awareness solely is not enough and needs to be translated into actions. Actions in the form experimentation and pilots are continuously taking place with great success, including a more inclusive and integrated governance approach .For instance the urban water buffer started as a pilot. (Interview Verlinde; Interview de Wit, 2022; Gemeente Rotterdam, 2022-a). However, often it is found difficult to scale up the pilots into new standards and make a bigger significant impact and enable a transformation (Interview van der Knaap, 2022; Interview Verlinde, 2022).

Cooperation

In order to execute these actions, cooperation among actors is required, which is key to a more inclusive governance approach. As confirmed by many interviewees, Rotterdam is known for its strong cooperation in a substantive, financial, and organizational way, while forming public-private-social alliances (Rotterdams WeerWoord, 2022). Cooperation on this topic is also encouraged by the national and regional government institutions (Ministerie van Infrastructuur en Waterstaat, 2016; Provincie Zuid-Holland, 2018). Interviewees agree that the process of collaboration among the actors is increasing. However, collaboration with other transitions in the city should ideally also go hand in hand but remain a challenge (Interview Verlinde, 2022; Interview van der Knaap, 2022).

Learning

Whilst taking the actions Rotterdam aims to continuously learn. On different levels so called knowledge agendas are being developed to gain more in-dept knowledge on specific topics regarding expectations and consequences of the climate hazards (Gemeente Rotterdam, 2022-a; Interview Bals, 2022). Gaining knowledge, using stress tests, is also the first step of the Delta approach. When new scientific climate knowledge arises, plans are being reconsidered. For instance, the Delta program performs this in a cycle



of every six years (Staf deltacommissaris, 2022; Ministerie van Infrastructuur en Waterstaat, 2016). Furthermore, Rotterdam enhances its learning capacity by looking to the future but also by back casting on its own strategies and actions (Gemeente Rotterdam, 2022-a). Moreover, Rotterdam learns through its local, national and international cooperation, which lessons if suitable are being integrated into the strategies and policies (Interview Verlinde, 2022). Especially, regarding the topics of drought and heat stress, interviewees agree that there is still plenty to learn. The different approaches to learning help with the governance transformation in becoming more adaptive towards the future and integrating adaptation into a broader policy. Nevertheless, there should be courage to learn about these topics, since the Dutch are known for their knowledge sharing across the world (Interview Wolters, 2022). To support learning internationally, coalitions such as the ‘Climate Action Coalition’ can help (Interview Ovink, 2022).

Long-term thinking

Long-term planning is essential for the transformation towards adaptive governance. Within the climate adaptation programs, a long term vision is used. This is inspired by the IPCC and KNMI reports, and national programs, which set goals for the year 2050 and provide a perspective towards the year 2100. Currently the Rotterdams WeerWoord is developing a book with long term perspectives to show the possible scenarios for the city and considering if their strategy is sufficient towards the future challenges (Interview Gebraad, 2022; Interview Verlinde, 2022; Rotterdams WeerWoord 2022; Staf Deltacommissaris, 2022). Interviewee de Wit (2022) states that long term thinking is becoming more important when labelling new locations and investments for the future. This is crucial for the long term planning, since space is needed to stay resilient for futures uncertainties (Interview Booisters, 2022). This long term and adaptive planning are crucial to enable a governance transition. However, this is not the standard yet. Despite the long-term vision, choices made or rather not made, lack resources, and short and mid-term interests are hindering the actual long-term agenda setting and actions. Also, the maintenance of the public space has a midterm planning of ten years ahead (Interview van der Knaap, 2022; Interview Verlinde, 2022).

5.4.1. Policy arrangements transformability

The policy arrangement elements regarding the adaptability dimension are provided in Table 10 and further elaborated per element in the text below.

Table 10: Overview policy arrangements transformability dimension Rotterdam (based on in text sources)

PA	What	Elaboration	
Actors	• Municipality of Rotterdam	• Coordination and facilitation toward more integrated, inclusive and adaptive governance transformation	
	• National and provincial governments	• Guiding governance transformation	
	• Waterboards	• Help stimulating and facilitating transformation	
	• Housing corporations	• Help stimulating transformation	
	• Private actors including citizens	• Increase actions and responsibilities regarding climate resilience	
Resources	• Leadership	• Active mayor aiming to lead in climate adaptation	
	• Finances	• Available at Rotterdam and steering actors for first step but lacking for transformation	
	• Human capital	• Available at Rotterdam and steering actors for first step but lacking for transformation	
	• Communication channels	• Available at Rotterdam and steering actors to research other actors	
	• Knowledge & expertise	• Available at Rotterdam and steering actors for first step but lacking for transformation	
	• Available land	• Scarce but needed to be adaptive towards future climate uncertainties	
	• Political stability	• Four year coalition cycle influences availability budget	
	Rules	• No additional rules than mentioned in previous dimensions	
		• Informal rules used to enhance the transformability	
		• Discussions on need for formal rules to ensure transformability	
Discourse	• Climate adaption should be an integrated standard in all other policy areas		
	• Need for adaptiveness towards future climate challenges		
	• Climate actions should become more inclusive regarding actor responsibilities		

Actors

To enable the system change all actors within the city have an important role and responsibilities. the municipality of Rotterdam will stimulated and coordinate the transformation towards more inclusive and shared responsibilities. They are the government body closets to its citizens and businesses after all (Rotterdams WeerWoord, 2022; Interview de Wit, 2022). This is guided by national and provincial government institutions (Ministerie van Infrastructuur en Waterstaat, 2016; Provincie Zuid-Holland, 2018; Staf deltacommissaris, 2022). Also the *waterboards* and the *housing corporations* are important when it comes to move all actors into the same direction. They both are able to reach private actors and citizens in their own way (Interview Bals; Interview Verlinde, 2022). To achieve the transformation, private actors and citizens need to take larger responsibilities and start acting themselves (Gemeente Rotterdam, 2022-a). Also all interviewees work within their own organisations to spread the word and enable the transformability towards more integrated governance. The actors are forming coalition that perform in a very beneficial way, which is really a strength that is needed to enable the system transformation.

Resources

The resources needed to empower a transformation as mentioned for Jakarta is an important but very difficult question. One of the elements mentioned is leadership. Rotterdam has a leader, the mayor, who states that climate resilience is important and aims to be leading in this nationally and internationally (Gemeente Rotterdam, 2022-a; Interview Hoogvliet, 2022). In addition, the resources available need to



be for “*the long haul*” (Interview Ovink, 2022). Rotterdam and its partnering and steering actors do have relatively a large amount of resources in terms of funding, human capital, communications channels, knowledge, and expertise, especially to facilitate pilots (Centre for Liveable Cities and Urban Land Institute, 2020; Interview Bals, 2022; Interview Raadgever, 2022; Interview de Wit, 2022). However, the realisation power and resources necessary to really transform into making that the new standards remains challenging and sometimes even lacking (Interview van der Knaap, 2022; Interview de Wit, 2022). This challenge is strengthened by local politics that form a new coalition every four years. Therefore, local financial resources for the future remain uncertain (Interview Verlinde, 2022). In addition to all the mentioned resources, available land is essential to prepare for the future climate uncertainties. Some interviewees state that this is still available for Rotterdam. However, others argue that this amount is limited.

Rules

The rules of the game described in the sections of the other dimensions are the basis of the rules for this dimension. There are no additional formal rules to ensure the transformability. The municipality and other government institutions currently aim to enable this system change by providing incentives in different forms, to increase the awareness and motivation of other actors (Observation Rotterdams WeerWoord symposium, 2022). However, interviewees and actors at the symposium did discuss that in order to transform some hard rules formed by the government might be desired and required.

Discourse

The discourse regarding transformability of Rotterdam is that climate robustness and especially adaption should be an integrated standard in the plans and actions of governmental organisations. This should become more inclusive by including private actors and citizens, and be more adaptive taking all long term future climate challenges into mind (Gemeente Rotterdam, 2022-a; Rotterdams WeerWoord, 2022). There is a growing awareness towards this discourse and first steps are taken. This however, is a long term process since this discourse is in contrast with the one of the robust system that make people feel safe without having own responsibilities (Interview Verlinde, 2022). Also interviewee Wolters (2022) argues that in general the policy field has a slower transformability capacity compared to society and is sometimes conflicting with other interests (Interview Bals, 2022). In the most recent coalition agreement of 2022, the statement was made that “*water and soil should be steering*”. This is reflecting in the documents of the Rotterdams WeerWoord. However, that is only the start of a whole process of integrating this discourse into broader policy program discourses.

5.5. Balance among resilience dimensions

The three resilience dimensions should provide a balance in which change is supported in order to preserve stability of the social-ecological system. The resilience balance of Rotterdam bends towards the preserving stability by having a robust system, which reduces the climate hazards probability. Due to history the robust system focussing especially on floods, by means to keep the water out and provide



a feeling of safety regarding those threats. The robustness is provided as a government service without any responsibilities at other actors. Despite the current acceleration on adaptability efforts, the dominance of the robustness creates a trade-off regarding to the other resilience dimensions. Some adaptability measures are experienced as additional or a back-up plan toward the robust system, which is often not beneficial for their development. Moreover, adaptability is to reduce the consequences of climate hazards, implying that they can occur, in contrast to the robustness. The feeling of safety that is created by a robust system without any tasks for private actors and citizens provides hinder in the stimulation to those actors to contribute to adaptation measures. In adaptability, their role is of essence due to only 40% of Rotterdam is owned by the municipality. The focus of the adaptability measures is therefore mainly on heavy precipitation events which can be experienced by the citizens and consequently creates awareness and a sense of urgency. However, the coming years this will accelerate for heat stress and drought because the robust system is not built for those climate hazards, in which we can see another trade-off. It is questionable whether a robust system for those climate hazards is even possible. The active adaptability accelerating efforts do provide a cross-over with the aimed governance transformation in Rotterdam regarding climate hazards. It contributes to a new equilibrium that is intended for, in which currently small strides are taken towards the integration and changing division of responsibilities among climate hazards are central to create stability.

6. Conclusion, Discussion, and Recommendations

This chapter includes the conclusion, discussion, and recommendations of this research, which is based on the results of the research and are the outcome of the methods applied.

6.1. Conclusion

This section presents the conclusion of this study by answering the research questions, which were derived of the research aim. The aim of this research is to gain a comprehensive understanding of the different conceptual meanings of resilience. Moreover, the aim is to find out how the resilience dimension are currently reflected by the policy arrangements for the contrasting urban areas of Jakarta and Rotterdam. This is to identify the current balance of the resilience dimensions and map the cross-overs and trade-offs, in order to discover the cities their respective strengths and weaknesses. This research aim has led to the following research question: *How are the climate resilience dimensions integrated in the governance of Jakarta and Rotterdam reflecting the policy arrangements, in order to identify the resilience balance?* In order to answer this main research question, firstly the sub questions will be answered leading to an overall conclusion.

Resilience conceptualized

The conceptual resilience types were first identified, which led to the resilience dimensions for this research. Through theoretical evolution of resilience, three consecutive main types of resilience have arisen: engineering resilience, ecological resilience, and social-ecological resilience. These types have evolved from bouncing back into a single equilibrium towards bouncing forward towards a new equilibrium. For this research the most evolved version of resilience is included: social-ecological resilience in which resilience is about stability as well as change. This is conceptualized into three dimensions:

- 1) Robustness, the ability to reduce climate hazards probability;
- 2) Adaptability, the ability to reduce the consequences of climate hazard;
- 3) Transformability, the ability to foster societal change into a new equilibrium to preserve the stability of the social-ecological system.

Jakarta

The resilience balance in Jakarta bends towards a dominance of the adaptability dimension. The centre of attention of climate hazards are efforts made to reduce the consequences. This focus has arisen out of necessity and a trade-off with the robustness. The robust system does not function as well as desired. Frequent floods show the lack of reduction of the climate hazards probability. The system is focussed on flood defence structures towards different flood threats, including different developed strategies and plans, but shows incompetent results. This has led and continues to lead to different sorts of flooding. The lack of a robust system reflecting the elements of the policy arrangements can be derived from divided and uncoordinated responsibilities on the flood defence structures, influenced by political interests and conflicts. This also influences the availability of financial resources which are required to



a large extent for a robust system. In addition, the city of Jakarta has limited to no land available to build a robust system. Therefore, efforts towards a robust system at vulnerable locations, have a large social impact mostly on exposed communities and their livelihoods. This social challenge is again interconnected with the political interests and efforts for a robust system. As a trade-off adaptability has developed towards a dominant approach. Adjustments at building level for the climate hazards that are nowadays labelled as spatial adaptation have been in the housing design by tradition. Furthermore, crisis management has really evolved over the years. Good warning and evacuation strategies and the execution of it are in place in a formal and informal way. The elements of the policy arrangements show that in general the adaptability comes from the ability of the private actors and citizens to adapt and recover, facilitated mainly by themselves. Nevertheless the public authorities also contribute in a certain form to the adaptability efforts and try to accelerate it on large scale in the public area. The transformability dimension in the context of the capital city relocation, can in theory provide a cross-over with the other resilience dimensions. The new capital city contributes to a change into a new equilibrium by reducing pressure of Jakarta and provides lessons and spatial availability to implement the lessons learned and expand the other dimensions, since available space is currently a lacking resource, which is of urgency. However, reality has to show if these cross-over opportunities do not convert into a trade-off towards the other dimension. There are also arguments that states that the transformation could also lead to a decline of political interests and investments in Jakarta, which makes the required resources even scarcer and the city more vulnerable. This can lead to an even large dependence on the adaptability of the Jakartans.

Rotterdam

The resilience balance in Rotterdam bends towards the robustness dimension, which focusses on the perseverance of the social-ecological system. Due to history, the robust system is focussing on flood defences which is also reflected in the policy arrangements elements. The Dutch have special water authorities that together with other government bodies fulfil water management, guarantee flood defences and focus on keeping the water out, without any responsibilities for other actors. This provides a feeling of safety among all the other actors. The robust system is boosted by the policy arrangements elements of rules and resources. After the flood in 1953, the Delta program including a Delta fund have been created to ensure a robust system. This is supported by other national and regional Acts and regional and local tax incomes. Despite the current acceleration and efforts made regarding the adaptability dimension, the dominance of the robustness creates trade-offs regarding the other resilience dimensions. In general, adaptability measures are experienced as additional or as a back-up plan towards the robust system, which is not beneficial for the development of adaptability efforts. Furthermore, adaptability measures focus on the reduction of the consequences of climate hazards, which imply the occurrence of it. This is contrasting with the feeling of safety created by the robust system without any responsibilities for private actors and citizens. This can un-prioritize adaptability measures at other public organisation and can hinder in the stimulation of these actors toward taking adaptability measures.

In contrast to robustness, a large variety of actors have responsibilities including the private actors and citizens, which is also of essence since only 40% of Rotterdam is owned by the municipality. Nevertheless, in all adaptability elements the government remains in the lead and fulfils a steering role. The urgency of adaptability is accelerating which is also seen by the inclusion of adaptability elements into the Delta program and Delta fund. In addition, public actors are developing adaptation strategies themselves and tax incomes are also used more often for adaptation measures. It is important to notice that these resources can only be utilized regarding water related measures. Currently, adaptation measures are mainly focussing on outer dikes areas to compromise the lack of robustness and the consequences of heavy precipitation events, in which the usability of these resources is not a problem. However, heat stress and drought are becoming just as important in adaptability, which is hindered by the resource availability. The acceleration on adaptability for these climate hazards is because the robust system is not built for those climate hazards, which is another trade-off. It is questionable whether a robust system according to this theoretical concept for those climate hazards is even possible. The robust system provides also a trade-off towards the transformability. A combination of the existing dominant robust system and the high socio-economic value of Rotterdam makes the change into a completely new equilibrium not realistic. However, the governance transformability that is aimed for focusses on an increase of the inclusiveness, integration and adaptivity of the system in Rotterdam. This is considering the integration and changing division of responsibilities among climate hazards is strengthened by the adaptability measures. This is a cross-over between adaptability and transformability, since the spatial adaption efforts at neighbourhood level with involvement of the citizens contributes to the aim of transformability. This will contribute stability of the social-ecological system by changing the governance and adjusting it in a physical way.

Overall climate resilience balance

Resilience is a combination of stability and change. It is a balance among the robustness, adaptability and transformability dimensions. Both cities show that due to cross-overs and trade-offs among the dimensions of resilience a balanced equilibrium is difficult to achieve. Also a balanced and inclusive focus regarding the various climate hazards in the resilience dimensions appears different in reality. Due to history both cities focus on flood related hazards and other climate hazards are not in the core of the policy arrangements, but are upcoming. For Jakarta this resulted in a dominance of adaptability, in which efforts are often relying on the adaptation and recovery ability of the citizens. This has grown

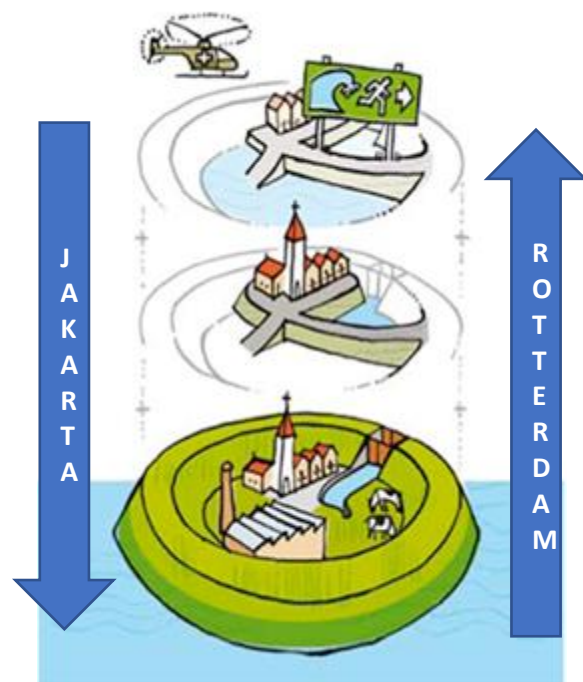


Figure 20: Resilience balance of Jakarta and Rotterdam (STOWA, 2017; adjusted by author)



out of necessity over the years, due to the frequency of flood events, high temperatures and the lack of efficient actions and responsibilities taken by other actors. This approach is based on the manageability of the consequences of climate hazards and accepting the occurrence. This dominance in efforts is visualized in Figure 16. For Rotterdam the trade-offs and cross-overs resulted in a dominance of robustness in which government steered responsibilities, rules, and resources to keep the water out. The Dutch approach includes a large managing capacity in which its primary focus is to prevent climate hazards from happening. Adaptability efforts are in the picture and accelerating nowadays, but often remain additional to robustness as visualised in Figure 16. Unless, the robust system is not covering, for instance in outer dike areas and regarding heat stress and drought. Both cities have plans and scenarios about transformability, the one more realistic than the other. However, the cases of Jakarta and Rotterdam both show that despite the plans and scenarios to change into a new equilibrium, it remains difficult due to a variety of social, political, and economic interests. Therefore, the cities their resilience is currently focussing on the elements of robustness and adaptability, of which their focus elements and approach is displayed in Figure 16. Due to the local context and trade-offs in place the balance of the resilience dimensions could be stated as the other way around.

6.2. Discussion

This section provides a critical reflection on the process and the content of this research. Also, the limitations of the researched are described.

Reflection on methodology

This research used a qualitative case study methodology with semi-structured interviews, document analysis and observation as methods for data triangulation. This methodology was most suitable since it collected the in-depth data which was required to answer the research question. However, the context of the methods creates certain points for reflection. First of all, most interviews were conducted online as a result of the aftermath of the global Covid-19 pandemic, which had certain pros and cons. Interviews conducted through online mediums were hindered in the transfer of non-verbal communication which is sometimes essential to understand the nuance of the spoken language. Also, the online interviews were sometimes disrupted by unstable internet connection which hindered the flow of the interview and sometimes caused miscommunication and possibly has affected data collection a little. On the positive side, online interviews caused a decrease in travel time, made abroad interviews available and contributed to the amount of interviews that were conducted. Furthermore, it was very beneficial for the study that the researcher was able to visit both cases and do observations. However, for full data triangulation it would have been beneficial if the observation in Rotterdam would have been in participating form guided by an expert, as in Jakarta. Moreover, the data collection methods for the Jakarta case were sometimes hindered by the language gap. Some documents were available only in Bahasa Indonesia which the researcher was not able to read. Therefore, the research had to rely for some information only on the data collected by the interviews and observations. The gap in language also



reduced to ability to communicate with relevant subjects in the surrounding during the observations and during the interviews, which potentially may have an influence on the sharpness of the collected data. More in-dept information could have been gathered for the research on the Jakarta case in event the visit was extended and relationships were built further with the interviewees.

Reflection on results

The results of this research are mainly in line with the expectations of the research and the existing literature. The result that Rotterdam has a dominant balance towards the robustness dimensions and the ability to resist regarding flood related challenges is in line with the result of the ability of the Netherlands in general in which the government takes all responsibilities (Hegger et al., 2016; Keessen et al., 2013). The results that Jakarta has a dominant balance towards the adaptability dimension and the ability to limit the impact is in accordance with previous studies showing that the urban flood resilience in Jakarta is centred upon the human abilities (Dwirahmandi et al., 2019; Rahmayati, Parnell & Himmayani, 2017). However, the results of the research did lead to a few notable insights. It was remarkable that regarding full climate resilience including heat stress and drought, the possibility for a robust system is questionable. This might be derivable from the fact that the climate resilience theoretical framework of Torabi et al., (2021) is based on a flood resilience framework. Additionally, the results of this research based on the collected data including the findings on the policy arrangements often focus mainly on floods due to tradition. Nevertheless, heat stress and droughts are becoming more important and the efforts regarding these challenges are accelerating. Furthermore, it was important to notice that some results on the resilience efforts taken in the cities are positioned in a grey area between the robustness and adaptability dimensions. Graaf-van Dinther and Ovink (2021), have identified five conceptual and operationalised dimensions of resilience, which might have provided more clarity in the translation of gained data into the results of the research. Furthermore, it is notable that the spatial adaption measures taken at building level in Jakarta are often 'building designs' by tradition to cope with certain climate circumstances and not new adaption measures that are nowadays taken regarding climate change.

Limitations

This research focussed on the city of Jakarta and Rotterdam as a whole reflecting to the PAA. This focus has led to certain limitations of the research. First of all a disclaimer on the Jakarta cases need to be given. Due to the time and resources framework of this Master thesis in combination with the large scale of Jakarta, this study does not claim to represent a complete overview of the resilience dimensions of the city. However, in the light of general information combined with examples, the study aimed to present a realistic impression of the resilience of Jakarta. Furthermore, due to the focus on the cities as a whole, specific neighbourhoods or activities as the harbour were not included. A more neighbourhood focussed approach might have provided more in-dept information of the cities and identified differences of the resilience balance among the city. Due to the focus of the PAA approach, actors involved were identified in general and mostly experts who could fills this in were interviewed. This resulted to the



fact that for both cases citizens were not specifically included in the research, which might have provided different views on certain resilience elements.

6.3. Recommendation

Recommendation for praxis

The main goal of this research is to identify the current balance of the resilient elements of the cities, which does not explicitly include providing recommendations. Nevertheless, during the research the following recommendation points came up for praxis. In the dynamic of both cities many transitions are currently ongoing which contribute to general resilience for the bigger picture of the city. Other active transitions are for instance the energy and mobility transitions. The climate resilience efforts are only one path in this large and general urban resilience. Therefore, it is recommended that these different transitions are approached in a more integral way, due to the limited and lacking of available resources, such as land which are of paramount importance for all transitions and can only be used once.

When providing recommendations for the climate resilience of Jakarta and Rotterdam specifically there are definitely recommendations to be given and lessons that can be learned from each other. However, the first recommendation is, when learning from each other it is important to not copy paste the lessons learned due to the many differing city characteristics. Lessons learned need to be translated into the local context. This can be done through international coalitions in which the different cities or countries come together and are able to gain knowledge and capacity building which contributes to the local situation.

For Rotterdam the recommendation is concerning the topics of heat stress and drought. The study has shown that more knowledge and capacity building is desired on these upcoming climate challenges. Furthermore, the adaptability and especially the mind-set in line with this needs to be improved to balance the resilience dimensions more. This includes investment in the knowledge and skills of citizens in order to stimulate them taking their own responsibilities. When adaptability is being strengthened and the acceptance and awareness of the occurrence of different climate hazard increases, a large step forward is made towards a more balanced resilience.

For Jakarta the most important recommendation might be an obvious one. It is recommended to strengthen the robustness. A precondition for this is to stop the land subsidence. However, this is easier said than done, due to the complexity of political interests and availability of resources. Therefore, it would be beneficial for Jakarta to also develop a program and fund that is separated from the political interests and changes, which could guarantee the continuation of the robustness, even if it is only on a small scale. Because a certain amount of robustness is required, since not all consequences can be reduced, for instance, the ecological and economic damage by a coastal flood.

Recommendations for further research

Recommendations for the academic field for further research are in line with the recommendations for the praxis. As mentioned there are many transitions regarding the general resilience of the city ongoing



which all depend on similar scarce resources. Therefore, a recommendation is to conduct further research for both cities on the resilience in general in which an integral vision is researched regarding all active transitions that contribute to resilience. Another recommendation for further research is based on gaining knowledge towards the challenges of heat stress and drought in Rotterdam. Follow-up research can provide insights on how to achieve climate resilience towards these climate challenges and integrated it in the bigger climate resilience picture.



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Appendixes

Appendix 1: List of interviewees

Jakarta Interviewees

Interviewee	Function	Organisation	Date	Location	Duration
Adang Saf Ahad	Former project manager NCICD project	Ministry of Public Works and Housing (PUPR)	June 2 nd , 2022	Physical	60 min
Victor Coenen	Project manager NCICD project	Witteveen + Bos	May 16 th , 2022	Online	60 min
Carel de Groot	Former First Secretary/ Thematic Experts water management	Ministry of Foreign Affairs: Dutch Embassy Jakarta	May 13 th , 2022	Online	60 min
Rully Irzal	Head of Regional body for planning and development (BAPPEDA)	DKI Jakarta	May 27 th , 2022	Physical	60 min
Peter Letitre	Sr. Project Manager – Part of NCICD Dutch consortium	Deltares: Jakarta office	April 21 st , 2022	Online	60 min
Ika Ningrum	Head River management of the Water Resource Agency (DSDA)	DKI Jakarta	May 31 st , 2022	Physical	60 min
Elisabeth Tarigan	Head of Planning section for geology, water conservation and clean water supply of the Water Resource Agency (DSDA)	DKI Jakarta	May 12 th , 2022	Online	60 min
Wendele van der Wiele	Sr. Program advisor Partners voor Water / Coordinator Indonesia	Rijksdienst voor Ondernemend Nederland	May 17 th , 2022	Online	60 min
Koos Wierix	Principal advisor NCICD project / former advisor Water Management Indonesia	Ministry of Infrastructure and Water Management	April 28 th , 2022	Online	60 min



Rotterdam Interviewees

Interviewee	Function	Organisation	Date	Location	Duration
Jurgen Bals	Area manager Rotterdam / program manager climate & space	Hoogheemraadschap Schieland en de Krimpwaard	April 21 st , 2022	Online	60 min
Corjan Gebraad	Strategic advisor urban management, water department / involved in Delta program	Municipality of Rotterdam	April 19 th , 2022	Online	60 min
Lizette Hemmen	Project manager climate adaption: resilient infrastructure	Ministry of Infrastructure and Water Management	April 26 th , 2022	Online	30 min
Marco Hoogvliet	Advisor urban water & subsurface / Manager of research program Resilient Cities	Deltares	June 7 th , 2022	Online	60 min
John van der Knaap	Advisor climate adaptation and transitions	Housing corporation Havensteder	April 21 st , 2022	Online	60 min
Johan Verlinde	Program manager Rotterdams WeerWoord	Municipality of Rotterdam	April 28 th , 2022	Online	60 min
Astrid de Wit	Program manager climate adaption	Province of Zuid-Holland	April 15 th , 2022	Online	60 min
Roald Wolters	Sr policy advisor climate adaptation	Ministry of Infrastructure and Water Management	April 13 th , 2022	Online	60 min



Jakarta & Rotterdam Interviewees

Interviewee	Function	Organisation	Date	Location	Duration
Nikéh Boisters & Tom Raadgever	Sr. Advisor Water Safety, Flood Risk Management, Climate Adaption / Consultant Climate Action Plan Jakarta & Sr. Advisor Water Safety and Spatial Planning	Sweco	April 21 st , 2022	Online	45 min
Henk Ovink	Special Envoy for International Water Affairs	Kingdom of the Netherlands	May 11 th , 2022	Online	30 min



Appendix 2: Interview guide

Interview guide scriptie: Climate resilience Jakarta en Rotterdam – NL

Introductie

- Dank voor je tijd!
- Introductie onderzoek en onderzoeker
- Uitleg structuur interview (in NL maar wel resilience)
- Goedkeuring opname + indien gewenst anonimiseren
- Mogelijkheid voor vragen

Opstart vraag:

- Zou je jezelf kunnen introduceren en je rol irt klimaat resilience in NL?

Robuustheid: Verminderen van de kans op klimaat verstoringen

- Wat wordt er momenteel gedaan om de kans op klimaat verstoringen tegen te gaan aan de hand van structurele maatregelen? Voor de verschillende klimaat verstoringen?
- Wat wordt er momenteel gedaan om de kans op klimaat verstoringen tegen te gaan aan de hand van ruimtelijke ordening ?
- Hoe relateren het beleid en de maatregelen om impact te verminderen van de verschillende klimaat verstoringen tot elkaar? (Cross-overs, trade-offs, verschillen)
- Wie zijn er **verantwoordelijk** voor bescherming tegen klimaat verstoringen?
- Wat/ Welke powers/**resources** zijn er (nodig hiervoor) voor de robuustheid in NL?
- Welke **regels** formeel of informeel zijn in plaats om de bescherming tegen klimaat verstoringen te realiseren?
- In hoeverre is het verminderen van de kans op klimaat verstoringen al terug te zien/dominant in de **discours** van de beleidsprogramma's en de visie van probleem en oplossing?

Adaptatie vermogen: verminderen van de impact of klimaat verstoringen

- Wat wordt er momenteel gedaan om de consequenties van de klimaat verstoringen te beperken?
 - Klimaat proof maken van bestaande en nieuwe infrastructuur en gebouwen?
- Wordt er op dit moment al gekeken naar het ontmoedigen van **kwetsbaar landgebruik**?
- Wat zijn de huidige **waarschuwing**(& evacuatie) procedures voor de verschillende klimaat verstoringen?
- Welke gedachtes en handelingen zijn er momenteel over het verminderen van de **financiële** schade van klimaat verstoringen?



- Hoe relateren het beleid en de maatregelen om impact te verminderen van de verschillende klimaat verstoringen tot elkaar? (Cross-overs & verschillen)
- Welke **beleidsvelden** zijn onderdeel van klimaat adaptatie?
- Wie/welke partijen zijn **verantwoordelijk** voor klimaat adaptatie?
 - Wie zou dit moeten zijn?
 - Zijn er wel eens strubbelingen hierin?
- Hoe staat klimaat adaptatie beleid van het Rijk (NAS) irt klimaat adaptatie in de stad/Rotterdam?
- Welke powers/**resources** zijn er (nodig hiervoor)?
- Welke **regels** formeel of informeel zijn in plaats om klimaat adaptatie te realiseren?
- In hoeverre is klimaat adaptatie al terug te zien in de **discours** van de beleidsprogramma's en de visie van probleem en oplossing?

Transformatie vermogen: aanmoedigen van maatschappelijk transitie ten aanzien van klimaat verstoringen

- Hoe ervaar je het **bewustzijn** onder burgers en andere stakeholders ten aan zien van klimaat verstoringen?
 - Wat wordt er gedaan om dit te creëren/verhogen?
- Hoe is de **samenwerking** met burgers en andere stakeholders?
- Wordt **leren en experimenteren** meegenomen en aangemoedigd, zo ja hoe?
- Worden **toekomstige uitdagingen** en onzekerheden gewaarborgd in het in de huidige beleid (NAS)?
 - Wat wordt er gedaan ten aanzien van **lange termijn denken**? En welk termijn is dit?
- Wie/welke partijen zijn er op dit moment **verantwoordelijk** voor het aanjagen in de maatschappelijke transitie ten aanzien van klimaat adaptatie?
- Welke powers/**resources** zijn er (nodig hiervoor)?
- Welke **regels** formeel of informeel zijn in plaats om deze maatschappelijke transitie waar te maken?
- In hoeverre is deze transitie al terug te zien in de **discours** van de beleidsprogramma's en de visie van probleem en oplossing?

Verhouding resilience:

- Wat is volgens jou de **balans** tussen de verschillende resilience dimensies in Nederland?
 - Is jou visie op deze balans evenwichtig ten aan zien van de **verschillende klimaat uitdagingen**?



- Zijn er **trade-offs**/compromissen die ontstaan onder de verschillende resilience dimensies?
- Zijn er bepaalde elementen binnen de resilience dimensies die elkaar kunnen versterken/**cross-overs**?
- Onder welke **beleidsvelden** worden de verschillende resilience dimensies nu gewaarborgd?
- Welke aspecten in de besproken resilience dimensies van NL zijn volgens jou een voorbeeld/**strength** voor andere steden/landen kijkend naar de toekomst? (aspecten → denk aan PAA elements)
- Wat zijn volgens jou nog de grootste **uitdagingen** in de verschillende resilience dimensies in NL met het oog op de toekomst? (aspecten → denk aan PAA elements)

Afsluiting:

- Mist er nog relevante informatie?
- Mag ik je nog benaderen later indien nodig?
- Vragen?
- Bedankt!

Appendix 3: Visuals coastal defence Jakarta of observation



Removal of the water hyacinth by dragging of a water retention area (Waduk) in Jakarta to maintain the storage capacity



Street in a Kampung in Northern Jakarta suffering from extreme land subsidence, becoming a 'bad tub' for water



Coastal dike showing the different construction layers developed over the years



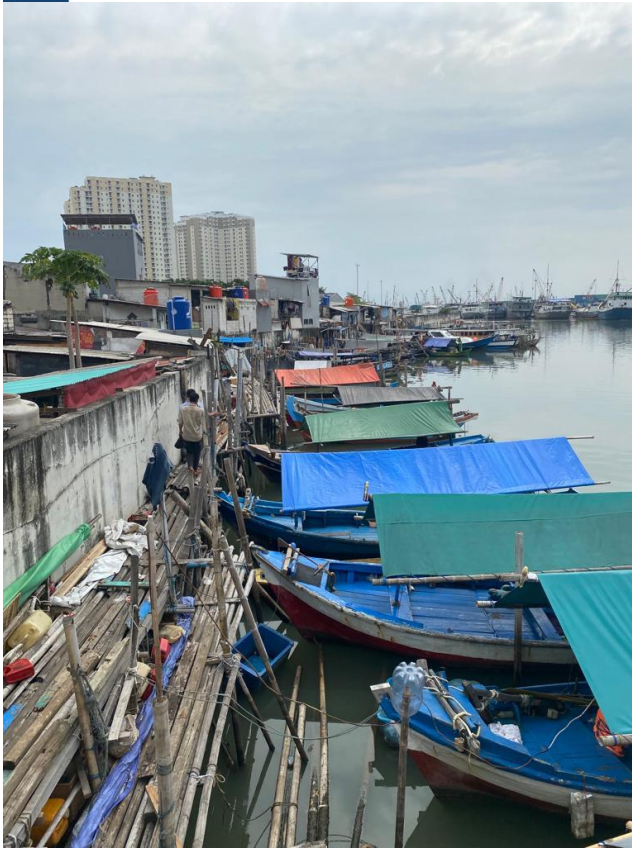
'Regular' coastal dike section



Functionality adjustments made by coastal community to a coastal dike



Houses built on stilts in the water in the coastal area



Coastal dike from a outer dike view adjusted by coastal community for functionality



Newly constructed dike section



Breached coastal dike in need of maintenance