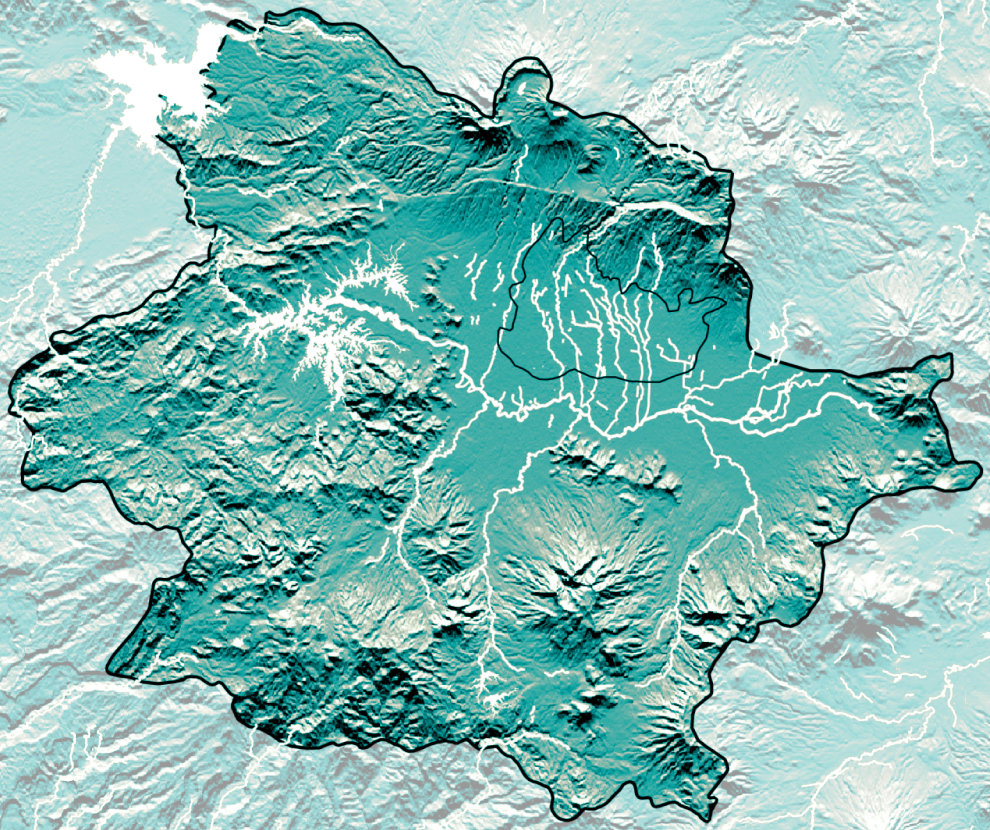
# ADAPTIVE RESILIENCE

| THE ADDED VALUE IN A CHANGING WORLD |



## FLOOD RISK ADAPTATION STRATEGY FOR OVERCOMING SOCIO-SPATIAL VULNERABILITIES IN BANDUNG REGION

| ILIYANA R. MITEVA |

# Colophon

**Adaptive Resilience: the added value in a changing world**

Flood Risk Adaptation Strategy for Overcoming Socio-Spatial Vulnerabilities in Bandung Region

Bandung, Indonesia

**Graduation Project**

**P5 Report**

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## IV. DESIGN



## V. CONCLUSION AND DISCUSSION

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To my family, for their unconditional love and confidence in me;

And to my parents, Pavlina and Rumen, to whom I owe all I have achieved, as without them I am incomplete.

# Abstract

Presently, the urban and natural systems in the world are trying to balance between coping with the extreme climate conditions and the expanding development. The urgency of accommodating these changes calls for flexible and adaptive response, which can sustain the risks and enhance the performance of the systems. This graduation thesis studies the possibilities of creating urban environments which can withstand and absorb shocks, ultimately increasing their resilience towards climate change. The focus of the research is the Bandung Region in Indonesia, a densely populated metropolitan area, highly exposed to flood risk due to its vulnerable socio-spatial context. The future predictions indicate that by 2035 the population in this area will increase double to the current situation (Djalante, Garschagen, Thomalla, & Shaw, 2017), leading to rise of the social inequalities and escalating vulnerabilities. By further exploring the existing practices for reduction of those risks, the research finds measures improving the safety conditions, but failing to address the issues of well-being and quality of life of the society. This leads to the understanding that overcoming the issues of vulnerability, within the framework of the uncertain future, requires more than just aiming at flood protection. Thus, this graduation thesis explores the added value of flood risk adaptation strategies through the lens of creating safe, healthy and inclusive urban setting.

**Key Words:**

Climate change adaptation, Flood risk, Design with uncertainty, Stakeholder Involvement, Healthy and just urban environments

# Introduction

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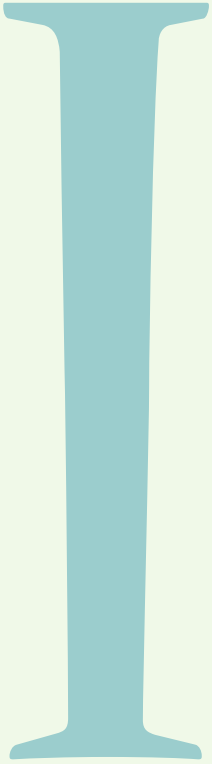

# 1. Preamble

## 1.1. Introduction

The traditional systems in today's cities are facing immense challenges driven by the global processes of climate change. In this context, integration and flexibility of the strategies coping with hazard exposure are critical for creating sustainable and safe urban environments. There is a need for better understanding of the driving forces of vulnerability in both social and physical systems and imagine how the future will unfold to them. In the recent years, there have been many studies on these topics and many emerging practices, which follow the goals of sustainable urban development and cohesion between nature and humans. However, the need of appreciation and acceptance amongst local communities and governments is bigger than before. In the context of rapid population growth and thus immense pressure to the territory, many of those practices fail to achieve their sustainability and safety goals. Therefore there is urgent need for locally-based approach, which considers the specifics and challenges of the area and encourages participation and stakeholder involvement.

This study revolves around the case of Banding, Indonesia. For the purpose of the project the term "region" will be used for a combined area of the four administrative boundaries that create the metropolitan area of Banding – namely West Banding, City of Chimahi, City of Bandung and Banding Regency (Figure 1).

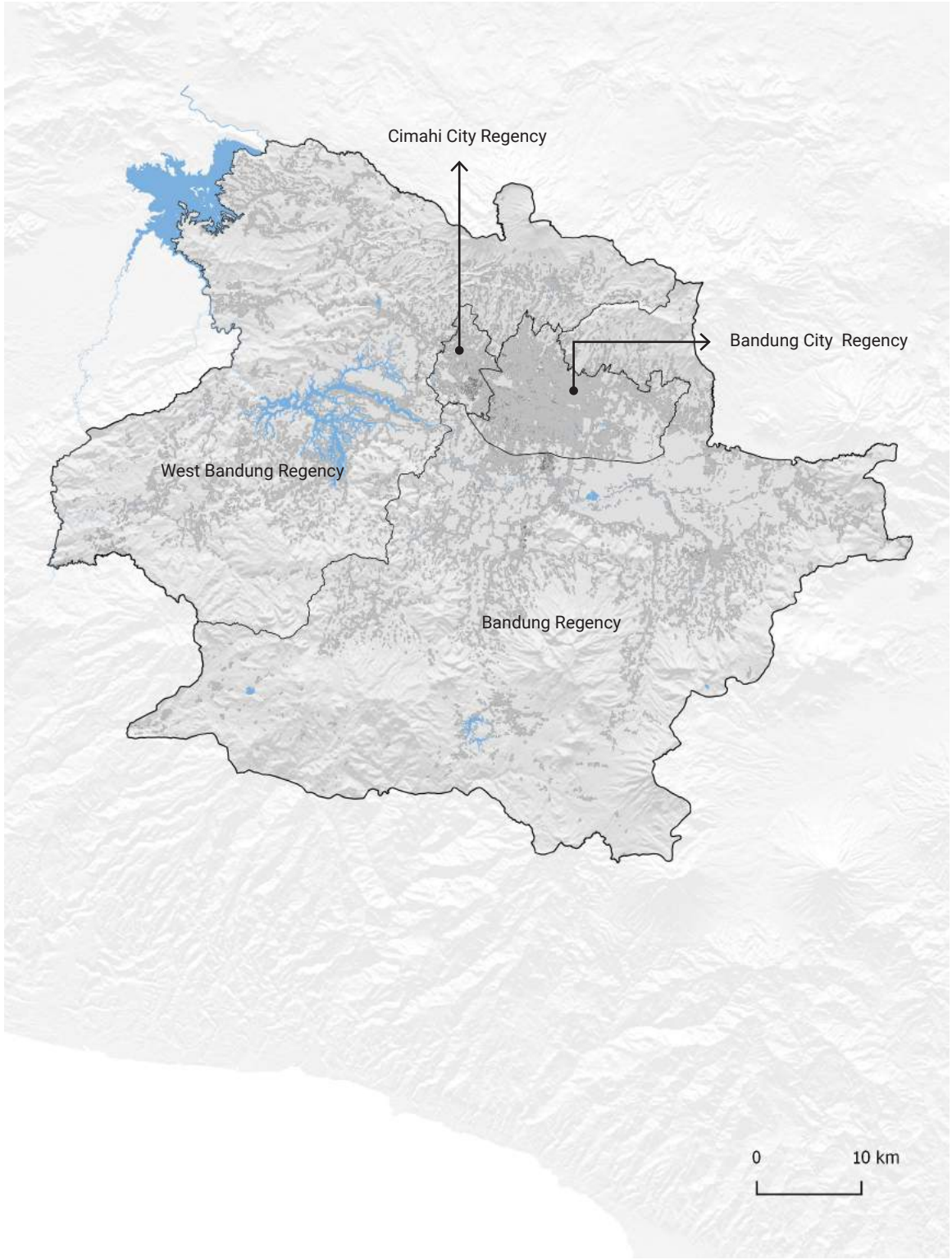


**Figure 1** Bandung Region
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## 1.2. Motivation

The motivation of this project started as a personal interest and excitement on the topics related with water systems. It was triggered by the world wide challenges that no person is immune to experience – floods, draught, no access to drinking water, pollution, etc. The attention of the project focused on the "too much" scenario as if unfolded in a case study of Bandung, Indonesia. As the thesis is done in the Netherlands, there were plenty of examples, good practices and measures that could have been applied to the research. This availability of strong base was an important asset that the study utilized.

However, except from the initial motivation to start the project, while in the process of exploration there was another very strong stimulus for it to pursue the adaptation capacity in detail. During the study visit in Indonesia, the project found its missing linkage to be strongly rooted in the traditions of the area. The incredible strength, positivism, capacities and adaptiveness of the local population played a crucial role into choosing the path of the project. The conversations and interviews that were conducted on the field trip allowed closer understanding of the values and mind-set that the locals have. The care and appreciation to their land and community creates an easier path towards overcoming any effects of flooding that there might be. This strong belief and capacity of the Banding people is tried to be preserved and build upon in this project.


**Figure 2** "A baby in a bucket"
Source: Photo by Novrian Arbi / Antara, 2016, adapted by Auther

# 2. Relevance

## 2.1. Societal relevance

The extreme consequences from the climate change are evident in the whole world, as billions of people struggle on daily basis for sustaining their homes and livelihoods. In the project area of this graduation thesis, Indonesia, has one of the most vulnerable positions in the world regarding it's geophysical predispositions towards natural disasters with floods being the most frequent and devastating ones. This, in combination with the rapid population growth and inability of the governance to cope with the vulnerabilities in the country, leaves millions of people exposed and unsafe. Therefore, this project is extremely relevant as it proposes a further exploration on the needs and vulnerabilities for creating a more adaptive system for facing future needs and challenges. This strategy will provide more innovative and flexible solutions, allowing interconnections and balance between humans and nature, instead of humans against nature. Taking it one step further, the proposal builds upon the improvement of the quality of life and healthy environment by obtaining an added value from the adaptive resilience framework. As the project observes also the pollution and waste management in the designed areas, it has a critical view on the challenges and needed changes in governance perspective, but also every day habits of the locals. The strategy provides the crucial elements for preparing the social and physical realm for the challenges of the area, emphasized by the inevitable climate change and urban growth , but also brings them one step further for coping with unpredictable adversities.

## 2.2. Scientific relevance

The graduation thesis focused on several scientifically relevant topics related to the complex dynamics of the urban and natural systems. It identifies links and conflicts within the context of an Indonesian region Bandung. The issues that emerge from this exploration are: understanding flood risk, justifying the need for improving spatial qualities towards healthier and inclusive urban environments, addressing uncertainty through adaptive and flexible measures. In order for all of this to be realised, the study undertakes a specific approach that combines research methods and theories with their design application in the specific case study area. This facilitates the attempt for transferring concepts into tools for urban design and implementation in reality.

The first example is the transition from the concept of Adaptive resilience (Yamagata & Sharifi, 2018) towards the creation of the more practically oriented Matrix of adaptive resilience (see page 29). The concept is grounded in the advances of the four components of vulnerability – threshold, coping, recovery and adaptive capacities. However, the research recognises the lack of clear examples to what would be the measures for delivering the improvement of these specific capacities. Thus, by extending the exploration, the Matrix of adaptive resilience was created, which interrelates both the spatial and temporal scales and presents different measures which directly influence the adaptive resilience of a region. This matrix is scientifically relevant because it advances on the theoretical base by putting it into practice.

Another example is the use of Dynamic adaptive policy pathways (DAPP) (Haasnoot, Kwakkel, Walker, & ter Maat, 2013) in the project and translating the chosen pathways in a design (see page 113). With the perspective of both planning and design the DAPP method has been very beneficial for the project itself. However, most of the reference projects have been looking at the method only through the planning perspective. Hence, the transition from pathways to design has not been a straight forward task. With respect to the uncertain future and help for the assembly of the adaptive pathway map (see page), the project proposes four elements which can compose the strategic framework. While creating the adaptive pathways map and simulating the reactions of the stakeholders on it, the project gained a significant element to the design – the stakeholder involvement strategy. The points of divergence and agreement on the example map specified not only the attention to certain stakeholders' interaction, but also timeframes where additional consideration would be needed for agreement with the future plan. This unexpected outcome fulfilled a very important knowledge gap of the involvement of stakeholders in the temporal scale of the project.

The main task of the project has been to address the issue of transferability of theoretical and methodological tools into practice. It gained many insides by looking into real projects and understanding their tipping points. It tries to bridge the gap of research and design by focusing on specific measures for implementation.

# II

# Research Design

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# 3. Context

## 3.1. Field Analysis

### Geographical Characteristics

The specific topography of the region of Bandung predisposes the area to floods. The valley in which the city lays was before the bed of a lake formed in prehistoric times (Figure 3). The plain of this former lake is nowadays called Bandung Basin, where the main river in the basin is Citarum. The plain (lowest point 640 m above sea level) is surrounded by volcanic mountains (highest point 2 400 m above sea level) (Figure 4) from where more than 10 other rivers start and then discharge in the Citarum river (Figure 5). Due to these rivers and the previous lake, Bandung is surrounded by fertile soil (Figure 6) ideal for rice terracing agriculture, but also swampy areas, which are prone to floods.

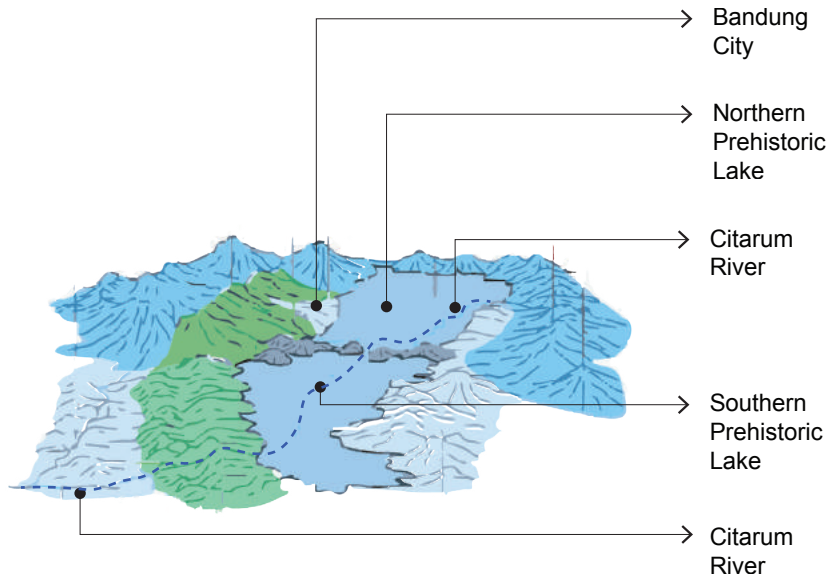



**Figure 3** Prehistoric Lake
Source: Tarigan et al., 2016

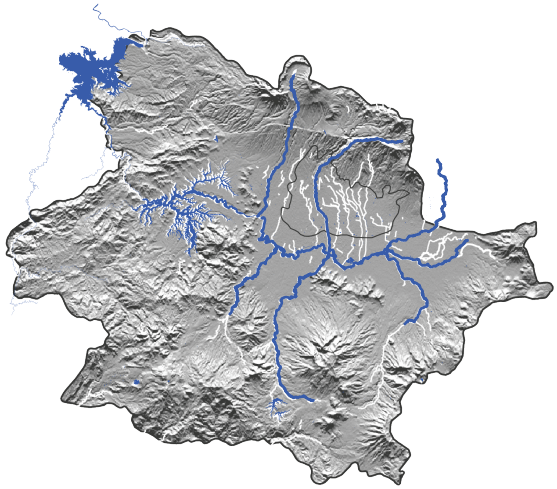


**Figure 4** Hillshade
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

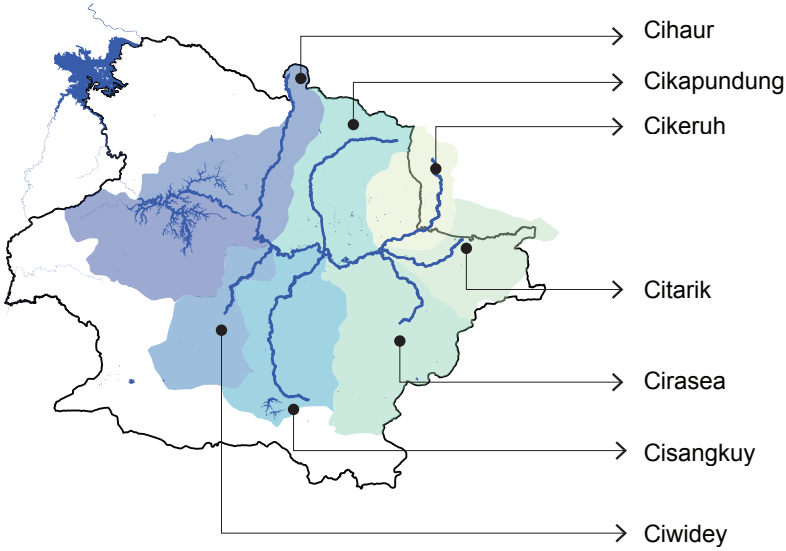



**Figure 5** Sub division catchment area map Citarum River Upstream
Source: Chaidar, 2017

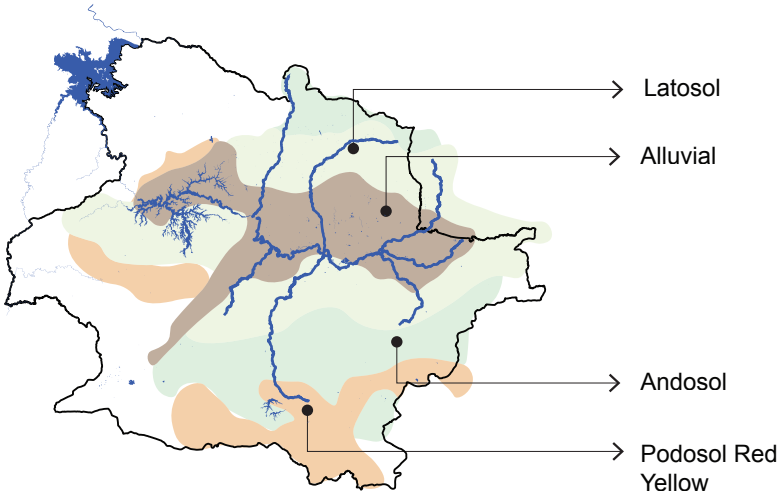



**Figure 6** Soil Type
Source: Chaidar, 2017

**Climatic Characteristics**

Another natural factor that needs to be taken into account for the predisposition of the area to floods is the tropical climate on the Java Island. The yearly peaks of rain in the wet season (there are two seasons dry and wet), happen during the months from December to March. At this time the occurrences of floods happen both due to heavy rainfall on the surface (pluvial) for shorter period of time, but also due to larger discharge volumes of the rivers (fluvial) in a longer rainfall.

**Socio-economic Characteristics**

However, if we observe these two phenomena with no other variables taken into account, then the flood occurrences would be seen as a normal cycle of widening and narrowing the riverbeds throughout the year. But in reality, these natural systems are much more complex, always dependent or in relation with other systems and processes.

For the purpose of this research there are two global processes that are worth mentioning in relation to flooding. The first one is climate change, the phenomena that has a great effect on most of the countries with a tropical climate and/or with mostly coastal inhabitation. The reason is that due to this change the peaks of extreme weather conditions are getting higher and more severe. Therefore, the amount of rain or the lack of it causes much greater damage to the environment (built or natural). Thus, the discharge volumes of water are bigger and the floodplain area becomes larger. This connected with the rapid population growth (the second global process in relation to the research) leaves immense number of people in a vulnerable position. A research suggests that by 2035 (Djalante, Garschagen, Thomalla, & Shaw, 2017), the population in Bandung will grow twice. Then the issue of coping with densification and informal settlements put enormous pressure on the environment and the city itself.

The increase of population means more available land needed for inhabitation and food production. Consequently, the need of land is satisfied by "creating" it - changing the uses or occupying dangerous, dilapidated areas. Most commonly, the chain of events goes from previously a forest (Figure 7) towards now used as an agriculture land or urbanized area, which has an immense effect on the ecologies. Deforestation upstream and incorrect agriculture creates an ease for more flash-floods and more sedimentation along the rivers. This raises the level of the water and like that the area that is affected is bigger. Also what adds to the sedimentation of the rivers is the absence of waste management, both for household and industrial waste. The solid waste that is dumped next to the river ends up in it and adds up to the sedimentation processes, aside from the high water pollution that it causes. Due to the pollution of the rivers, many people struggle with having access to clean drinking water. The practice in Bandung, as in many cities on the Java Island, is getting the water from wells. But as they provide fresh water to the citizens, an unintentional consequence is the subsidence caused by the ground water extraction. The subsidence of the soil increases the possibilities of flood occurrence.

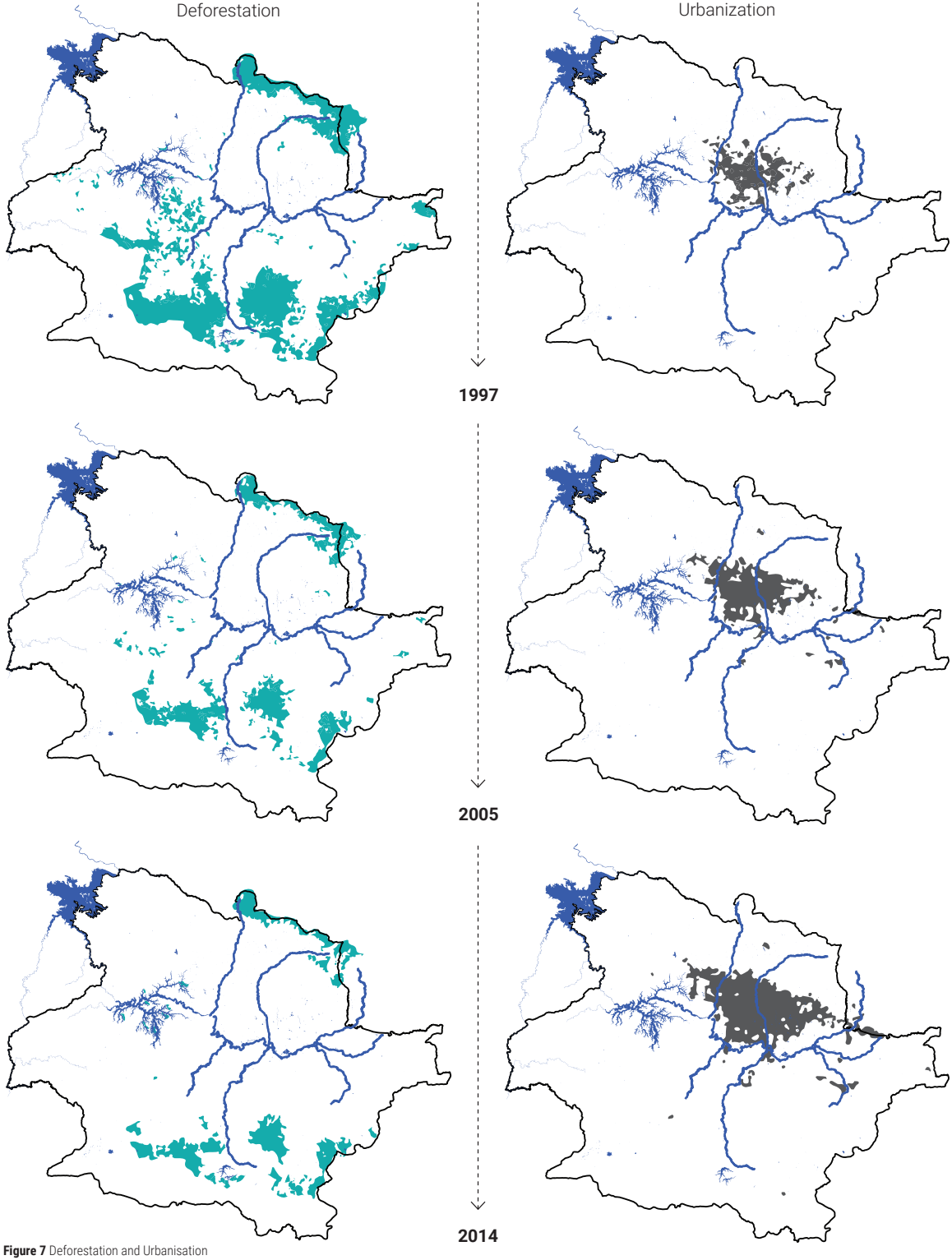



**Figure 7** Deforestation and Urbanisation
Source: Chaidar, 2017

# 4. Methodology

## 4.1. Problem Statement

Bandung Basin is a region in West Java that is strongly defined by Indonesia's natural and socio-economic conditions. The country is amongst the most disaster-prone territories worldwide due to its topographical and climatic characteristics, resulting in high exposure to a range of geophysical and hydro-meteorological hazards. The flood events are the most frequent ones and affecting the greatest number of people, especially those living in the urbanized areas. With the perspective of the global climate change, the devastating effects on these fragile ecosystems are immense.

Although there is a steady economic progress, Indonesia is facing increasing levels of poverty and deepening inequalities in the society. This, in combination with the dynamics of the rapid population growth, creates uncontrollable urban sprawl and escalation of informal settlements. The authorities in the Java Island are unable to cope and seem to neglect the rising informalities. They emerge in the most dangerous and dilapidated areas as their last resort for seeking opportunities in the city. In this context of vulnerabilities, both physical and social systems are at risk of being pushed to their extremes.

However, to overcome these extremes a paradigm change for flood resilience is necessary, where the aim is improvement of the urban realm, a unity between both social and physical aspects. In the case of Bandung region, such measures are taken with the help of flood risk management, which focuses on creating a safe and flood-proof region, by implementing structural solutions, hard mono-functional infrastructure for protecting the area. Yet, these measures to enhance safety, are lacking capabilities to improve the quality of life and well-being of the society; even sometimes being contra productive due to the rising informalities in the area. As a result, implementing flood resilient strategies only for the physical dimension, impacts the overall urbanisation process in the region with low consideration to the effects on the social dimension.

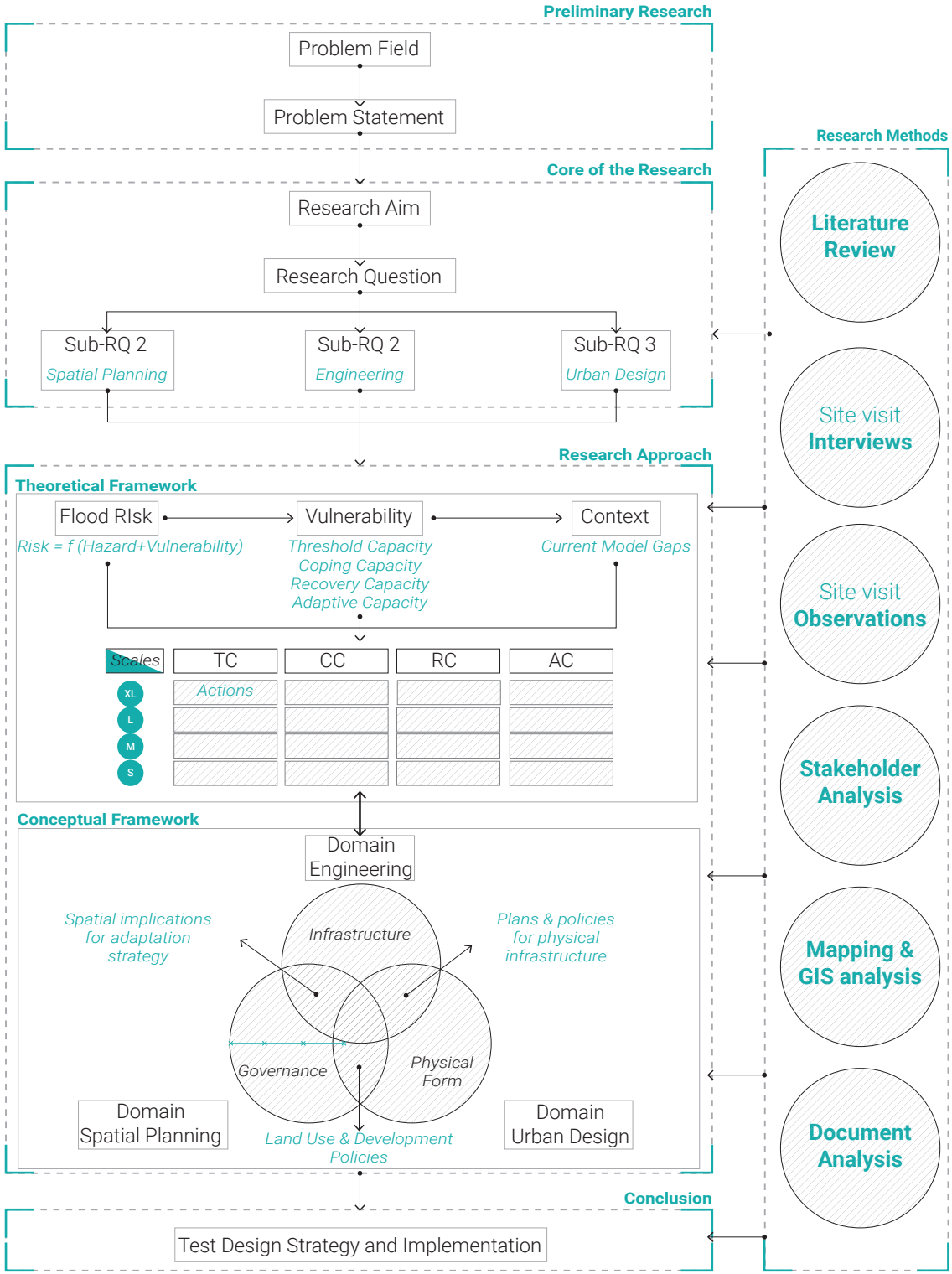



**Figure 8** Methodology Road Map
Source: Author

## 4.2. Research Aim

The research aims at overcoming the effects of extreme events of flood in Bandung Basin – to minimize the risk, create a capacity to cope and respond to such events, and gradually enhance the adaptiveness of the systems and society towards building a resilient region. However, this aim should not create further social segregation or harm the robust performance of the urban and natural environments. On the contrary, the ambition is to reinforce socio-economic stability and physical unity.

## 4.3. Research Questions

**Research Question**

**How can the flood risk adaptation strategies overcome both the physical and social vulnerabilities while sustaining healthy and just urban environments in Bandung?**

**Sub-RQ 1:**

*Spatial Planning (governance)*

How can land use and development regulation policies enhance the "healthy" and "just" performance of the urban environments?

**Sub-RQ 2:**

*Engineering (infrastructure)*

How can the physical infrastructure for flood risk adaptation allow for socio-spatial integration?

**Sub-RQ 3:**

*Urban Design (physical form)*

What are the spatial implications for flood risk adaptation strategies in the context of rapid population growth and rising informalities?

**How can the flood risk adaptation strategies overcome both the physical and social vulnerabilities while sustaining healthy and just urban environments in Bandung?**

**Literature Review**

Advantage: Understanding complexity
Limitation: Dependance on existing literature
Validation: Site Visit | Mapping

**Site visit Interviews**

Advantage: Understanding specificities
Limitation: Representative sample
Validation: Literature Review | Document Analysis | Mapping | Stakeholder Analysis

**Site visit Observations**

Advantage: Obtaining personal position
Limitation: Time
Validation: Literature Review | Mapping

**Stakeholder Analysis**

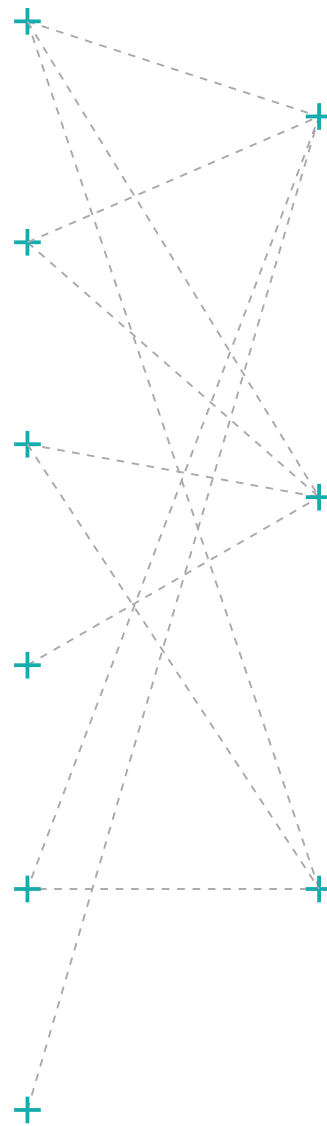
Advantage: Understanding relations, needs and conflicts
Limitation: Full grasp
Validation: Interviews | Literature Review | Document Analysis

**Mapping & GIS analysis**

Advantage: Organising data & draw conclusions
Limitation: Data Scarcity
Validation: Site Visit | Literature Review | Document Analysis

**Document Analysis**

Advantage: Understanding the currently executed plans
Limitation: Objectiveness
Validation: Mapping | Stakeholder Analysis | Interviews



**Spatial Planning (governance)**

How can land use and development regulation policies enhance the "healthy" and "just" performance of the urban environments?

**Engineering (infrastructure)**

How can the physical infrastructure for flood risk adaptation allow for socio-spatial integration?

**Urban Design (physical form)**

What are the spatial implications for flood risk adaptation strategies in the context of rapid population growth and rising informalities?

**Figure 9** Research Methods
Source: Author

## 4.4. Research Methods

The research methods of the graduation project also need to be worked out in synchrony with the main objectives and aims. They constantly reflect on the research questions that are asked in the core of the study. Due to the complexity of the study a mixed method approach is undertaken, so that qualitative and quantitative studies can correlate and contribute to the decisions throughout the process.

**Literature review**

The method of literature review comes from multiple sources of body of knowledge, in order to obtain batter understanding on the complexity of the issues in the urban realm. Academic, historic or statistics literature favour other methods towards effective representation of the context. It frames the theoretical tools that are main components in the construction of the research approach and it also informs the method of mapping. An example of that is the vulnerability assessment that the authors Adger and Kelly (1999) put forward in their research (Figure 9). It brings forward tangible assessment methods, which are easily represented by mapping the social indicators using CENSUS data overlaid with governance literature, practices and laws. These indicators in combination, with further explored additional theories, will be used for understanding the vulnerability in the context of Bandung region, which will guide the choice for narrowing down the scope of the study and locating better the design interventions.

**Site Visit**

The site visit is used as a method for gathering information, obtaining personal position and building on the literature review. It provides important insights for the specifics of

| Vulnerability indicator | Proxy for: | Mechanism for translation into vulnerability | Measured by |
|---|---|---|---|
| Poverty | Marginalisation. | Narrowing of coping strategies; less diversified and restricted entitlements; lack of empowerment. | Material or experiential poverty measures. |
| Inequality | Degree of collective responsibility, informal and formal insurance and underlying social welfare function. | *Direct*: concentration of available resources in smaller population affecting collective entitlements. *Indirect*: inequality to poverty links as a cause of entitlement concentration. | Measures of the quantitative distribution of assets and entitlements. |
| Institutional adaptation | Architecture of entitlements determines exposure; institutions as conduits for collective perceptions of vulnerability; endogenous political institutions constrain or enable adaptation. | Responsiveness, evolution and adaptability of all institutional structures. | Study of institutions through decision-making, social learning and inertia. |

**Figure 10** Analysis of measures of vulnerability
Source: Adger and Kelly,1999

cultural, socio-spatial, environmental conditions that could be very hard to grasp only from reading texts. It frames the context of the sites that are explored and enhances the understanding. Within the site visit there are several methods that are guiding it as interviews, observations, etc. After accumulating all this data it needs processing and refining in order to be comprehended and informative.

**Stakeholder Analysis**

The stakeholder analysis is a method for identifying the interested parties in the project area and more importantly to understand the relations between them. It develops an analysis of their needs, ambitions and urgencies which is a needed asset for completing the goals of the graduation thesis. An important factor in the stakeholder analysis is the awareness of the relations and conflicts that can emerge between different parties. In this research this will be crucial analysis for the understanding of the definition of "just and healthy" urban environments.

**Mapping and GIS Analysis**

The method of Mapping with the means of GIS analysis helps to organise and summarise ideas and data from multiple sources. This method has a direct connection to the literature review, which provides the research with many written documents, or historic maps that need to be transferred into coherent information. The collecting, analysing and refining data is a major part of the research approach as it informs the structure of the study and the following design steps. The regional scale of the project is hard to grasp with only through literature or with the means of the field trip. The use of GIS analysis helps to construct more tangible relations in the context, but also to test different design outcomes and create better informed decisions.

**Document Analysis**

The method of document analysis is considered only the first step towards the aim of the project – flood risk adaptation. In order to be able to construct an adaptive strategy for the region, there needs to be understanding of the gaps of the current governance and policy system. When this is obtained a further approach can be followed – an example is the dynamic adaptive policy pathways (Figure 11). It is a method for supporting decision making and building scenarios for the uncertain future (Haasnoot, Kwakkel, Walker, & ter Maat, 2013). It is presented in the form of a map, which shows different routes towards one particular goal, but has expected tipping points and available further actions. The limitation of this method is the need of computation in order to create accurate steps, which is hardly possible with the availability of time and experience for this thesis project. Therefore, a qualitative research will be obtained, based on the literature, policy and planning documents analysis and interviews.

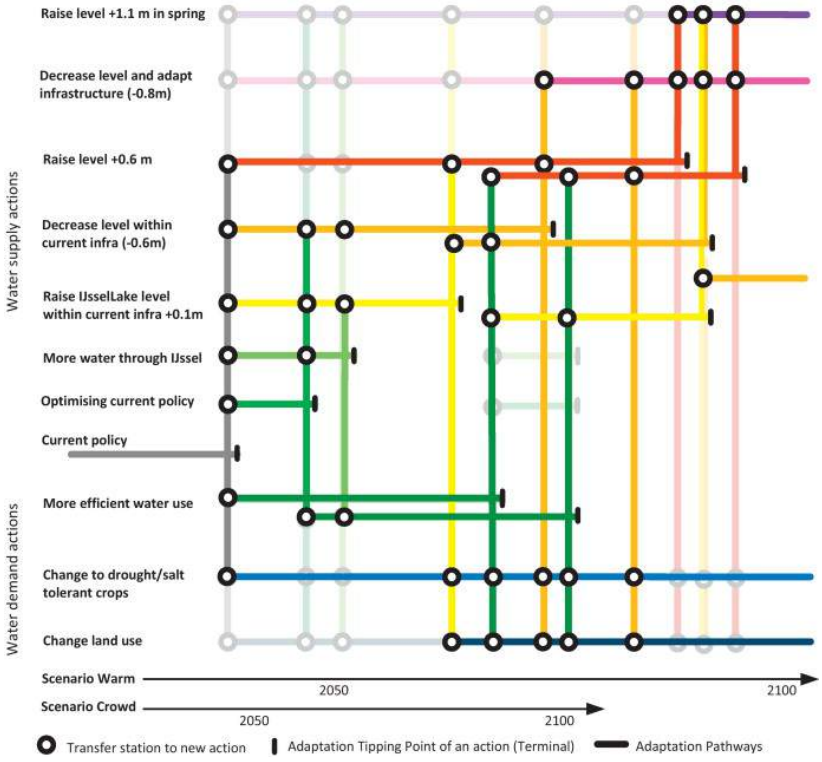



**Figure 11** Dynamic Adaptive Policy Pathways example representation
Source: (Haasnoot, Kwakkel, Walker, & ter Maat, 2013)

# 5. Research Approach

## 5.1. Theoretical Framework

The establishment of the research approach starts with putting forward relevant theories and concepts derived from the literature and combined with the context analysis.

> *"At the heart of this methodology lies the interplay among induction, derivation of concepts from data, and deduction aimed at hypothesizing the relationship between concepts."*
> *- (Jabareen, 2009)*

In order to construct the theoretical framework of the graduation thesis, we derive all the needed theories and concepts through the initial data analysis of the case study (literature review, field work, interviews, mapping, etc.). The inductive approach guides the theoretical basis of the project, as it allows the research to be more grounded and aligned with the contextual preconditions that could define the end goal of the project. Therefore, we build the theoretical framework using multidisciplinary literature, considering the complexity of the urban realm and its various components that need to be addressed (Jabareen, 2009). The direction of the graduation thesis is established, using two theoretical starting points and their interconnections.

**Reduction of Flood Risk**

The issue of natural disasters is becoming more and more relevant for the context of the case study of Bandung, due to the unconditional effects that the climate has to the site. As mentioned previously, flood events are the most frequent ones in Indonesia, hence the ideas of further understanding their risk is necessary for completing the aims of this research. This risk can be measured through its function of the probability of flood hazard, combined with the vulnerabilities in the area (Figure 12 ). In this equation the predictability of hazard exposure is highly uncertain, therefore in order to reduce the risks of floods we need to understand better the components of the second variable - the vulnerability. The literature review guided the alignment of the definition of "vulnerability" and helped establishing a position towards the components and measures that it is determined by. The term provides the "entry point" for the research on the significance of climate change and its related risks (Adger & Kelly, 1999), but it also supports the understanding of the necessary tools for overcoming them. We find that vulnerability is the extent to which both social and physical systems at risk are able to sustain damage and to recover to their initial state, or further enhance their performance. Many authors

discuss the components of the vulnerability to climate change, hence there are many different views on their definition and understanding. For the purpose of this thesis work we take the framework (Figure 13) from Rutger De Graaf as central and then associate the related findings of other authors. In his work De Graaf explains the components of vulnerability by the sequence of four building capacities – threshold, coping, recovery and adaptive, by which the term is defined.

*(1) Risk = f (Hazard x Vulnerability)*

*(2) Vulnerability = f (Threshold Capacity + Coping Capacity +*

*+Recovery Capacity + Adaptive Capacity)*

**Figure 12** Elements (1) and their links (2) of Flood Risk
Source: Adapted from De Graaf, 2009, de Graaf, van de Giesen, & van de Ven, 2007

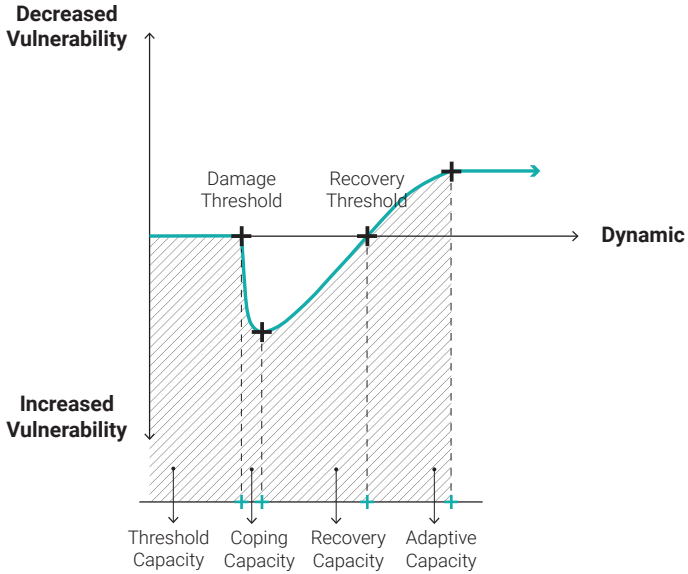
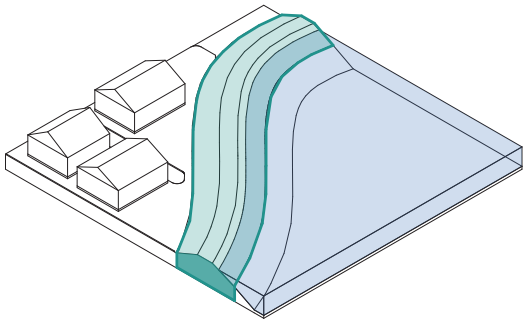



**Figure 13** Vulnerability Framework
Source: Adapted from De Graaf, 2009, de Graaf, van de Giesen, & van de Ven, 2007

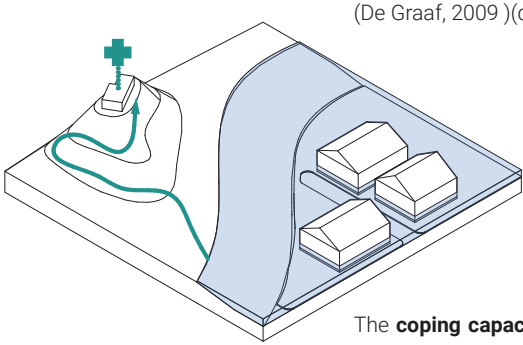
| Component | Related Terms: | Objective: | Duration: | Responsibility: |
|---|---|---|---|---|
| **Threshold Cap.** | Exposure \| Sensitivity | Prevention | Continues Practice | Socio-economic & Institutional Structures |
| **Coping Cap.** | Decision Making | Reduction | During Emergency | Local Safety & Institutions |
| **Recovery Cap.** | Potentiality | Reaction | After Emergency | Economic & Institutional Structures |
| **Adaptive Cap.** | Adaptation | Anticipation | Future Envisioning | Undefined |

**Figure 14** Description of the components of the vulnerability framework
Source: Adapted from De Graaf, 2009



**Threshold Capacity**

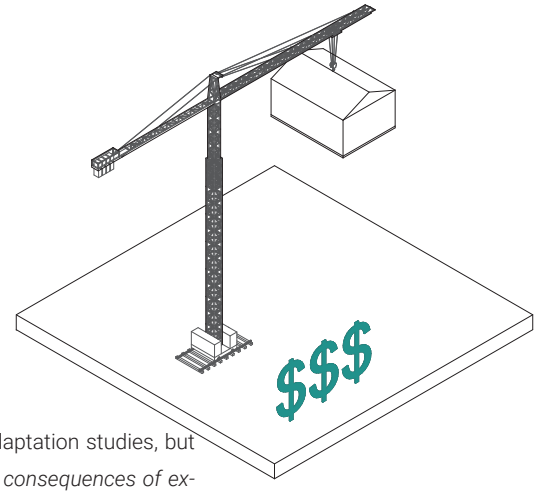
The **threshold capacity** of a system can be found in other researches as *exposure or sensitivity* of the system to risk (Adger, Huq, Brown, Conway, & Hulme, 2003). This is the physical setting and/or the existing defence infrastructure, which can be characterised with the location of the built system (floodplain, hill slopes, low coastal zones, etc.) (Adger et al., 2003). The objective of the threshold capacity is to prevent risk and increase safety, therefore to enhance the ability of the society to avoid possibilities of damage (Juarez Lucas & Kibler, 2016). If we related it to the practice, this would be building of defence line, dikes, dredging of rivers to increase the flow capacity, floodgates, etc. These solutions are mostly engineered hard infrastructure, which need special attention towards their construction and maintenance. Thus, the threshold capacity is highly dependent on the efficiency of the socio-economic and institutional structures, their abilities and resources (De Graaf, 2009 )(de Graaf, van de Giesen, & van de Ven, 2007).



**Coping Capacity**

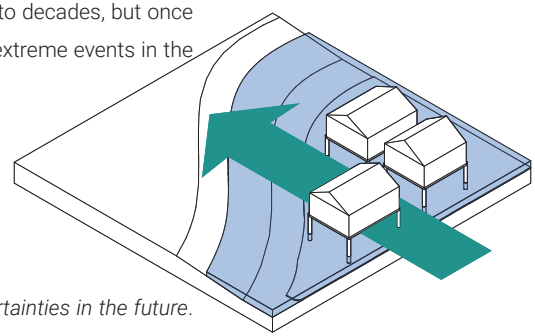
The **coping capacity**, referred to also as *building community capacity or decision making reinforcement* (Huntjens et al., 2012), reduces the damage during the extreme event, when the threshold capacity is surpassed. In practice it relates to the evacuation plans, emergency signals, organizational structure among inhabitants and institutions. The organization can be based on planned measures, considered and taken by the government in favour of the society, but also it can be self-sustained and managed by the people themselves (Adger et al., 2003) (Huntjens et al., 2012). The objective of the coping capacity is to develop the ability of reduction of the impacts from the risk event, which needs multiple actors to be involved in cooperation from the civic society, through the technical and emergency support teams, to government institutions (De Graaf, 2009). This aim has been elaborated by other authors as the need of social capital involvement, introduction of flexibility and innovation in the governance system and engagement of the private sector initiatives (Adger et al., 2003) (Otto-Zimmermann, 2011).

**Recovery Capacity**




The recovery capacity is rarely discussed in climate resilient or adaptation studies, but still it can be found as the *potentiality of a system to meet severe consequences of exposure and recover from the stress* (Adger & Kelly, 1999). The reality suggests that it is the capacity to rebuild and reconstruct damaged critical infrastructure, connections, housing, defence infrastructure, etc. The objective is to create a capacity to recover from the disaster event as quickly and effectively as possible (De Graaf, 2009) (de Graaf, van de Giesen, & van de Ven, 2007). However, the potentiality to restore the previous order strongly depends on the abilities and financial stability of the institutions and socio-economic cohesion of the population (Adger et al., 2011). Rutger De Graaf also explains that the recovery time is not easily defined, as it may vary from weeks to decades, but once overcome, it makes the population more resilient towards similar extreme events in the future.

**Adaptive Capacity**



The **adaptive capacity** is the ability of a system *to cope with uncertainties in the future*. Adaptation is the adjustment of the systems to the extreme unpredictable disturbances, which occurrence is rare but effects are immense. In the framework of Rutger De Graaf, he argues that even though a system functions nowadays, there could be exogenous or endogenous factors that could put it under great risk, where examples could be climate change, rapid population growth and uncontrollable urbanization sprawl. In those cases, the act of adaptation needs to be taken into consideration by society in general, based on the availability of resources like physical and technological capital, knowledge, institution flexibility etc. (Adger et al., 2011). Unfortunately, it is very difficult to address and define the actors for building the adaptive capacity, since the risk and impacts are in deep uncertainty. The objective of the adaptive capacity is building understanding and ability to foresee developments for the future in which the main goal is establishing robust and healthy living environment (De Graaf, 2009)(de Graaf, van de Giesen, & van de Ven, 2007). Without such adaptation systems and planning, the society will come to a capacity threshold to which recovery can no longer be possible (De Graaf, 2009).

Each of the components of vulnerability has particular implementation in reality and most of the times identified responsible actors (Figure 14). Some of them refer to a specific infrastructure based model (threshold capacity), others to more soft measures with policies and social reinforcement model (coping capacity), to the economic model for rebuilding (recover capacity) or to flexible and robust urbanization model (adaptive capacity). Reducing the risk means that there is a decrease in the vulnerability variables as the hazard exposure is unpredictable. However, an important note is that for the creation of a resilient to flood risk strategy we need to consider each of the vulnerability components, and design respectively to their implementation models, also identify how to connect them for obtaining the most advantages.

**Context analysis based on the theories**

In the current model of the dynamics of the vulnerability to flood risk in the Bandung Province (Figure 15) is highly focused on three of the four capacities. The episodic disruptive events are creating a cycle of retaining, coping and recovering from the flood disasters. The state of recovery continue until the systems are brought back to baseline functioning, which is reasonable measure for the present risk exposure. However, in this times of deep uncertainty, climate change, rapid urbanization etc., these measures might not be enough for coping with the expected vulnerabilities. Therefore, there is a strong need for change in the current model and addressing the last component - the adaptive capacity. In this way we will be creating a step forward and be more prepared for future disruptions of the systems. The advantages and limitations of the new model are explored further and advanced through the concept of Adaptive Resilience (Figure 16)

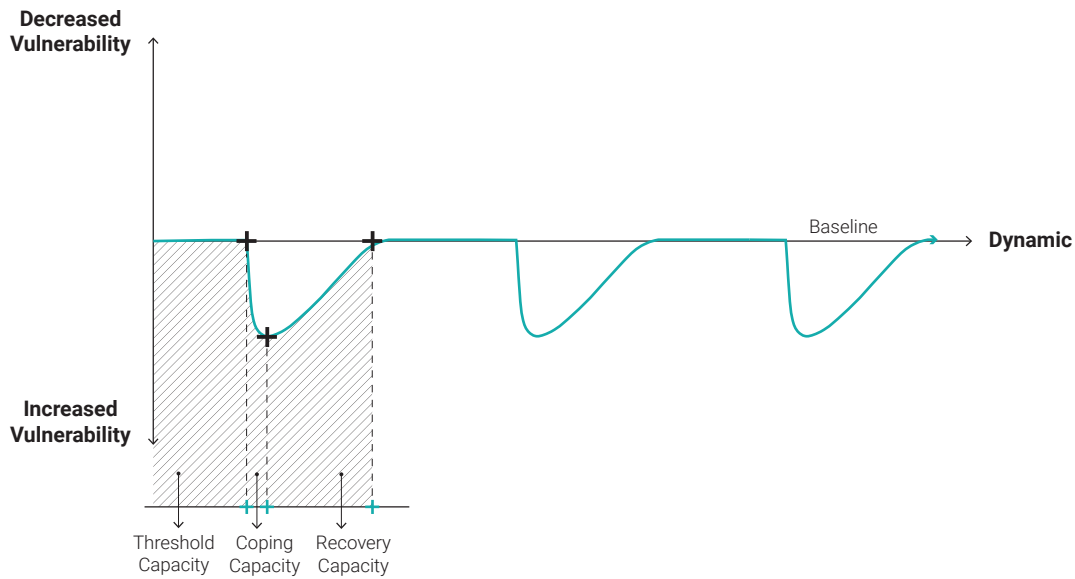




**Figure 15** Current model of the dynamics of the Vulnerability to Flood Risk in Bandung Province
Source: Adapted from De Graaf, 2009 and IOM, 2016

**Adaptive Resilience**

"The ability of urban systems to continuously develop **short-term coping** and **long-term adaptation** strategies - considering, and in response to constantly changing system dynamics and complexities over a range of **spatial and temporal scales** :

- to mitigate hazards, → **Threshold Capacity**
- withstand and absorb shocks, → **Coping Capacity**
- rapidly bounce back to baseline functioning, → **Recovering Capacity**
- and more effectively adapt to disruptive events by bouncing forward to better system configurations." → **Adaptive Capacity**

Source: Adapted from Ayyoob Sharifi and Yoshiki Yamagata, 2018

The Adaptive Resilience is a concept which emerges from the field of ecology, which considers the dynamic of the systems as a core of the complex socio-ecological inter-relations. The dynamic of this model follows the performance of the system through different temporal and spatial scales. The time defines long term and short term actions, which gradually organizes the "*short periods of chaotic change"* towards the "*long periods of stability" (*Ayyoob Sharifi and Yoshiki Yamagata, 2018*).* The long term and short term actions correlate with the above mentioned vulnerability components - building capacities. In order to create flood risk adaptation strategy all of those capacities have to be addressed for decreasing the vulnerability. In addition, the taken long-short term measures need to address different spatial scales and integrate the actions throughout these scales.

Building up the last component - adaptation capacity, creates forward thinking and better system functioning, but also it creates opportunities for obtaining social benefits (Figure 16). This is possible due to its feature of building understanding and ability to foresee developments for the future in which the main goal is establishing robust and healthy living environment (De Graaf, 2009) (de Graaf, van de Giesen, & van de Ven, 2007).

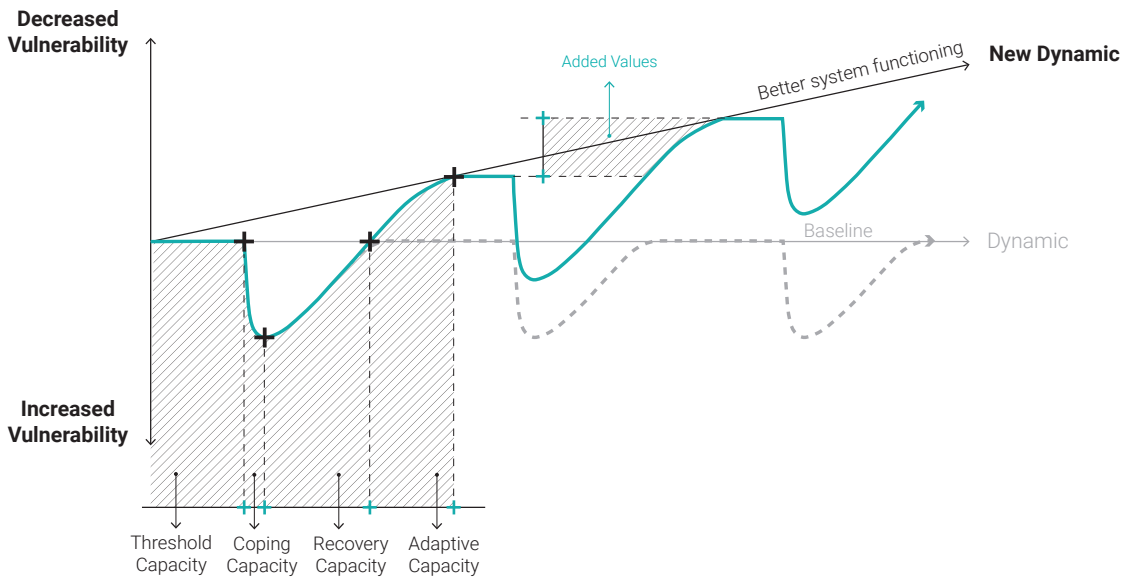



**Figure 16** Adaptive Resilience
Source: Adapted from De Graaf, 2009 and IOM, 2016

## 5.2. Conceptual Framework

The conceptual framework of this graduation project is grounded in the correlation between the theoretical framework and the context analysis of the case study (Bandung, Indonesia). Greene, Caracelli and Graham (1989) explain this approach as the interplay between theory and practice. In this way the broader understanding of the components connect the "phenomena under study" and the "relevant social, political, and environmental phenomenon or social behaviour" (Jabareen, 2009). When using the conceptual-causal threads within these components, we determine the boundaries of the thesis work. The goal of the conceptual framework is to identify the scope of assumptions that can lead to the possible answers of the research question of the thesis. In order to arrive to this goal, we present the conceptual framework as a sequence of overlapping domains, each of which refers to a particular sub-research question (Figure 17).

The theoretical framework establishes the Adaptive Resilience Matrix (Figure 18) that could deliver the aim of the study. The Conceptual framework follows this Matrix and builds upon it as it creates linkages and defines the actions within the three domains of the Conceptual Framework. It recognizes the "urban development", the "governance system", the "infrastructure measures for flood prevention" as main variables in the graduation thesis. In line with the research, the three sets of actions that refer to the main domains, are cross-validated, creating the best balance and obtaining additional value when combined.

**Domains:**

The graduation project aims at both physical and social adaptation to extreme flood events, while having a balanced impact on the urban and natural environments through the implementation of flood resilient measures in Bandung Region. In order to achieve this aim, there needs to be integration between fields of knowledge of the urban realm. This is evidenced by the lack of success of the previous attempts of enhancing the safety in the region. Considering multiple views, while creating a solution for flood vulnerability, increases the feasibility of the proposed strategy. An important note for accomplishing this is also working out the strategy through the perspectives of different scales, temporalities and sectors. Thus, the complex challenges of the adaptive strategy building can be more tangible and concrete. The three overlapping domains of the conceptual framework are the Spatial Planning, Engineering and Urban Design. Each of those domains responds to a certain sub-research question, which informs the main ambition of the project. The first one, the Spatial Planning Domain is looking closely into the governance and the factors that define the physical and social adaptation to flooding. An example of that can be the building of institutional capacity and local communities' empowerment to cope with risk, or the model of decentralization of the "power" which distributes the responsibilities in the governance system in Indonesia (Djalante et al., 2017). The second - Engineering Domain responds to the infrastructure needed for creating flood resilience in the social and physical terms. These can be factors defining safety or practices of risk

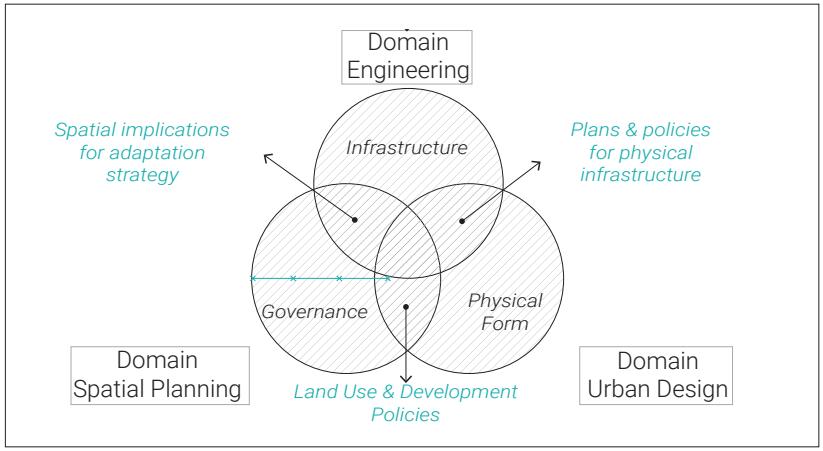



**Figure 17** Conceptual Framework
Source: Author

management. And the last one, the Urban Design Domain relate to the physical form and what it means for building the resilience in the region of Bandung. The factors can be development practices that decrease the density of certain vulnerable areas or propose different urban typology that is flexible to flood events.

**Interrelations:**

The conceptual framework shows the interrelations between the domains explained above, which are the points where the different bodies of knowledge interact. The idea is that if there are more factors that integrate between the domains, there will be better adaptive performance of both the physical and social systems. We propose three examples of this:

1. If the Spatial Planning meets the Engineering there can be plans and policies for physical infrastructure for flood resilience that pay special attention to the social integration and physical unity in a flood-prone area.
2. If the Engineering meets the Urban Design there can be specific spatial implications that can benefit the flood resilient strategies.
3. If the Urban Design meets the Spatial Planning there can be land use and development policies that regulate the impacts of the built environment to the population.

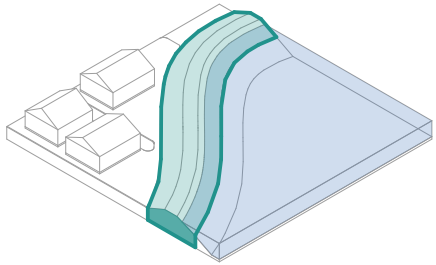
**Outcome:**

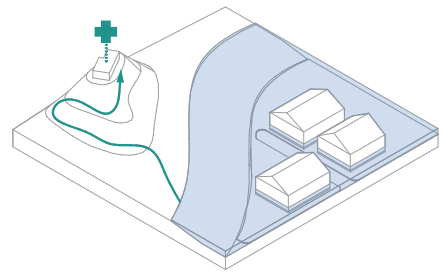
The region of Bandung Basin is in need of change towards a more holistic, adaptive approach for both the physical and social systems, in order to overcome the extremes. The establishment of a new logic in the processes of spatial development by combining flood resilient strategies through time, scales and sectors can build the much needed adaptive resilience to respond to the vulnerabilities of flood risk. This adaptiveness is the equilibrium between the domains of spatial planning, urban design and engineering, creating co-benefits for healthier and just urban environments.

## Matrix of the Adaptive Resilience

**Temporal Scale** — Threshold Capacity | Coping Capacity

**Spatial Scale**





**XL**

(G) Land Use Regulation
- Agriculture restrictions in infiltration areas
- Reforestation

(G) Defense system plan
(G) Creating Water Associations
(G) Waste management regulation
(G) Critical infrastructure location regulation

(G) Regulations for road infrastructure
- Road size parameters for enabling safe evacuation

(G) Regulations for potential pollutant materials
- Fuel Stations
- Factories

(G) Flood Forecasting information

**L**

(I) Efficient Sewer System
- CSS or SSS

(I+G) Infrastructure Maintenance
(I) Defense system
- Dikes
- Flood Gates
- Dams
- Super Levees [3]

(I) Increase river flow capacity
(I+G) Critical infrastructure protection
(I*G) Real time control & monitoring

(I) Maintenance of priority roads
(I) Elevated Priority roads for Evacuation
(G) Evacuation Plan
- Organization Structure
- Preparation of Support teams
- Coordination of Institutions and Communities
- Publication of flood maps
- Food Provision

(G) Early Warning roads

**M**

(I) Network of Water storage facilities Plan
(I+F) Water Storage and Retention
- Smart Tunnels
- Water Parks
- Drainage Canals

(I) Emergency Overflow
- Artificial flood ways
- Temporal water storage

(I) Evacuation Paths
(I+G) Strong Shelters
- Hospitals
- Schools
- Universities
- Gathering Centers
- Secure open Areas

**S**

(I+F) Water Storage
- Water Square
- Rain water tanks
- Storage tanks

(I) Temporary flood protection for emergencies

(I) Raising Ground Flood [1]
(G) Evacuation Plans Instructions
(G) Emergency Support Team
(I) Safety Equipment
- Tents
- Mask Supplies
- Life Vests
- Boats

(F) Evacuation Signs



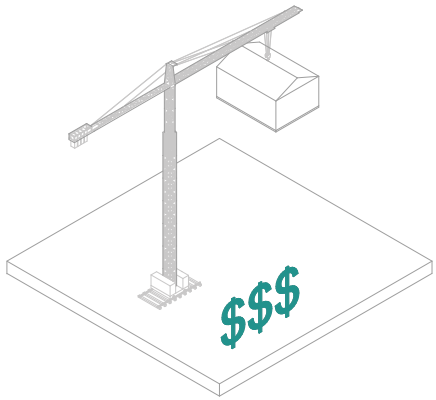
**Figure 18** Matrix of Adaptive Resilience
Source: Author

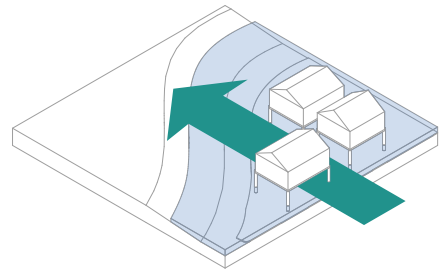
Temporal Scale

Spatial Scale

Recovery Capacity

AdaptiveCapacity



XL

(G) Insurance of Flood Risk
(G) Disaster funds
(G) Health care

(F+G) Secure Building Regulation
Robust Buildings and infrastructure
Buildings with Sealable First Floor
(I+G) Prediction scenarios of vulnerabilities
(G) Land Use restriction for vulnerable areas
(G) Relocation Strategies

L

(G) Recovery Plan
(I) Recovery of basic services [4]
Water
Energy
Waste
Sanitation
(I) Rebuilding of critical Infrastructure and road networks
(G) Damage evaluation

(G) Cross boundary flood mitigation plans
(G) Adaptive construction Plan
Regulations for floating Buildings
Regulations for permeable pavement

M

(G) Environmental Health Risk Assessment
(G) Remediation plan from polluted areas
(G+F) Social Services functions
(G) Information Centers

(F) Network of ecological sites for Waste Storage, Retention and Infiltration
Green & Blue Corridors

S

(F) Rebuilding process
(G) Financial Support & Credit
(G) Temporary Housing
(G) Sanitation
Cleanup
Medical care

(F) Floating Buildings
(F) Houses on stilts
(F) Permeable Pavement
Street
Parking
(I+F) Water Storage, Retention and Infiltration
Retention Roof [2]
BioWales [2]
Private Gardens [2]
Open ground for infiltration
Biopory

# III

# Context Analysis

## Table of contents

# 6. Setting the Test Cases

## 6.1. Preliminary Analysis

In the previous chapter the Research Approach set the guidelines for creating a consistent and integral strategy for flood resilience. Through series of socio-spatial analysis we derive the focus areas for creating test cases in the example of the region of Bandung. The aim is to concentrate and examine the strategy in the most vulnerable places, which can show more ways of resolving issues in the areas.

The analytical part starts with defining the broader scope namely the regional scale of the project. Bandung region as, mentioned before, has four regencies - Bandung, Bandung City, West Bandung and Cimahi. This region is also part of the Upper Citarum River basin, which goes through the Bandung regency, continues through a dam in the West Bandung regency and flows North towards the Java Sea. The flood plain of the Citarum river has the most consequence over the region due to the high population density and rapid urbanization growth after the colonization period.

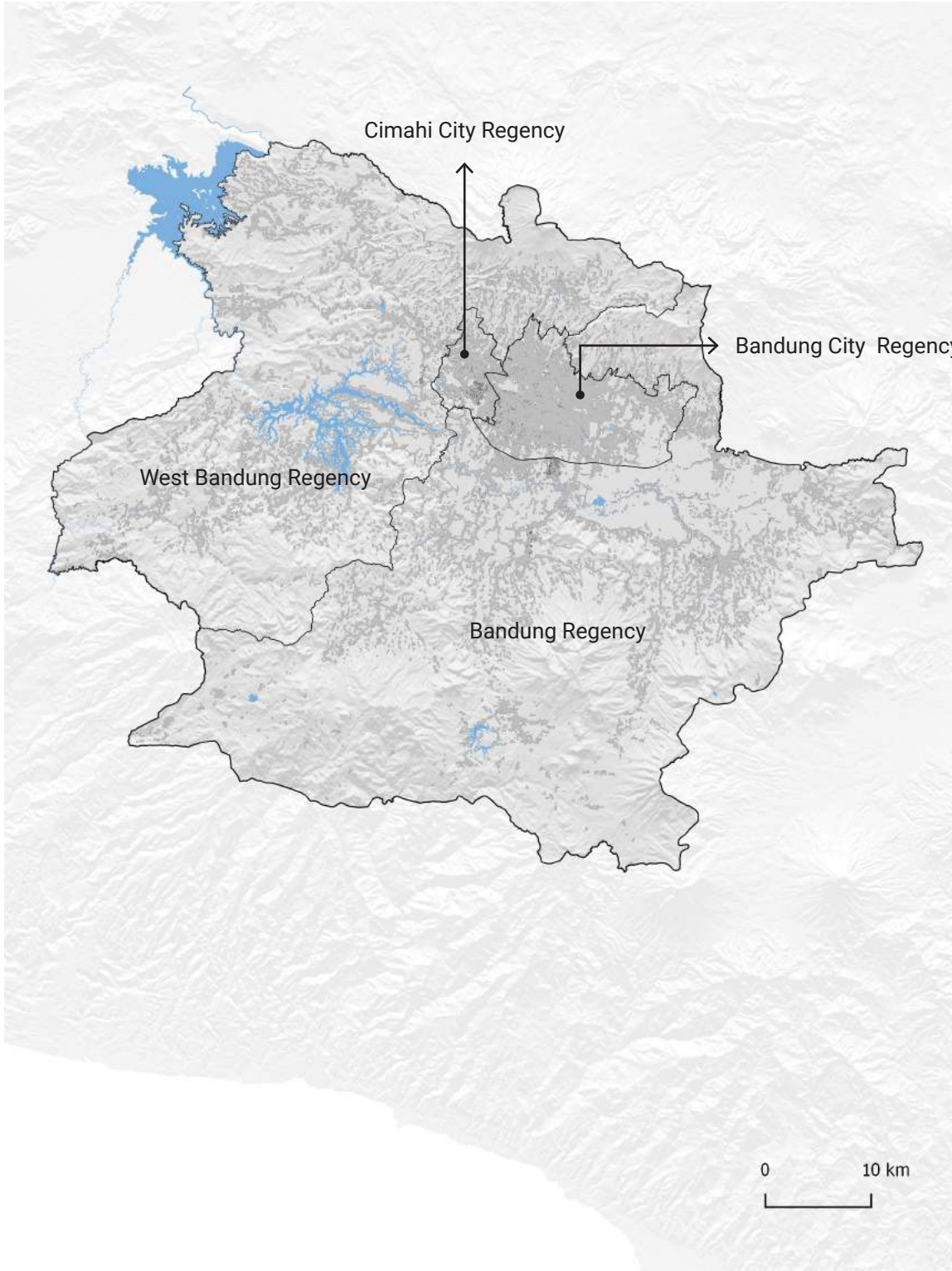
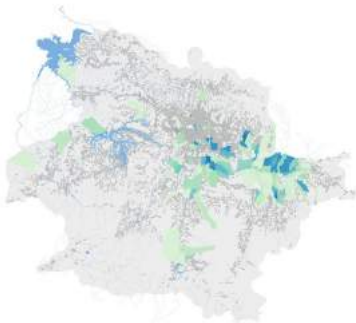



**Figure 19** Regencies in Bandung Region
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

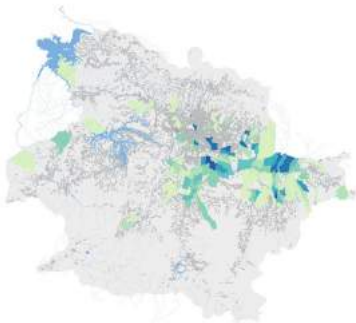
**Flood Events and Population Allocation**

Within the flood plain is very clearly outlined when gathering the results from three consecutive years 2011-2013. The observation shows two target areas (darkest blue) in which the concentration of flood events is much higher than the rest. If we overlay the analysis of the urbanization and population density to the flood map, we also see that in those prone to flood areas there is high density of population, which results in higher amount of population in a vulnerable position.

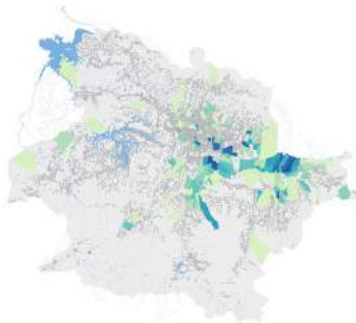
In most parts outside the floodplain of the Citarum river the reason for the disasters are mostly flash floods, which is strongly related with the imperviousness of the ground due to high urbanization index.



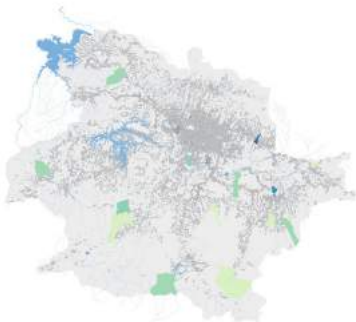
Flood Event 2011



Flood Event 2012



Flood Event 2013



Flash Flood Event 2011

Flash Flood Event 2012

Flash Flood Event 2013



**Figure 20** Affected Areas from Flood and Flash Flood Events between three consecutive years 2011-2013
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset — Indonesia

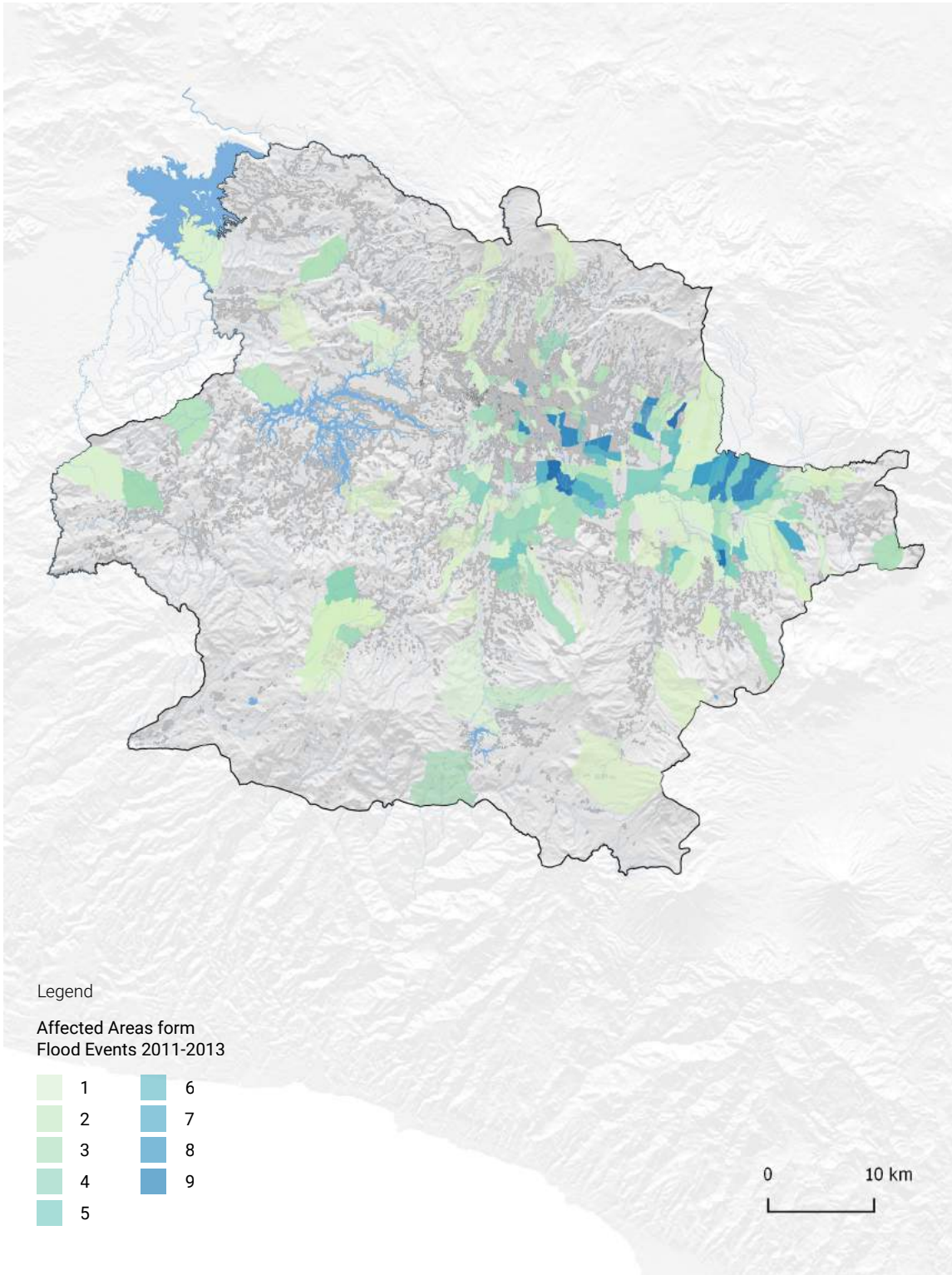



**Figure 21** Affected Areas from Flood Events 2011-2013
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset — Indonesia

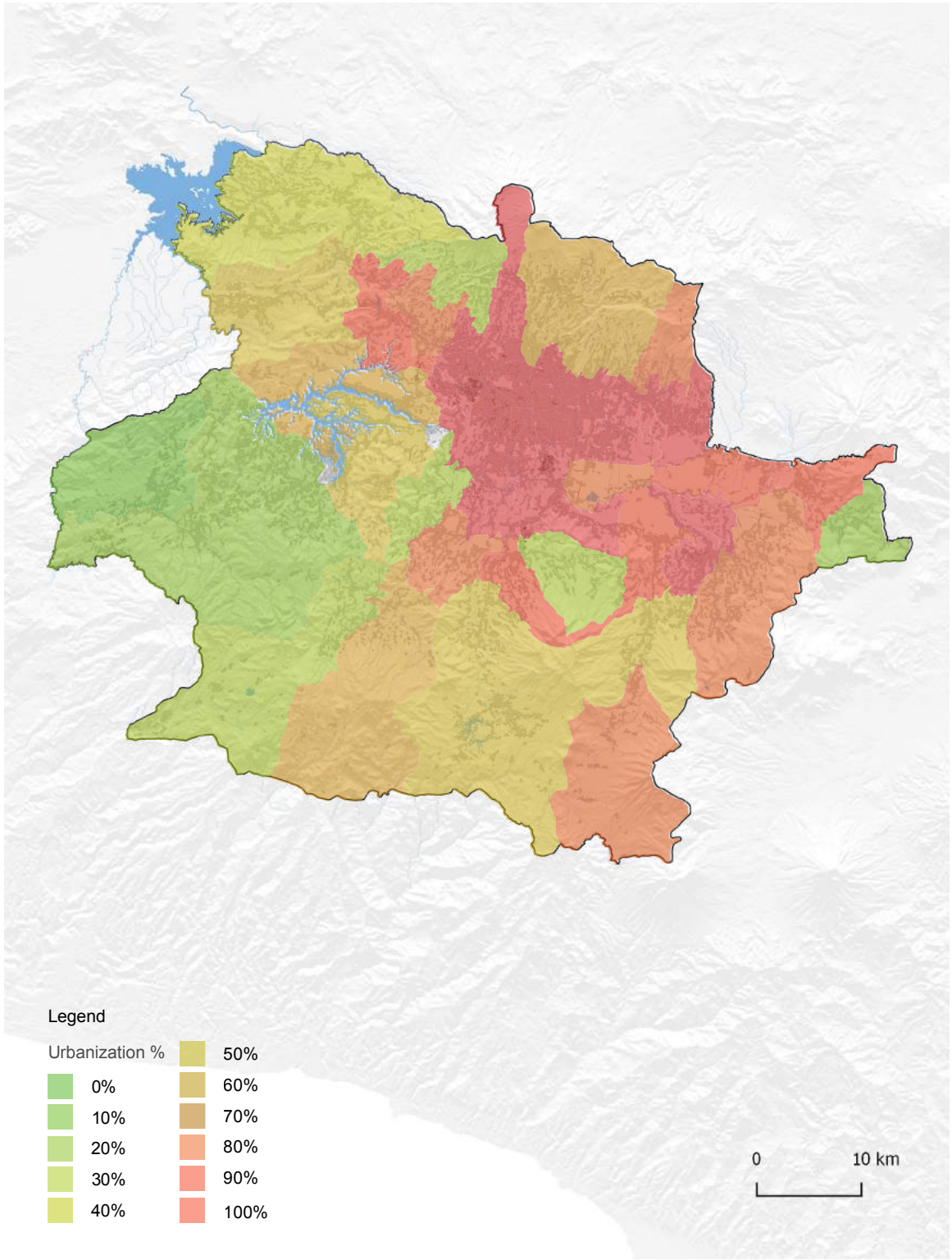





**Figure 22** Urbanization
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset — Indonesia

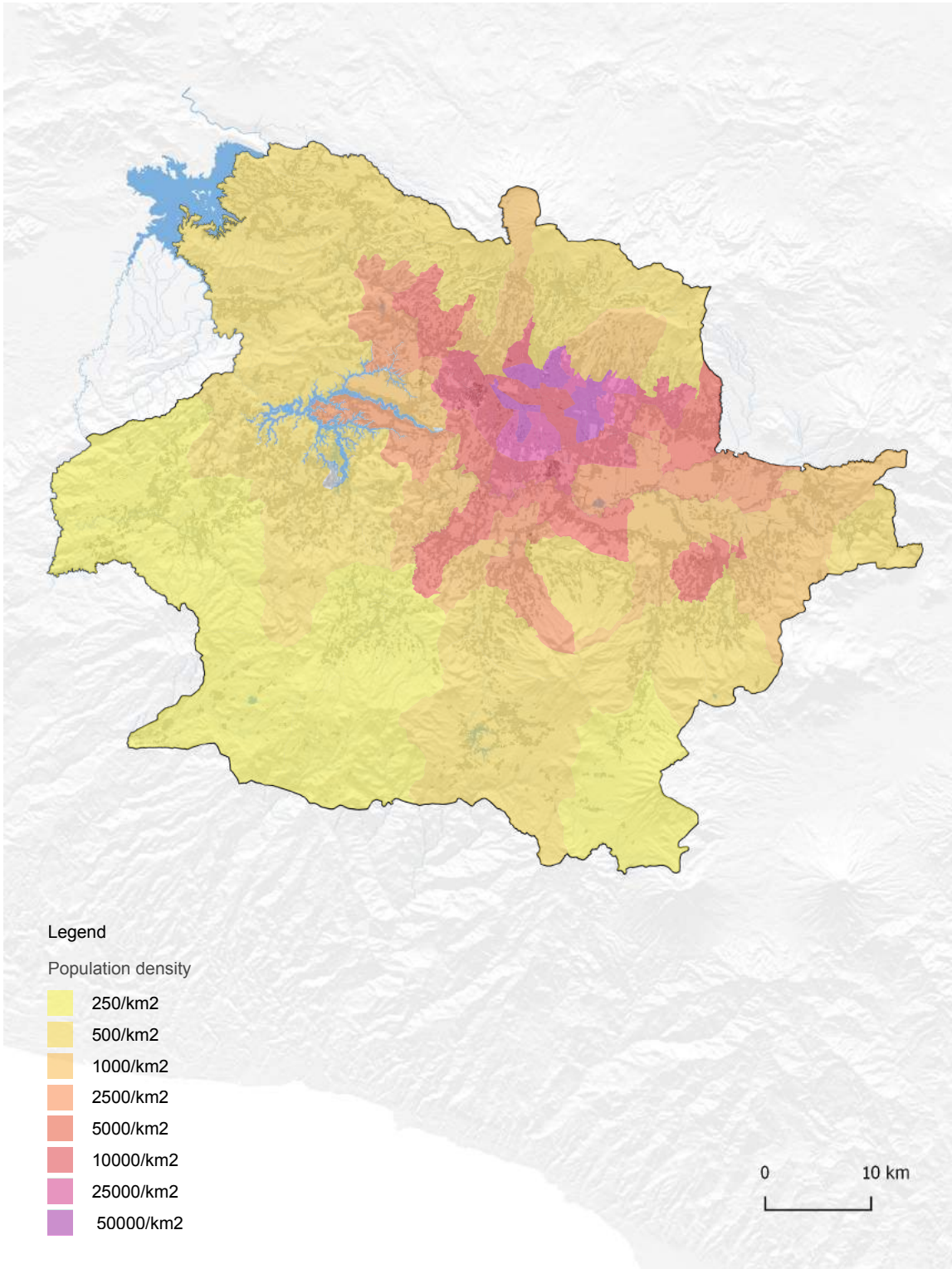



**Figure 23** Population Density
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset — Indonesia

**Coping Capacity**

There is a gap between the vulnerable to flood areas and the safety systems that can help the population in an emergency events. Most of the floods happen during the night as most of the rain is during the late afternoon and night. Therefore, systems as natural disaster early warning and safety equipment are of most need along with shelters and evacuation routes. The analysis shows very high unpreparedness from the authority structures. However, the communication paths in the neighbourhoods usually goes beyond any governmental structure. There is a very high community feeling, which helps the self organization in emergency events.

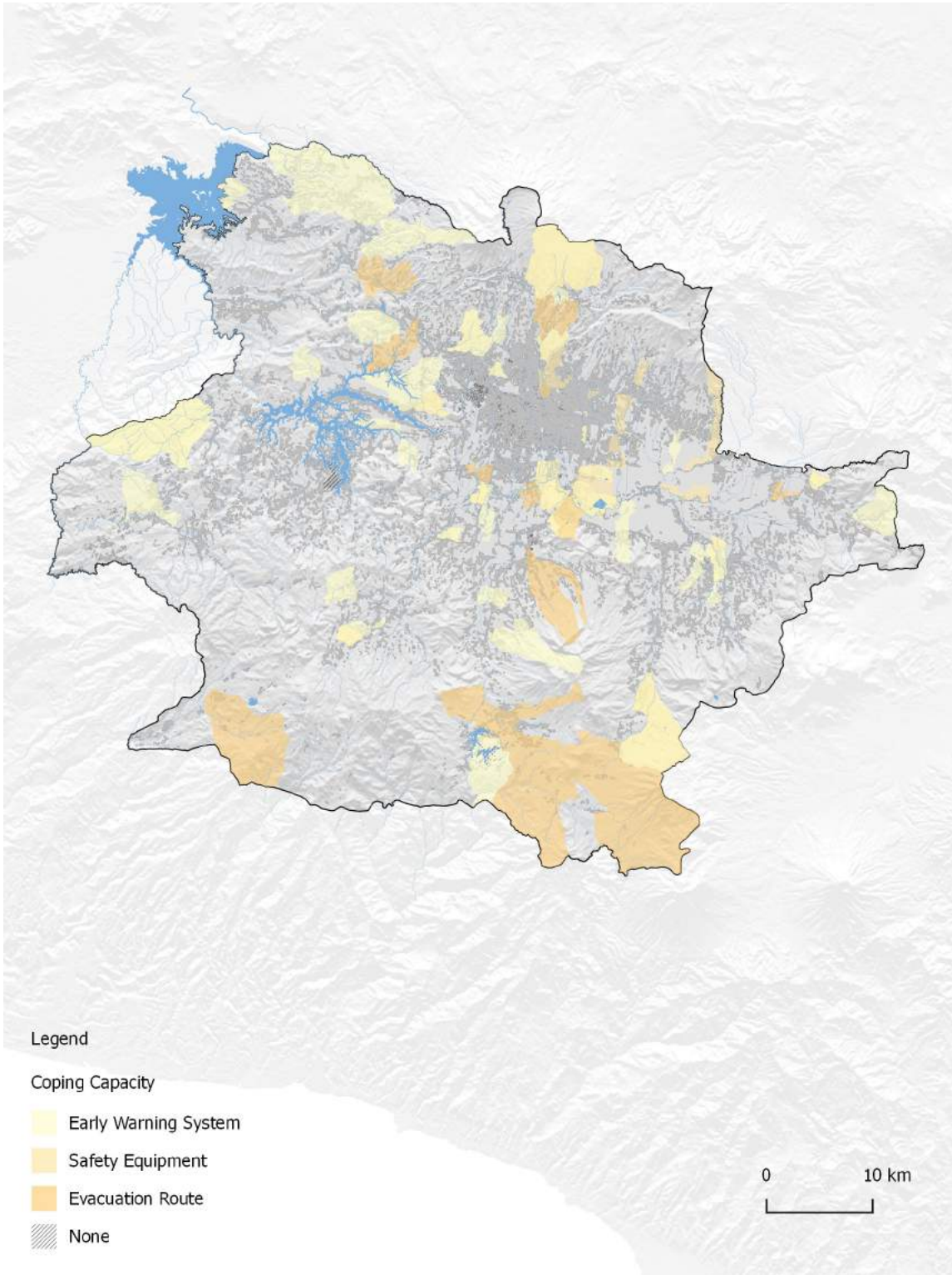
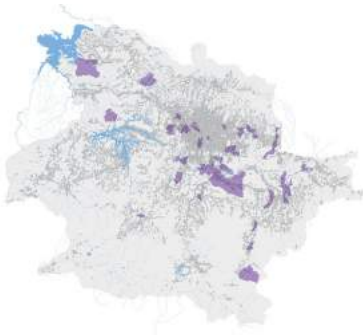


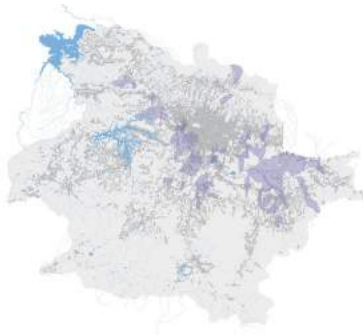

**Figure 24** Coping Capacity
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset – Indonesia

**Pollution Events and Waste Management**

The pollution and waste management is an important topic to be discussed in the cases of flood events, as they can bring a second wave of disaster - diseases and contamination. The analysis of the pollution events in the soil and water shows very high levels in the flood plain of the Citarum river. This reflects many of the issues with waste management, uncontrollable sprawl, unregulated slums, lack of treatment of waste water and general lack of restrictions. All this ends up in a cycle back to the population, which in many cases uses again the river water or extracts ground water for drinking and cooking. The highlighted gray areas where natural water usage and pollution overlap are potential intervention zones due to higher health risk.



Water Pollution Events from Household



Water Pollution Events from Industry

Water Pollution Events from Others

Soil Pollution Events from Household

Soil Pollution Events from Industry

Soil Pollution Events from Others



**Figure 25** Soil and Water Pollution Events between three consecutive years 2011-2013
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset — Indonesia

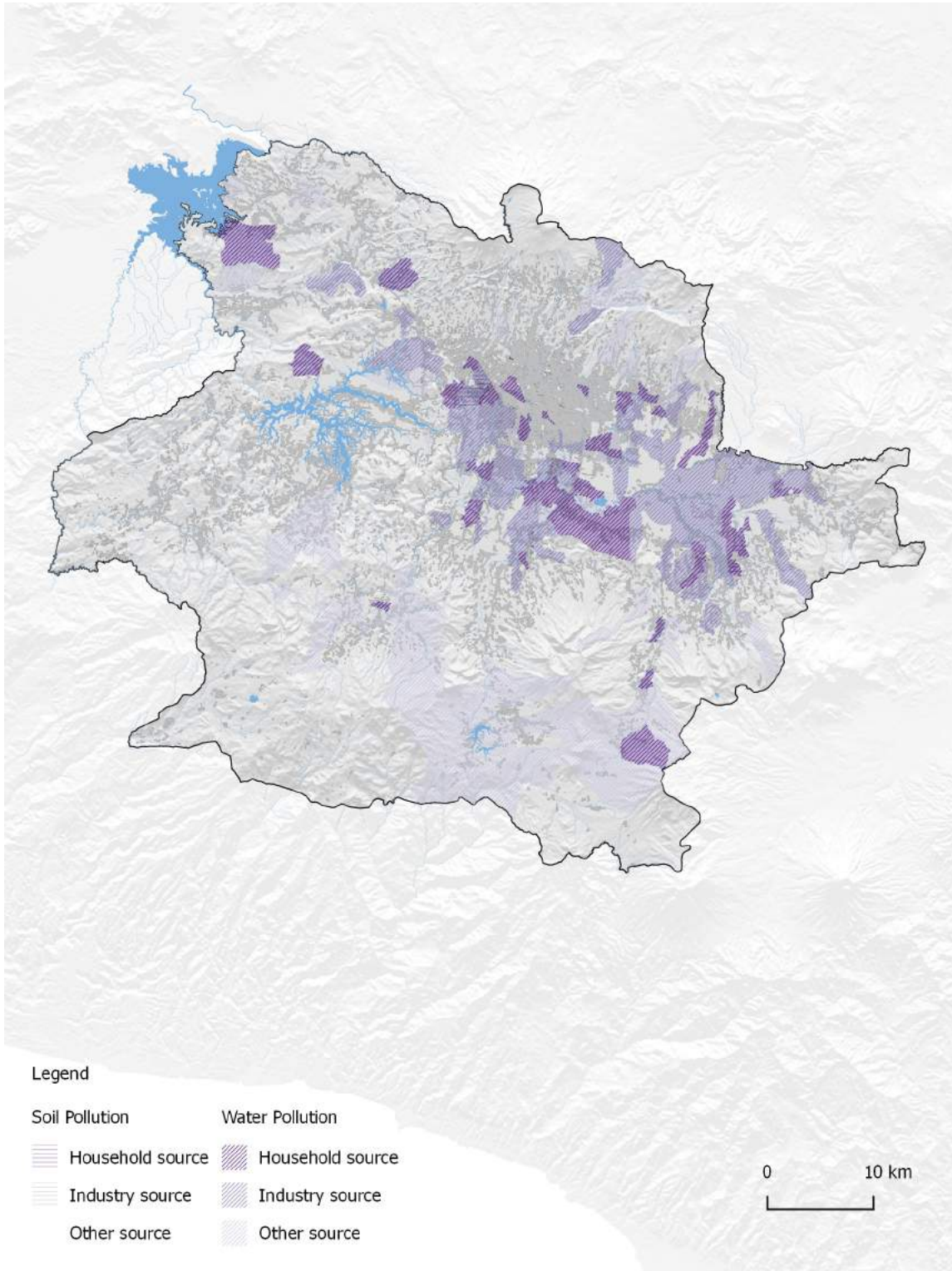



**Figure 26** Soil and Water Pollution
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset — Indonesia

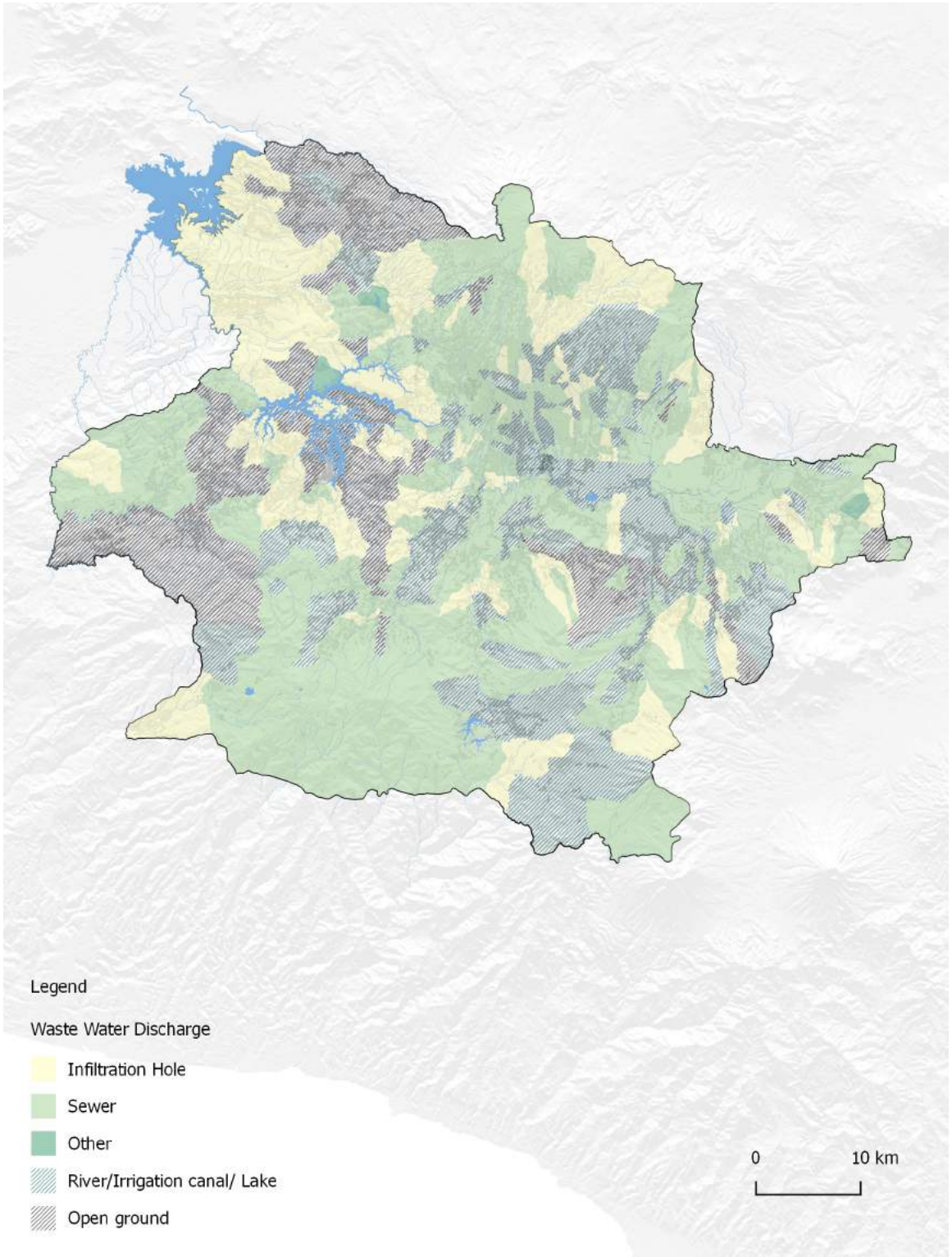





**Figure 27** Waste Water Discharge
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset – Indonesia

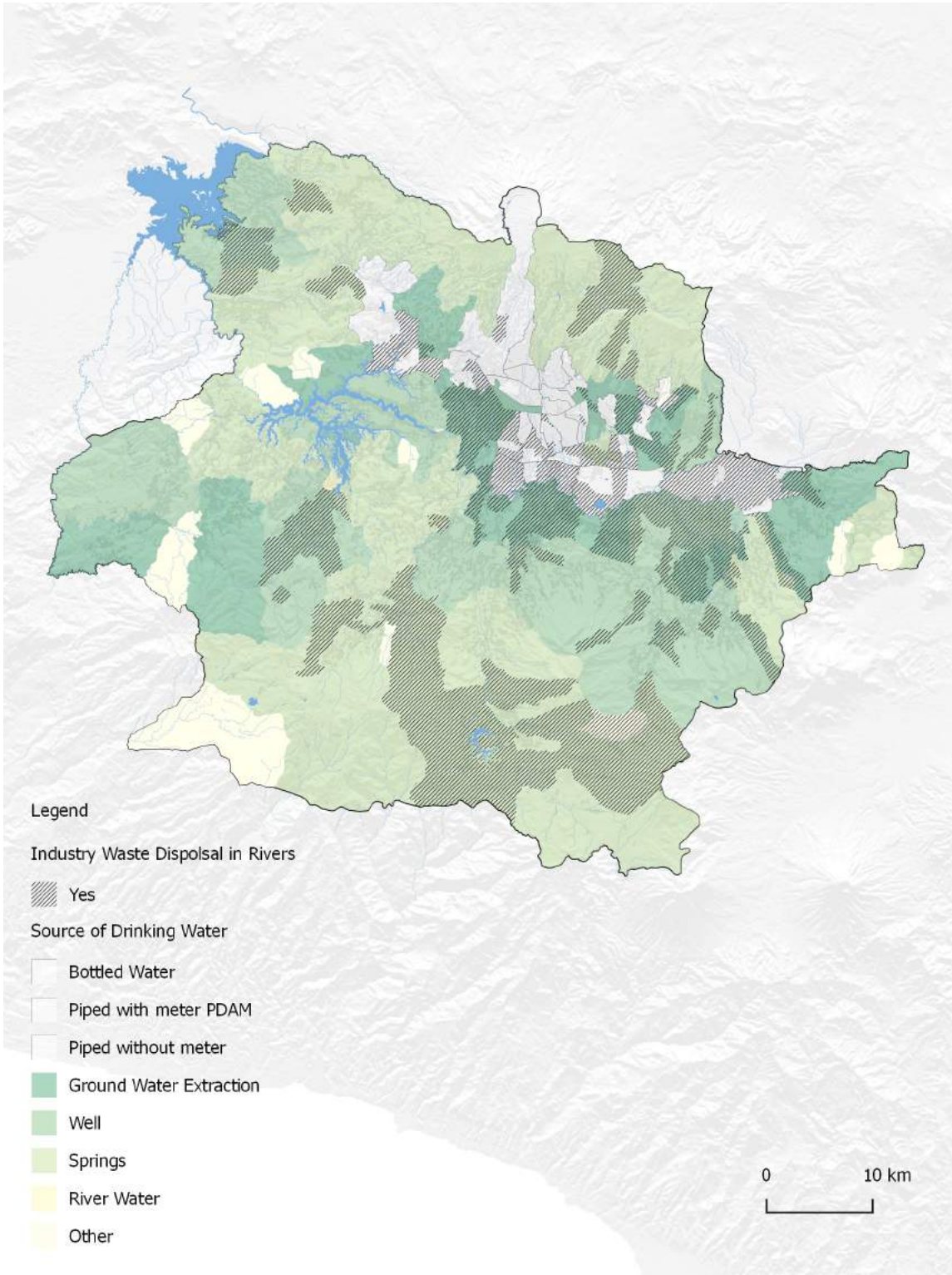



**Figure 28** Industry Waste dispolsal in Rivers and Source of Drinking Water
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)
Statistical Data Source: Village Potential Statistics (PODES) 2014 Dataset – Indonesia

## 6.2. Case study

The following figures represent the essence of the previous analysis and allocates the general Vulnerable Zone in the project, also two focus areas with highest flood frequencies. Within this outline we seek an informed decision about which is the most favourable test area for the research framework.

The percentage of the urbanization index and population density in the Vulnerable flood plain of the Citarum river has a slight difference between 60-80%, although still in the areas in Dayeuhkolot the percentage is higher. These are the only areas in this zone, where we can find availability of safety systems such as safety equipment (boats, tents, first aid supplies, etc.), natural disaster warning systems and evacuation routes.

Considering the pollutions in the area - soil and water, we can see it is evenly distributed throughout, with high concentration of household polluters, which is almost even to the industry ones. In the Dayeuhkolot area there are many factories, as this is an area just outside the city of Bandung, where the land is affordable and the communications are good. However, this it is also very densely populated with high amount of kampungs (slum villages). Therefore, the waste disposal in the rivers for both households and industry threatens these areas, as when the flood comes, all the toxic elements are entering houses and work places, contaminating the soil and endangering the health of the people who live and work there.

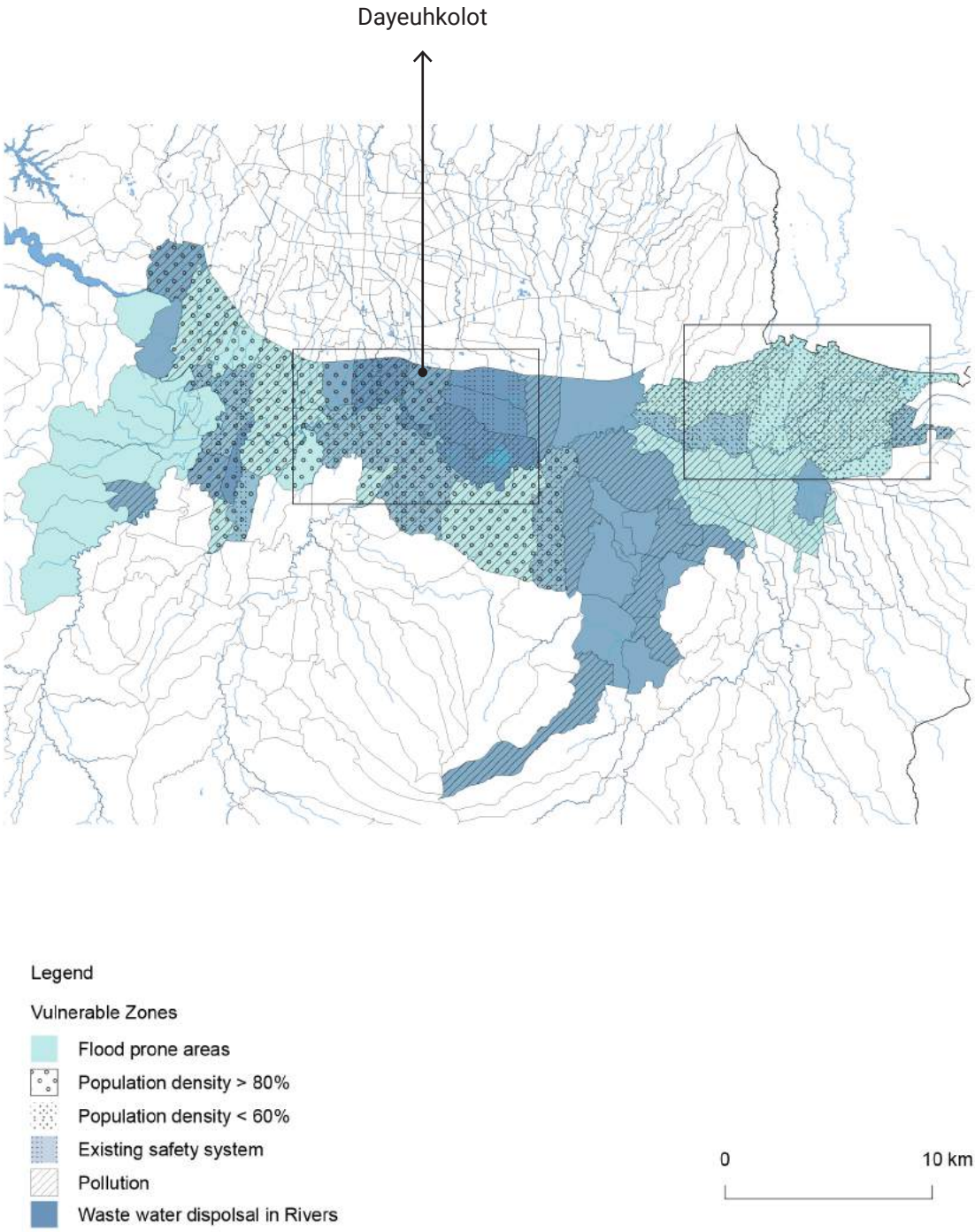



**Figure 29** Vulnerable Zones Zoom
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

# 7. Spatial Analysis

## 7.1. Methodology

This chapter addresses the analysis of the region of Bandung in territory, natural resources and trends in recent years. It seeks to unfold in more deepness the causes of extreme weather conditions and effects that flood events have on the area. The data for this section was obtained through series of document exploration, GIS mapping exercises, statistical data visualization and observations from the field trip. It is important to note that the findings on the regional scale are continued in the next chapters in local scale exploration and stakeholder analysis.

To follow up the larger regional scale analysis, this section goes into depth within the focus area of the Citarum River Basin. It is a large floodplain consisting 11 district areas, which are largely rural settlements. There are three districts Dayeuhkolot, Rankaek and Margahauyu, which can be considered as peri-urban districts with concentrating large amount of the population in this area. Many of the sub urban districts are industrial zones of the adjacent city of Bandung. The industries create a lot of economic opportunities for the population in the basin, but also give rise to many of their adversities.

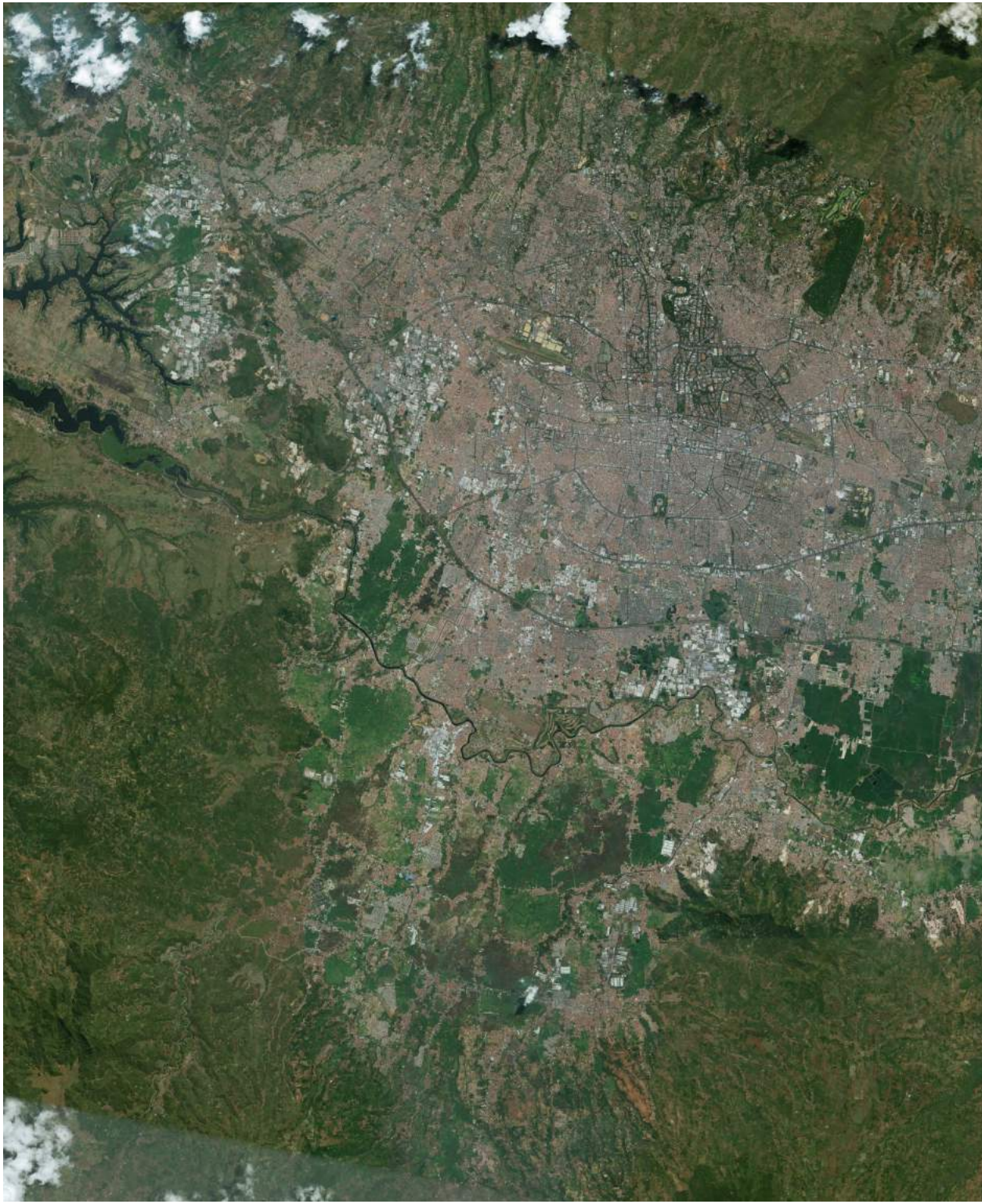
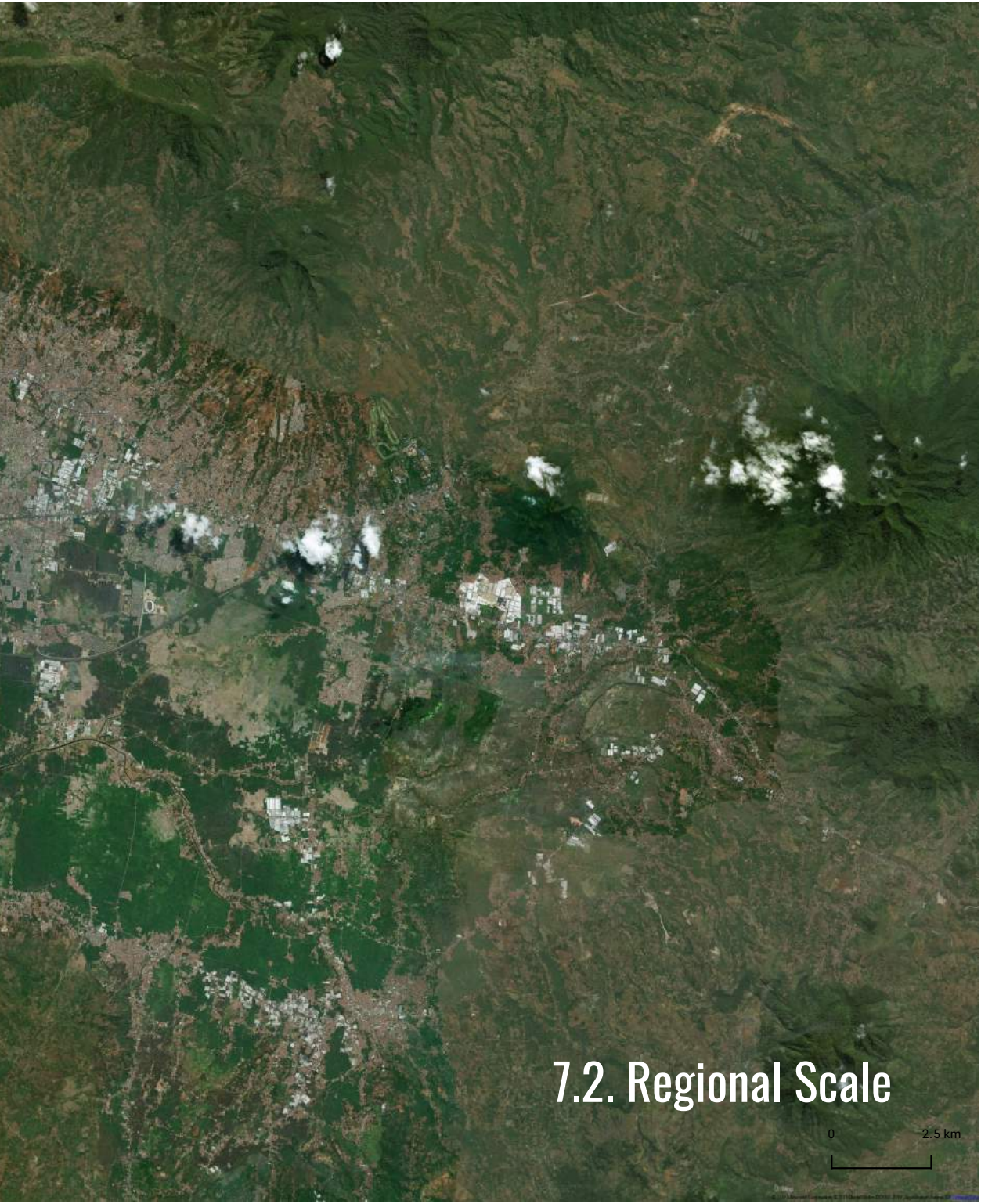


**Figure 30** Aerial Photo of Regional Scale
Source: Bing Aerial




# 7.2. Regional Scale

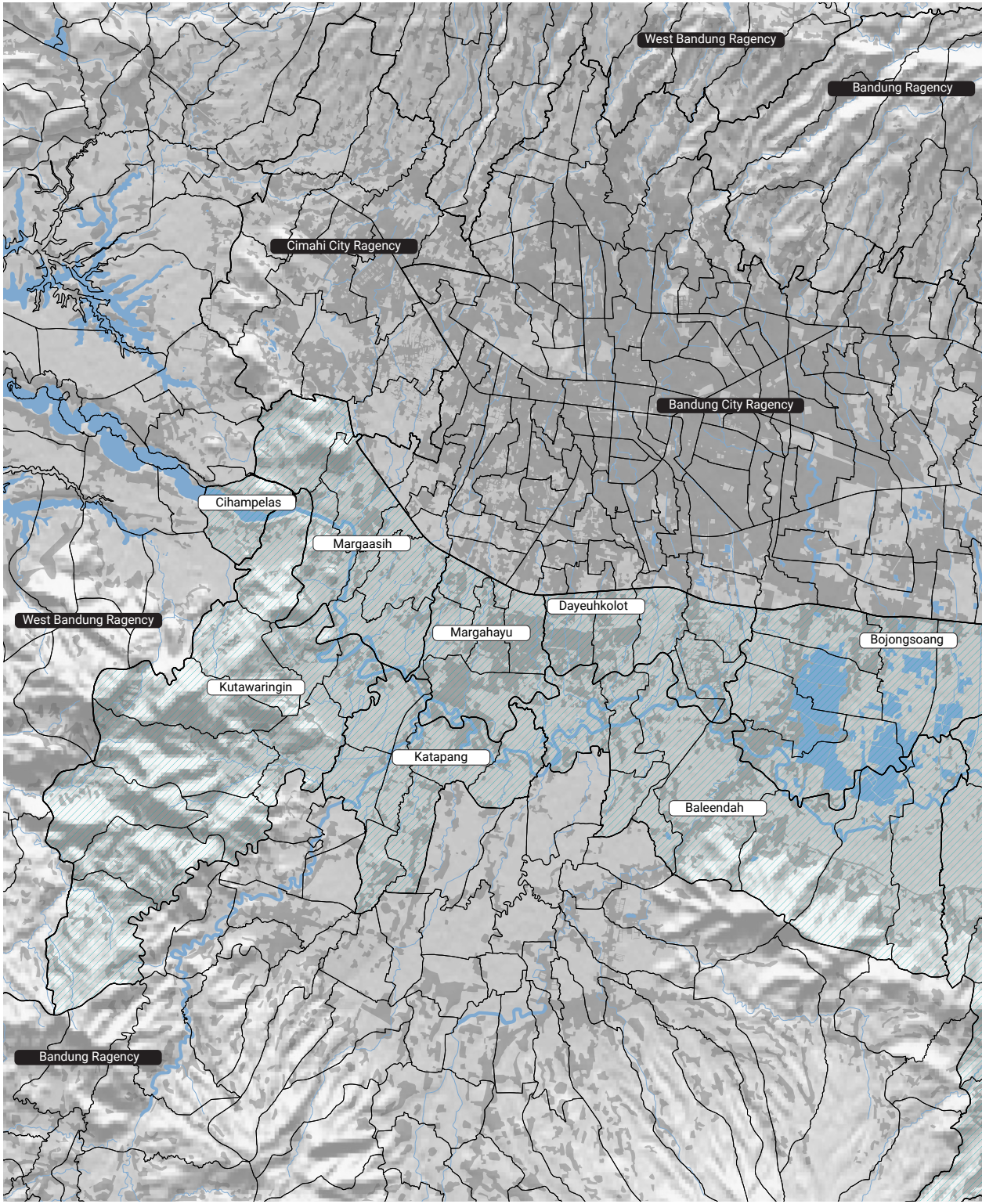
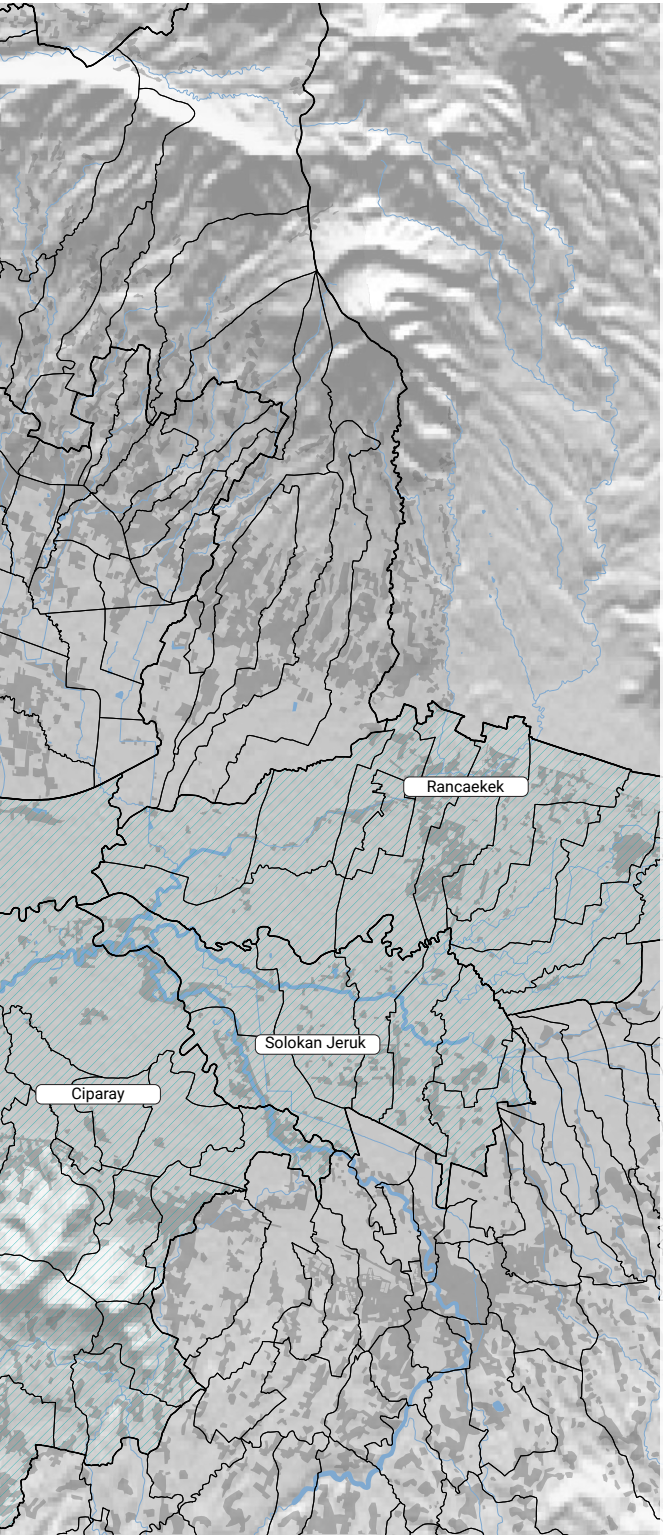





**Figure 31** Topography
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia) ; JICA, 2010




## Topography

The topography of the Bandung basin area, as mentioned previously, is characterised by a vastly flat floodplain, which lies between high volcanic mountains. The main attitude is between 655 and 670 meters, which is almost 13 percent of the total basin area (UCBFM, 2011). The lowest point in the basin is the village Dayeuhkolot 652.1 meters. The flatness of the basin and close proximity to the second largest city on Java creates fast urbanisation speed. This creates a big challenge for the area as nearly all flood events happen in the floodplain.

The geological conditions of the basin also are assisting in extending the effects of floods. The prehistoric lake composed the sediments in the area, which formed fluvial soil with series of thick lacustrine deposits. The lake also formed the present Citarum River with its tributaries as the main drainage system of the basin. The hydrologic characteristics of the area suggest multilayer aquifers in depth, combined in two systems – the shallow aquifers, which are only a few meters below surface (around 40m) and are commonly exploited for water wells (usually household use); and the deep aquifers, which are from 40m to 250m below surface, also exploitable, but with deep wells (usually industrial use).

Legend

Bandung Ragency — Ragencies
Dayeuhkolot — Districts
Urbanized Areas
Water Bodies
Flood Prone Districts
Ragency Boundaries
Village Boundaries

0 2.5 km

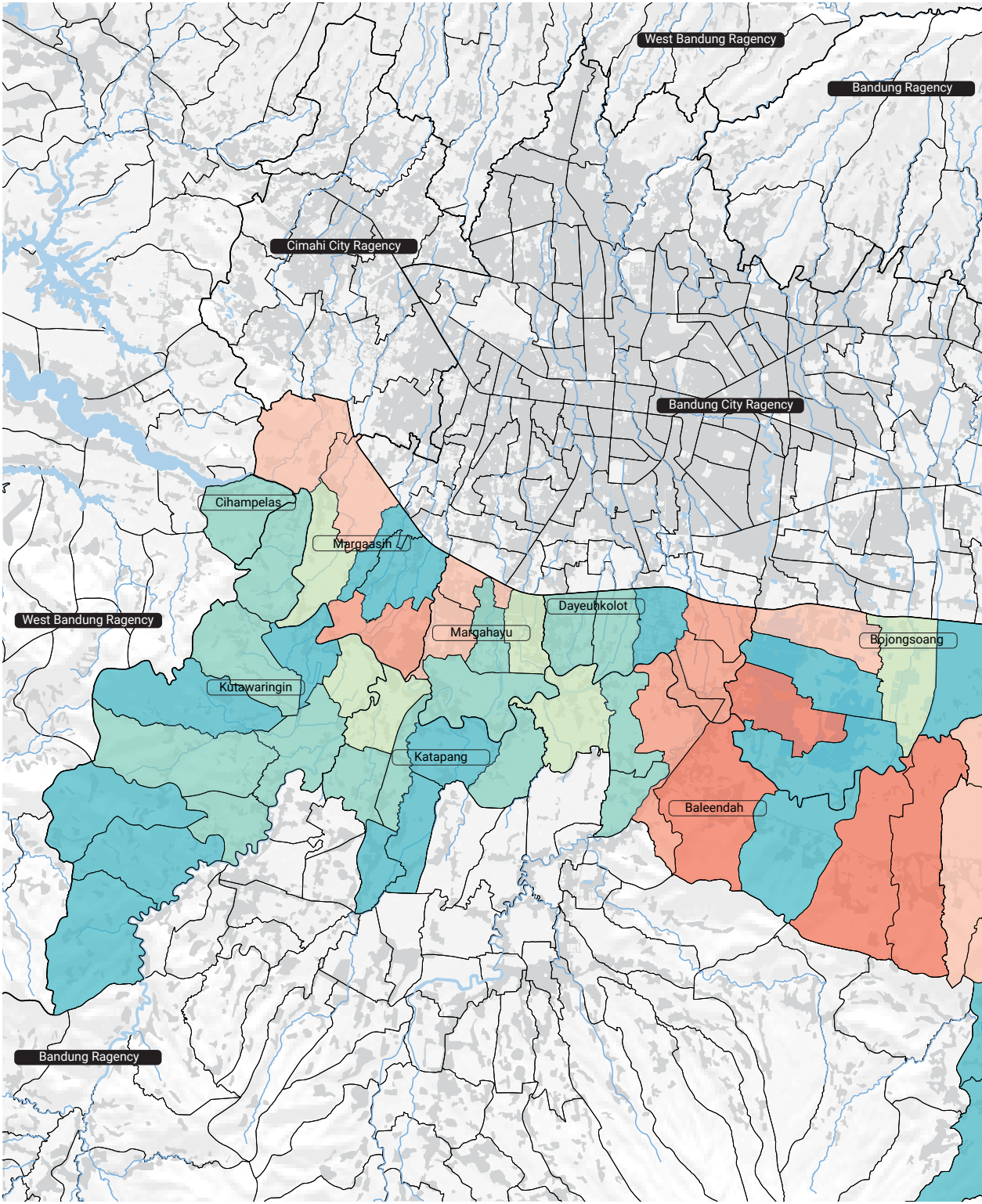
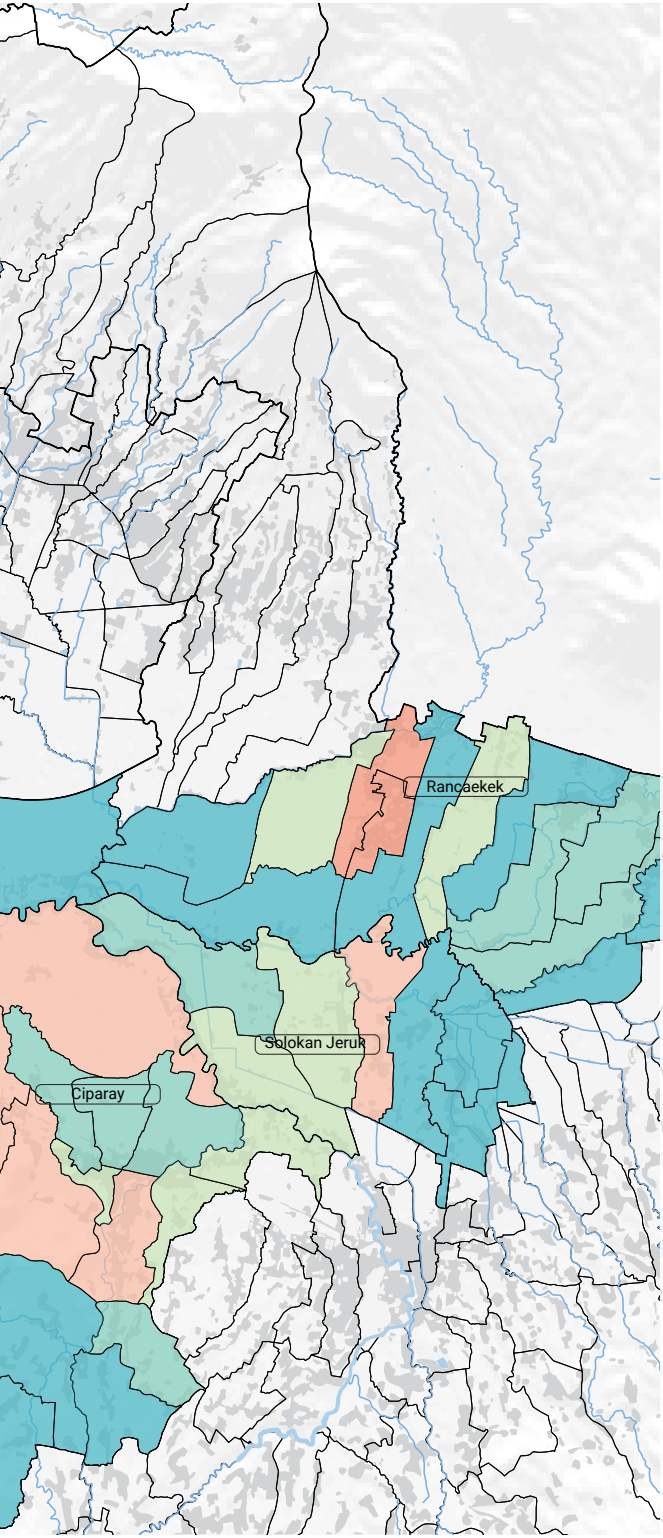





**Figure 32** Population in the Flood Prone Area of Citarum Basin
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia) ; JICA, 2010

## Population

The population in the area of exploration is more than 2.5 million people living in the peri-urban villages. The villages that are affected by yearly flood events are 80 on average, which makes more than half of the people in the region vulnerable to these floods (UCBFM, 2010). The average population growth in the Banding region is 2.8 percent per year, which creates expectancy for doubling the amount of people in danger by the year of 2035. The consequences related with these extreme events such as life loss, destroyed or damaged houses and household goods, severe health issues and loss of income, are hazardous to the population. There is lack of data on the amount of people that were forced to leave their houses and seek shelter. However, there has been a rough estimation on the humanitarian costs for one whole rain season in the report of UCBFM – "Annex G, Socio Economic Analysis. Social impact and flood damage". They approximate the total amount of 11.1 billion Rupiah (1.2 million dollars) humanitarian help for the season in 2010 and predicted to increase in the years ahead. Other costs related to the flooding such as loss of life or health issues are difficult to track and estimate. No exact information on the number of people suffering from health problems due to floods, but it is assumed that these losses are very high with the percentage of affected population.



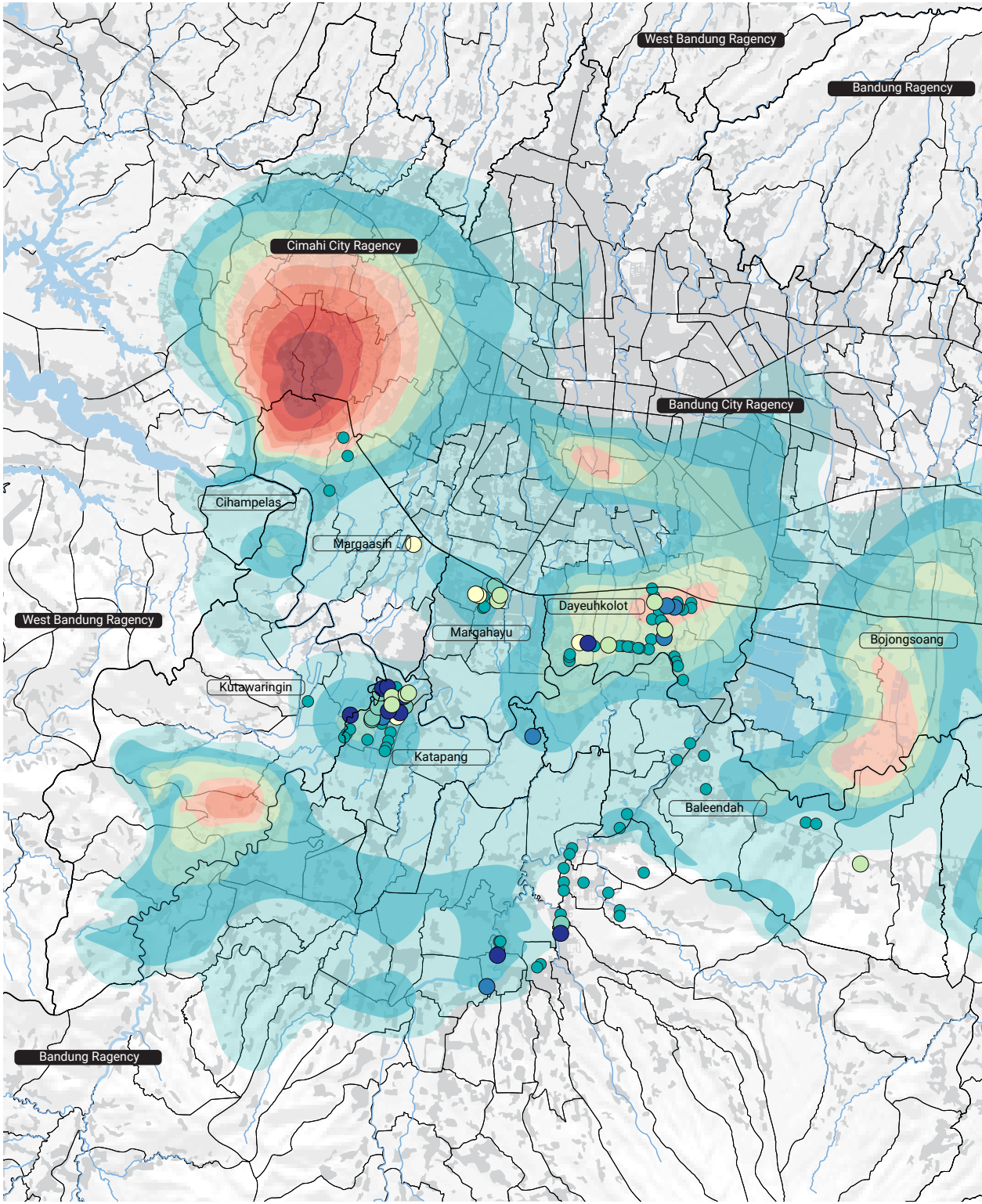
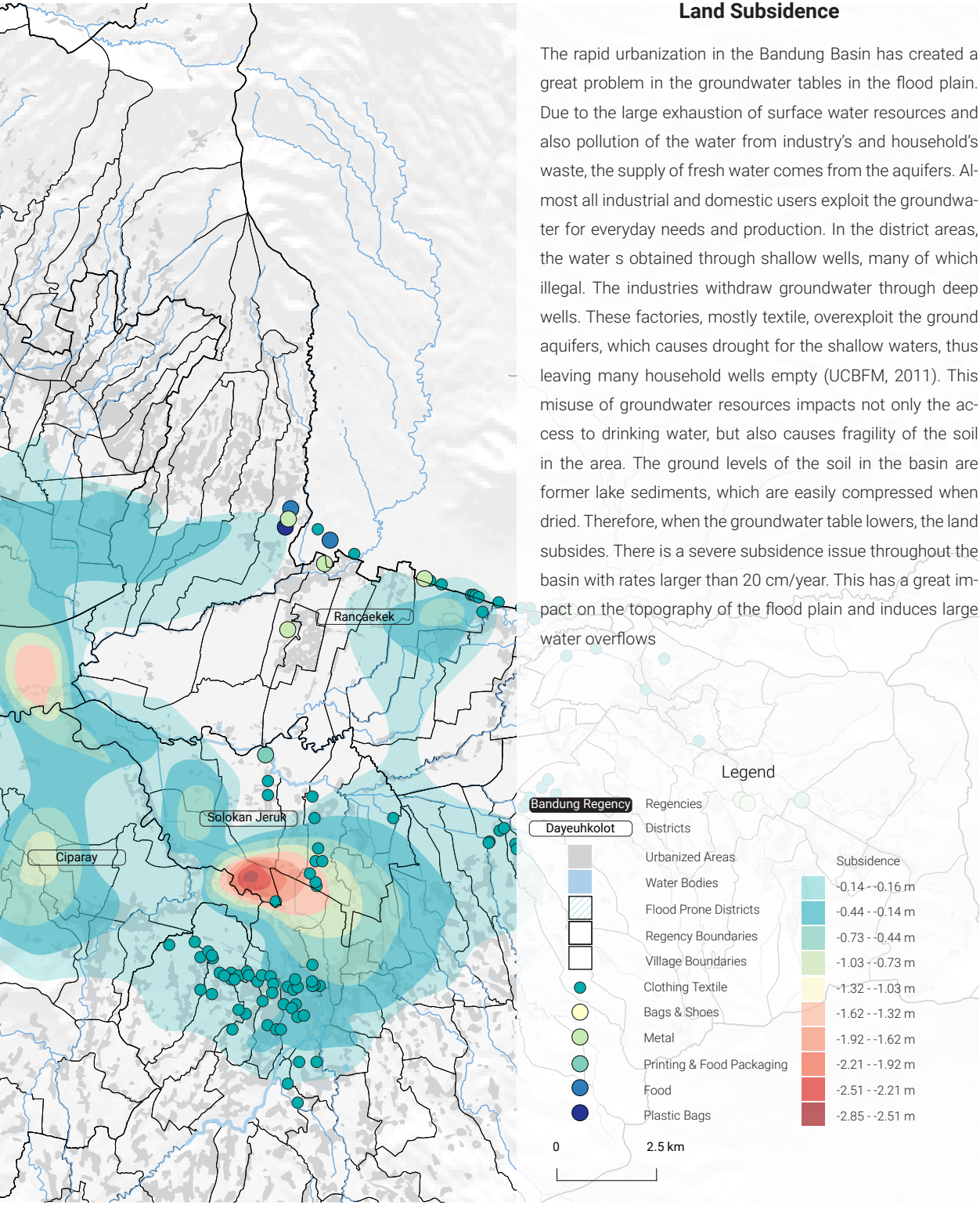





**Figure 33** Subsidence and types of Industries in the Citarum Basin
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia); JICA, 2010

## Land Subsidence

The rapid urbanization in the Bandung Basin has created a great problem in the groundwater tables in the flood plain. Due to the large exhaustion of surface water resources and also pollution of the water from industry's and household's waste, the supply of fresh water comes from the aquifers. Almost all industrial and domestic users exploit the groundwater for everyday needs and production. In the district areas, the water s obtained through shallow wells, many of which illegal. The industries withdraw groundwater through deep wells. These factories, mostly textile, overexploit the ground aquifers, which causes drought for the shallow waters, thus leaving many household wells empty (UCBFM, 2011). This misuse of groundwater resources impacts not only the access to drinking water, but also causes fragility of the soil in the area. The ground levels of the soil in the basin are former lake sediments, which are easily compressed when dried. Therefore, when the groundwater table lowers, the land subsides. There is a severe subsidence issue throughout the basin with rates larger than 20 cm/year. This has a great impact on the topography of the flood plain and induces large water overflows



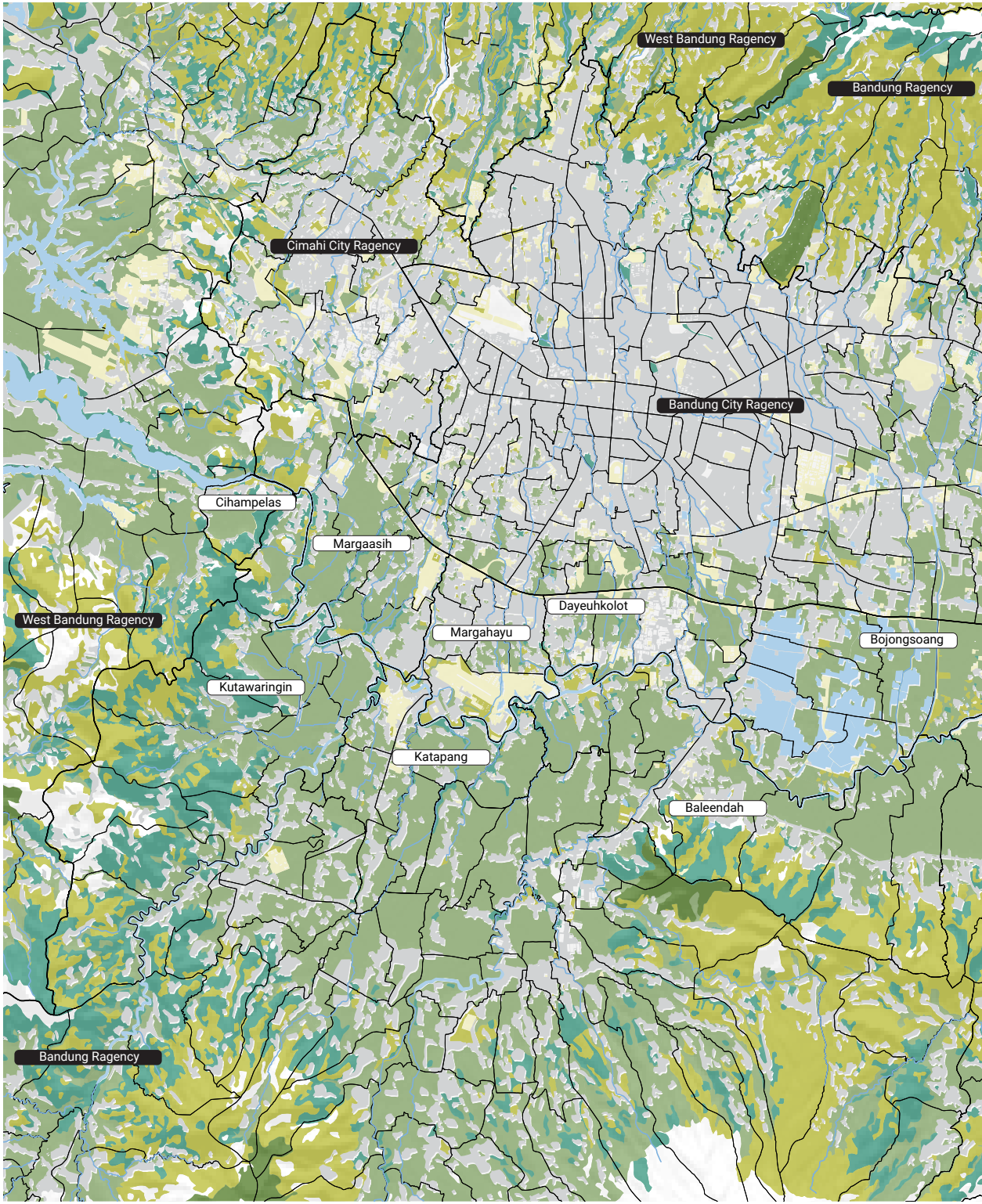
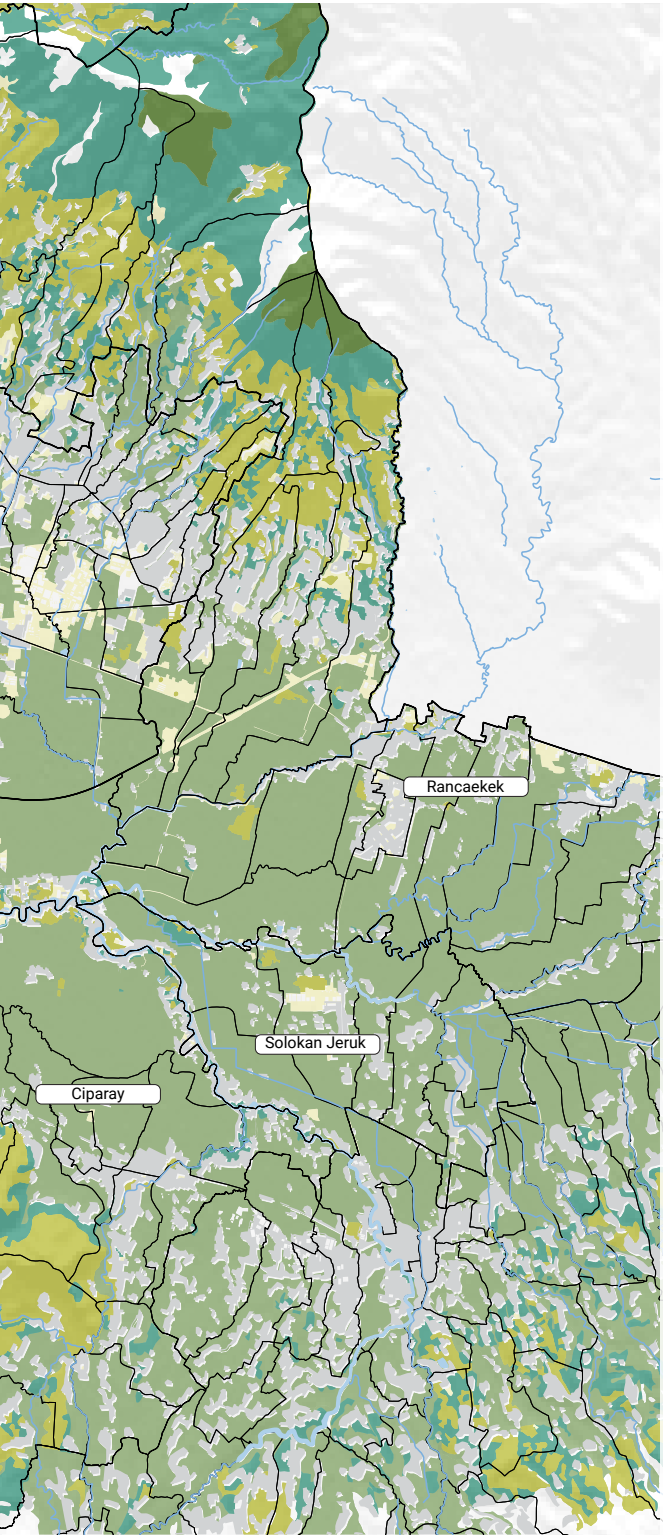





**Figure 34** Land Use of Citarum Basin
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia) ; JICA, 2010

## Land Use

The land use in the area experiences major changes due to recent trends, and with that big challenges. One of them is the rapid urbanisation, which started after the colonial times. In the first half of the 20th century Bandung had only 40 000 people living there, where by 1961 the population grew to 1 million. In the next decades it increased rapidly to almost 5 million by 1994. Nowadays, the population in the metropolitan area is estimated to 8 million. According to recent studies it will continue to grow, and in the next 15 years it will double due to internal migration and natural population growth. Clearly, this creates a large urgency in the region due to land availability. The main land use pattern has been forests on the top of the mountains, followed by bushes and dry crops on the slopes and irrigated rice fields, and the settlement on the bottom of the valley. However, nowadays, the urban areas have increased rapidly, using predominantly agriculture land. This creates a basis for quick deforestation processes, substituting former woodlands with agriculture production. The trends in production of products that do not sustain water, such as potatoes, create the possibility for easy storm water runoff. This increases the discharge of the rivers, which carry the water and sediments downstream and many times create floods.



## Rainfall

Bandung Basin is located in the tropical climatic zone, which implies two seasons in the region – the rainy and dry. The annual rainfall in the basin varies between 1200mm and 3000mm (Figure 35). The annual average is 2215mm, data from 1950-2007. The report of the UCBFM – "Strategic Flood Management Strategy" divides the sub-basins of the Citarum River into southern and northern tributaries. It is observed that the rainfall is concentrated in the southern part of the basin, rather than the western one, which affects the amount of water discharged in the river Ciwidey and river Cisangkuy, thus in Citarum River (for reference see page 10). The wet season in Bandung usually starts from November and lasts until April with monthly mean values of 250mm. Typically October and May are transitional months which suggests reduction of rainfall to 50mm and less (UCBFM, 2011). The estimation of the hourly rainfall plays an important role in the creation of flood mitigation strategies and improvement of the coping capacities. During extreme rainfall events in the Citarum Basin there are typical hours in which typically the rain falls. This is due to the convective origin of the rainfall: "moist air masses are lifted by the daily heating of the surface, cool, form droplets by coagulation due to differences in vertical velocities and rain out" (UCBFM, 2011). This phenomenon takes place usually during the afternoon hours in a limited extend of time. The peak intensities are often experienced between 15:00 and 16:00, which creates an accumulation of water in the river basins and peak discharge only after 17:00 (Figure 36). Due to this peak discharge hour mostly the flood events happen during the evening and night period. This creates a large disadvantage and need for accurate evacuation system and good planning.

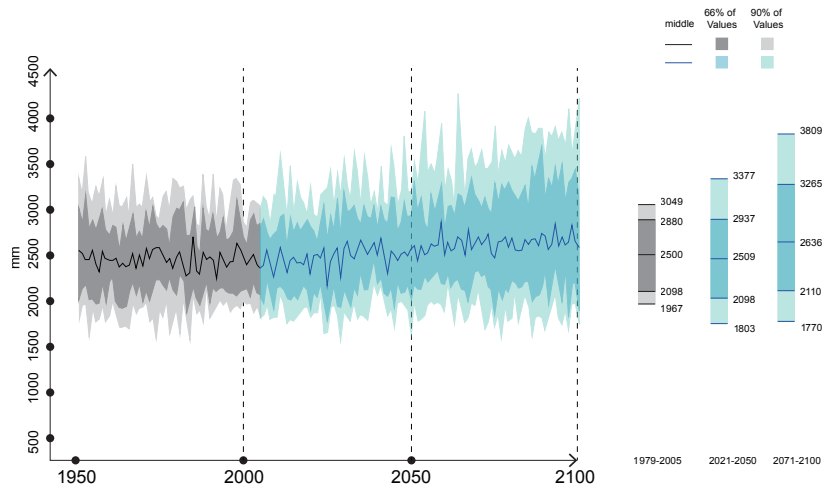



**Figure 35** Annual Rainfall in Bandung 1950-2100
Source: www.theclimatedatafactory.com

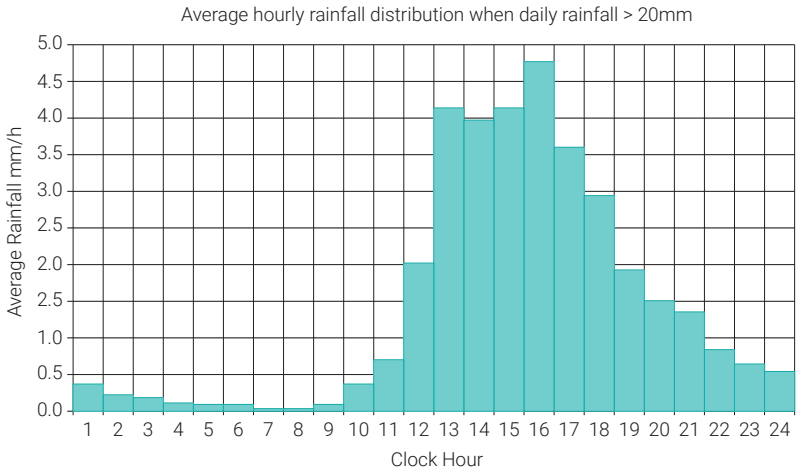



**Figure 36** Average hourly rainfall distribution when daily rainfall > 20mm
Source: UCBFM, 2010

## Flooding Areas and Flood Depth

All the above mentioned factors, natural conditions and recent trends, contribute to the vast consequences of extreme flood events. The vast urbanisation in the region, combined with growing pressure from the rise in population expands the vulnerable areas in the floodplain. The growing population requires large amounts of resources, which enforces the over exhaustion of groundwater supplies, land availability, etc. Thus, much of the harm from flood events was caused due to the overpopulation of this area. In Figure 37 are depicted the flood zones and depths in certain return periods. Within the spectrum of two year return period, it can be observed that mainly agricultural land is inundated. However, there are also many settlements that flood frequently, and as much as these do not represent the most amount of flooded square meters, they are the most costly. From document and literature review was retrieved information on the areas of main intervention. It is known that the focus of the attention until now has been implementing structural solutions upstream to the tributaries of Citarum River. The three largest urban settlement areas Dayeuhkolot, Rankaek and Margahauyu were only partly included in the recent flood management plan from the research of the Japan International Cooperation Agency (JICA, 2010). The graduation study suggests that this was due to insufficient data availability on the number of affected population and following consequences as these areas consist of mostly illegal houses. The next chapter the thesis looks closely into the issues and measures proposed in the most affected of these areas – Dayeuhkolot Village.

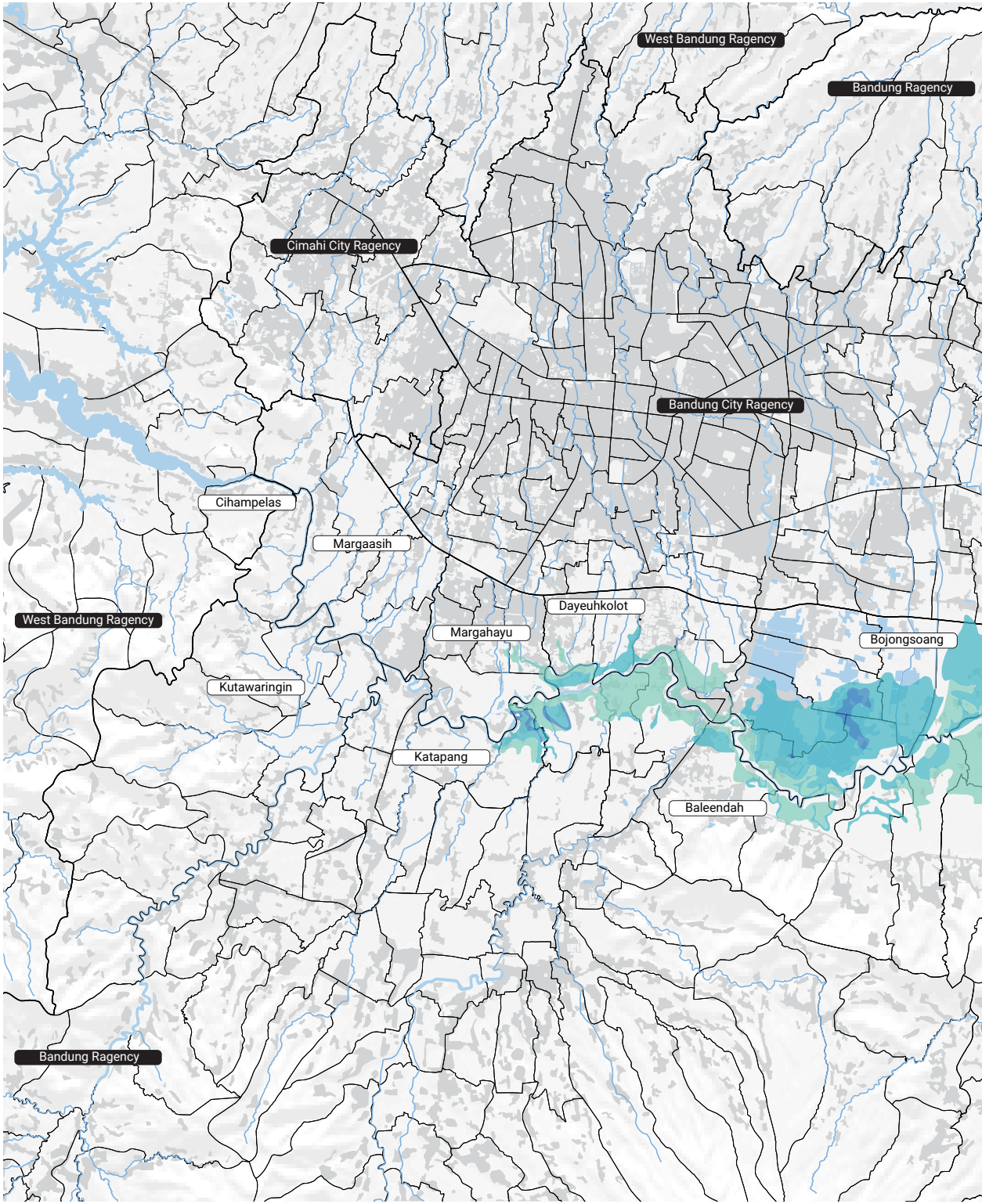





**Figure 37** Flood Depth 2, 25 and 100 years return period in the Citarum Basin
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia) ; JICA, 2010

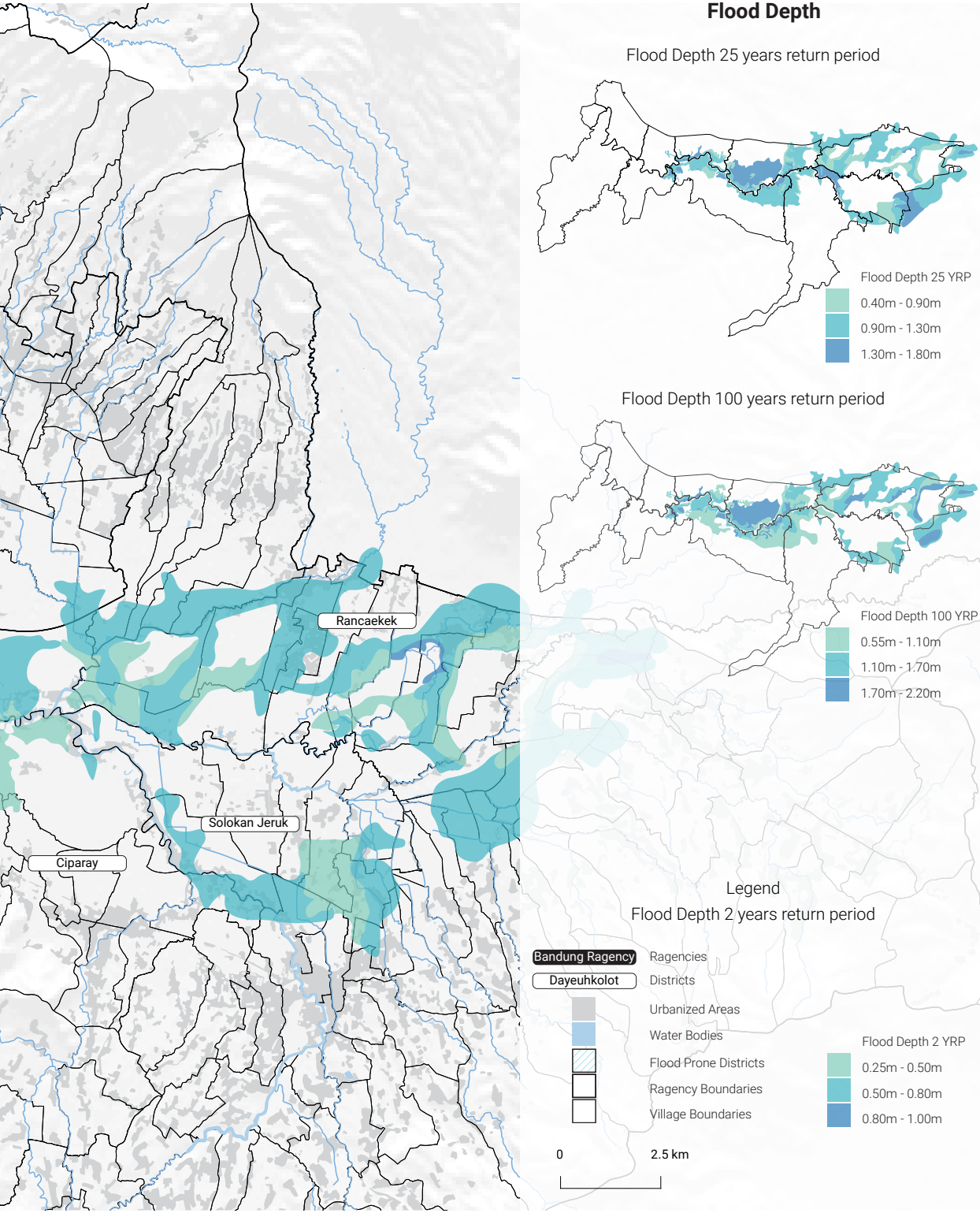

Flood Depth
Flood Depth 25 years return period
Flood Depth 25 YRP
0.40m - 0.90m
0.90m - 1.30m
1.30m - 1.80m
Flood Depth 100 years return period
Flood Depth 100 YRP
0.55m - 1.10m
1.10m - 1.70m
1.70m - 2.20m
Rancaekek
Solokan Jeruk
Ciparay
Legend
Flood Depth 2 years return period
Bandung Ragency
Ragencies
Dayeuhkolot
Districts
Urbanized Areas
Water Bodies
Flood Prone Districts
Ragency Boundaries
Village Boundaries
Flood Depth 2 YRP
0.25m - 0.50m
0.50m - 0.80m
0.80m - 1.00m
0
2.5 km



**Figure 38** Aerial Photo of Dayeuhkolot Village
Source: Bing Aerial

# 7.3. Village Scale

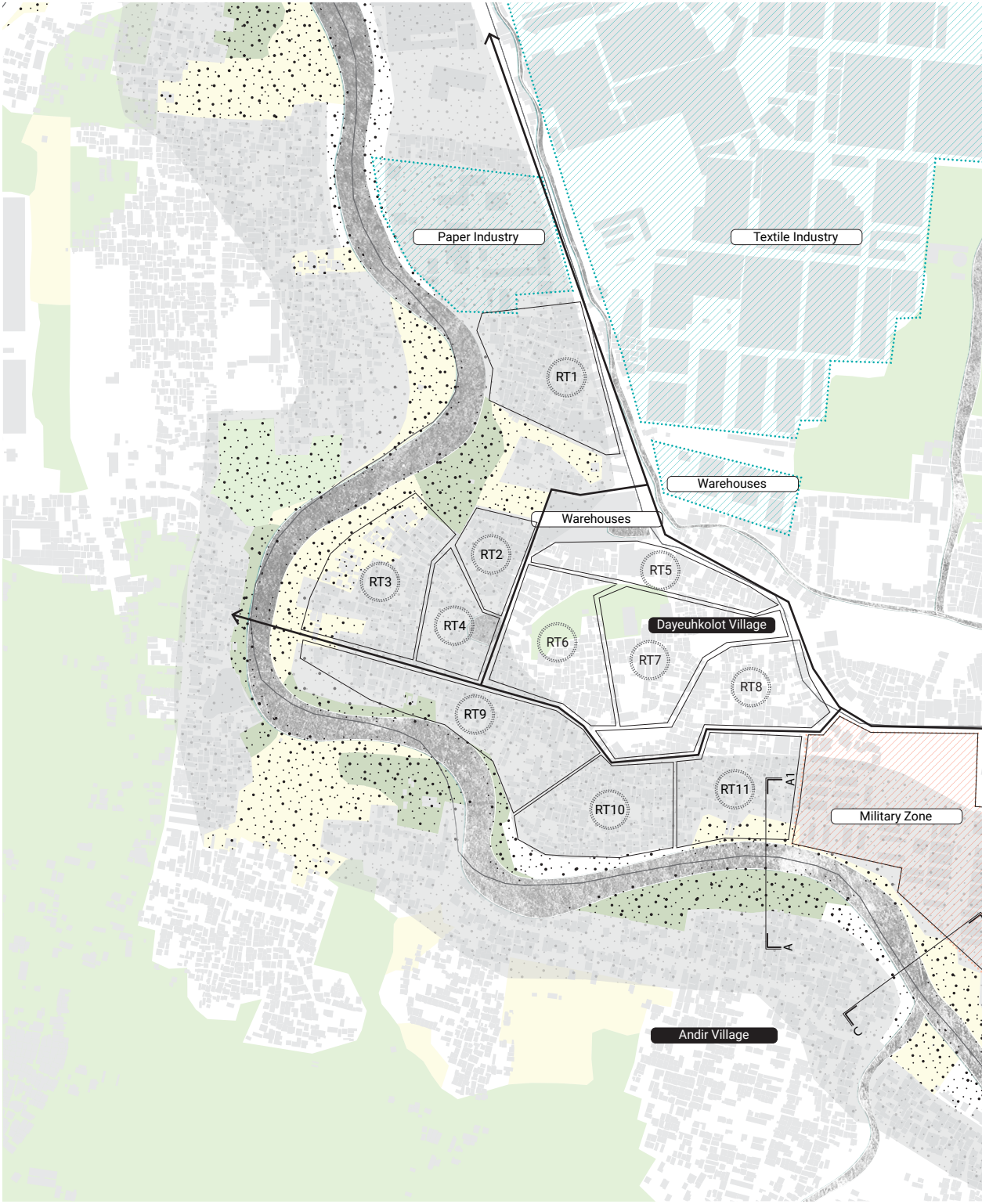
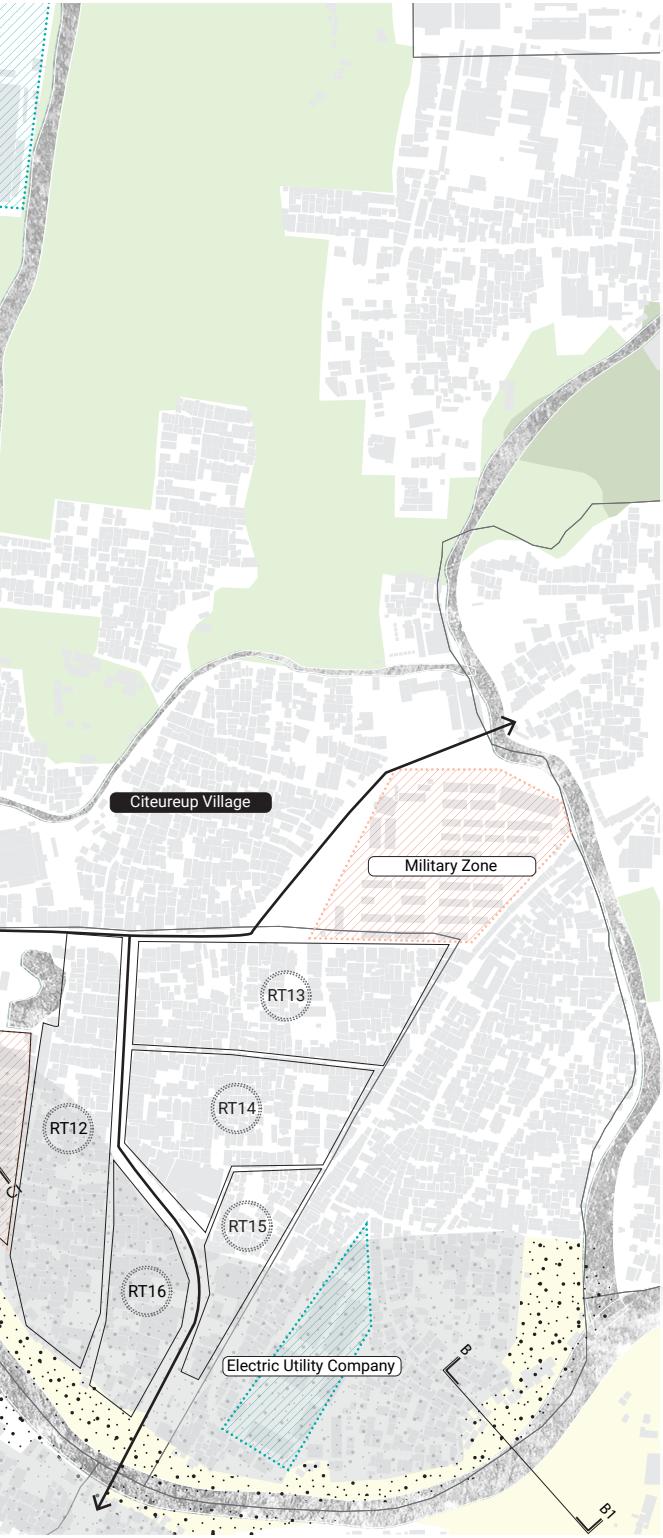





**Figure 39** Dayeuhkolot Village
Source: Author




**Reading the space in Dayeuhkolot Village**

The name of Dayeuhkolot village in direct translation from Sundanese means "the old city". This has been the original settlement of Bandung city, established before the colonial times. Due to the heavy floods happening in the area and also due to planning the new railway and main road system through the whole Java island, the Dutch decide to move Bandung centre to its current location. This village remains as a peripheral and mostly agricultural land with complete irrigation system in place. Nowadays, parts of the area around the village are still preserved as agricultural land, but due to the rapid population growth the settlement is now part of the industrial zone of Bandung.

The Dayeuhkolot Village consists of 16 neighbourhoods which are informally established by the local leaders (neighbourhood heads - RT). Commonly the neighbourhoods are divided by large communication networks, but many times the boundaries are only known within the communities, with no visible border in the built environment.

The areas adjacent to the Citarum river are highly polluted by illegal waste collection or from waste thrown in the water and brought by the current. Apart from the solid waste, the soil and water contain many pollutants such as heavy metals because of unregulated spills of waste water from the industrial areas upstream. This pollutants are spreading inland with every flood event in the, causing infections and bringing diseases to the population living and working in the area.

In the following pages, we zoom in to 3 significant places, looking closely to the identities of these places and the effects of the implemented flood infrastructure.

Legend

- Villages
- Urbanized Areas
- Water Bodies
- High Polluted Areas
- Low Polluted Areas
- Neighbourhood Boundaries
- Zones
- Fields
- Rice Fields
- Farms
- Industrial Zone
- Military Zone

0 250 m

**SOLID WASTE**

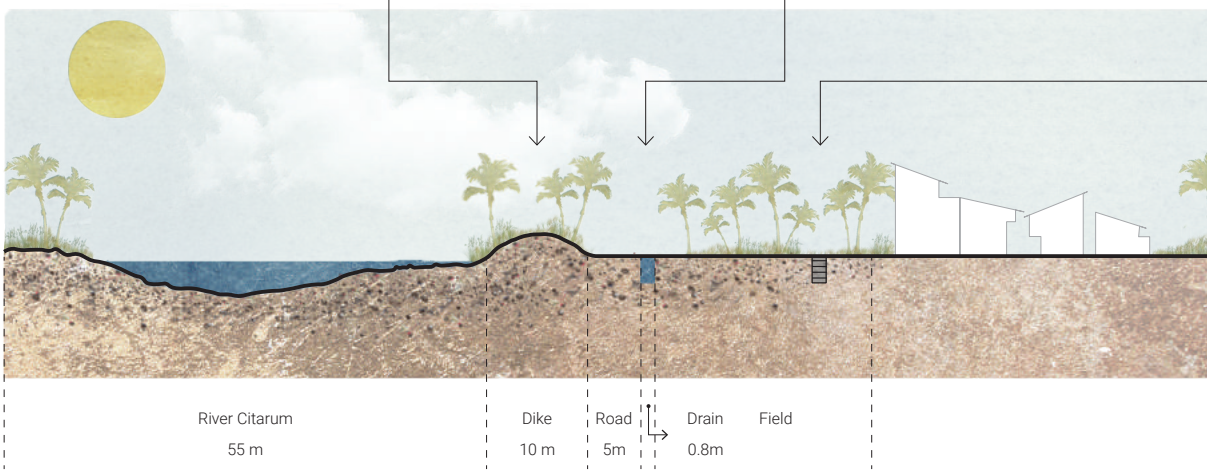
The unregulated landfills near the river Citarum and constant floods cause spreading of solid waste along the whole river basin. The shores in the area of Dayeuhkolot are highly polluted which creates health risks but also failure of the flood infrastructure (Figure 40).

**EXISTING DIKE**

The implementation of the dike in the area of Dayeuhkolot has been partly executed (Figure 41). After gathering the building material there has not been any other measures for strengthening the dike, which predisposes landslides and sedimentation spread in urbanized areas.

**DRAINAGE SYSTEM**

The maintenance of the drainage system has been neglected by the responsible authorities (Figure 42). Due to constant flooding events it is not functioning accordingly.




The current situation in the Village of Dayeuhkolot is depicted by the section A. The flood protection system project starts with dredging the river bed, that allows better water flow, but also clean river from years of sedimentation processes. The material from the river bed is put aside and is used for the construction of a dike. The present profile of the dike is around 2 meters high (differs along the river) and 10 meters wide. Additionally to that, an inspection road was planned from both sides of the river and a drainage system adjacent to it.

However, the implementation of the plan has been controversial. The river bed is highly polluted with solid waste and also heavy metals, due to the unregulated landfills on the river banks, discharge of waste water from the industries without treatment and also household waste. Therefore, the material that was used for the construction of the dike is highly polluted soil, with big percentage of plastic solid waste. In some cases of legal urban areas this material has been cleaned, yet in the focus area of this project - Da-

**WASTE GATES**

Dayeuhkolot village head has initiated the building of 8 waste gates (Figure 43) around the boundaries of the village with the cooperation of the local government. They serve as filter for the solid waste in case of flood event.

**OPEN SPACES**

Spaces like the field on the section (Figure 44) that has not been built up many times lack maintenance and become landfills or space for plastic waste separation.

**BUILT ENVIRONMENT**

Many of the buildings in Dayeuhkolot have suffered floods higher than 2 meters which causes loss of the construction stability or unusable living environment (Figure 45). There are many empty properties due to health and (flood) safety issues.


yeuhkolot Village this measures has not been implemented. The strengthening of the dike with bricks or additional layer of impervious material that prevents landslides is only available near legal settlements.

In addition, the construction of the inspection road has been only partly carried out. In the area of the Dayeuhkolot Village this road is interrupted by the Military zone (section C) and the industrial area of the paper company, which is a national enterprise. Hence, only the segment of the kampung has this road, which in fact is inaccessible. Therefore, the infrastructure maintenance has been impossible or neglected.

The third element of the defense system - the drain has been implemented, but due to the regular flood events it is filled with sludge, which is not being cleaned and properly maintained.

**Figure 40** Repairs of the existing dike failure due to landslides
Source: Author

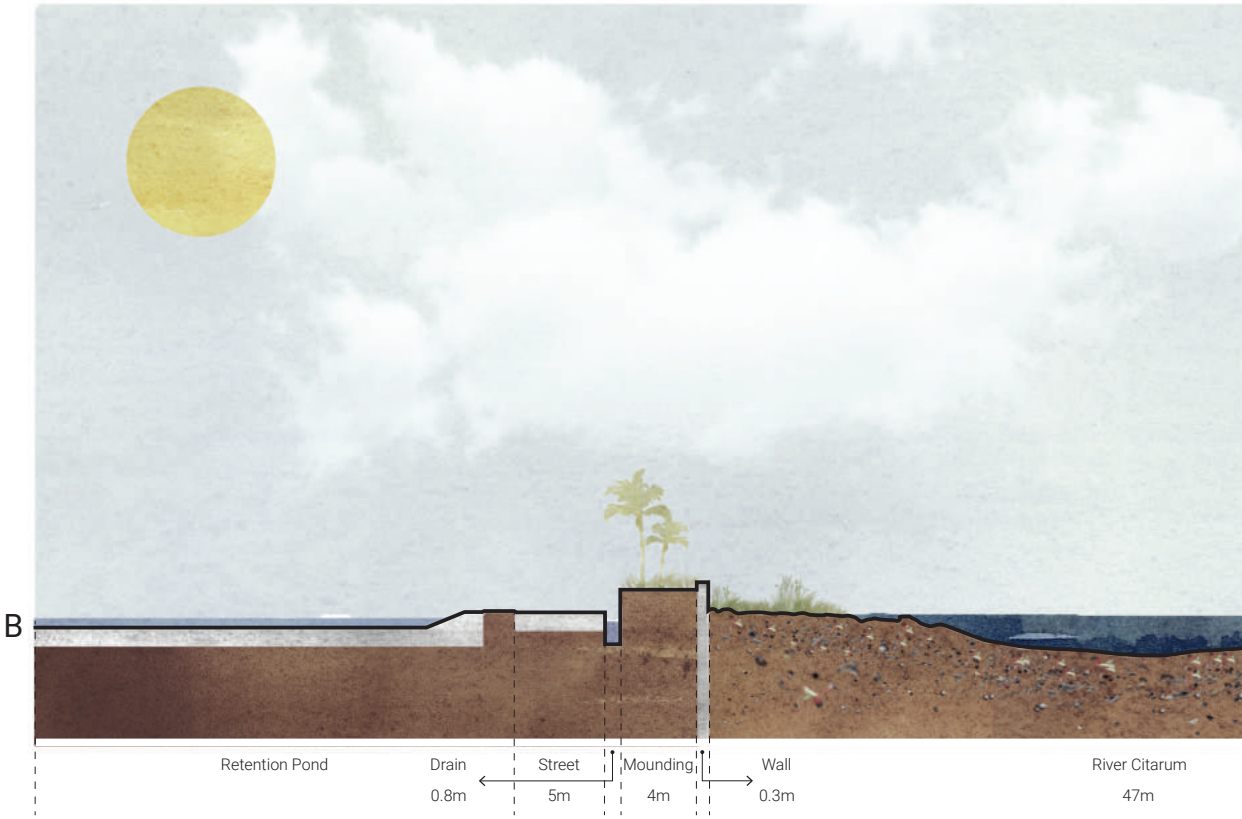
**Figure 41** Existing dike near Dayeuhkolot Village - hight and condition of the soil
Source: Author

**Figure 42** Condition of the inspection road and drain. Dayeuhkolot Village
Source: Author

**Figure 43** Water Gates installed for protection from solid waste entering the area during flood events
Source: Martin Muljana

**Figure 44** Landfill area adjacent to the Citarum river bank
Source: Author


**Figure 45** Property for sale during a flood event, 21 April 2019
Source: Martin Muljana




The section B is showing the part of the same project of flood protection, which is the implementation of the retention pond on the South side of the Citarum river - opposite to the Dayeuhkolot Village. The construction of the retention pond has been of a great value for the area. However, the design of the retention pond has been constructed as a mono-functional hard infrastructure with no additional values for the users around it.

The combination with the dike system have decreased the yearly flood, but not overcome completely. Due to the above mentioned implementation gaps the flood events are still happening at least twice every year with minimum of 40 cm of water in the village. In the section B and the following images we identify the different types of defense measures used - a dike with hard embankment, or just material dredged from the river bed or as in this case a flood wall of around 2 meters high (differs along the river). This contrast in the implementation of the flood protection project has a negative effect on the stability and jeopardizes the performance of the proposed actions.

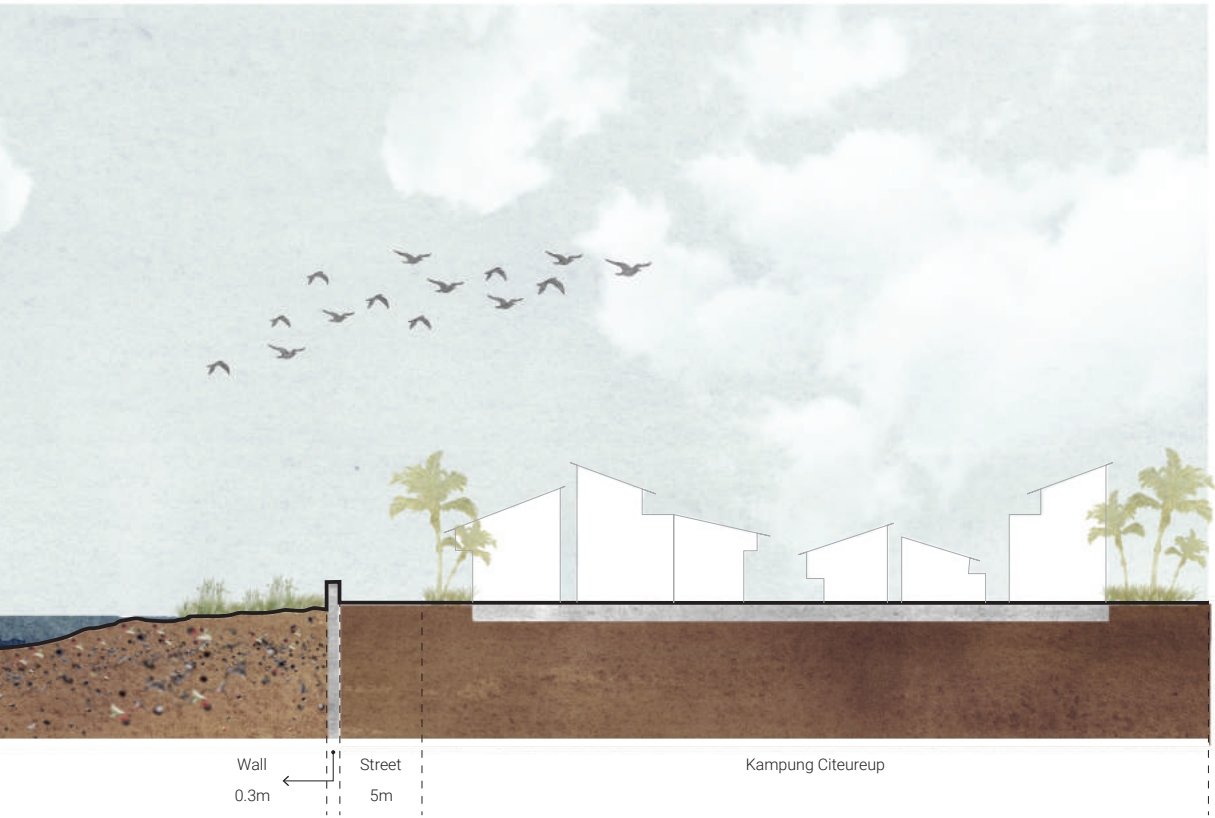
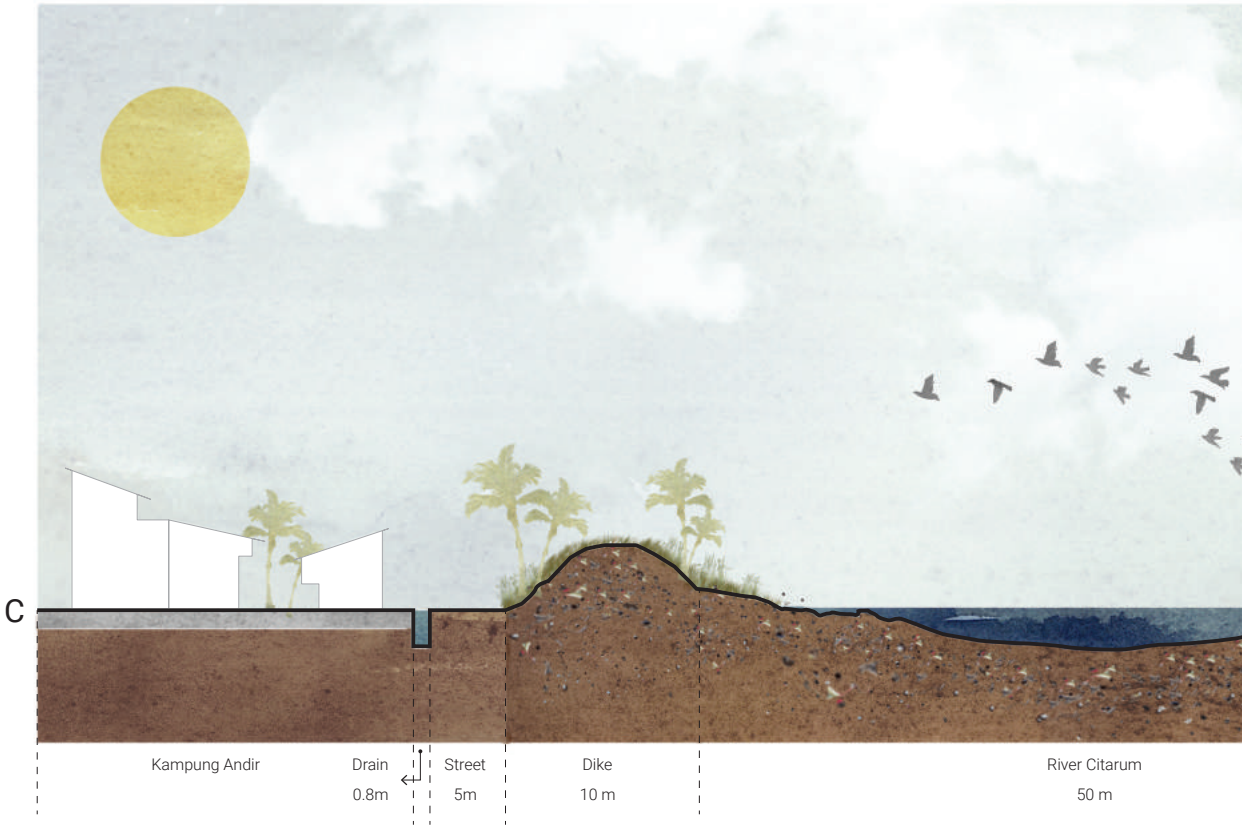

B1
Wall
0.3m
Street
5m
Kampung Citeureup

**Figure 46** Retention Pond on the South of Citarum river
Source: Martin Muljana

**Figure 47** CItarum river and the flood wall on the opposite side of the retention pond
Source: Martin Muljana




The section C is crossing the Citarum river and the adjacent military area. The implementation of the flood protection project in this area is also has specific modifications. Due to the protection zone of the military area, the planned inspection road has not been completed as mentioned above. Also an addition to the initial plan is the overflow area which acts like a temporary water delay and is equipped with a pump station for after the flood event. Many buildings have suffered from previous floods and many of them that are immediately next to the river have been abandoned due to irreversible damage.

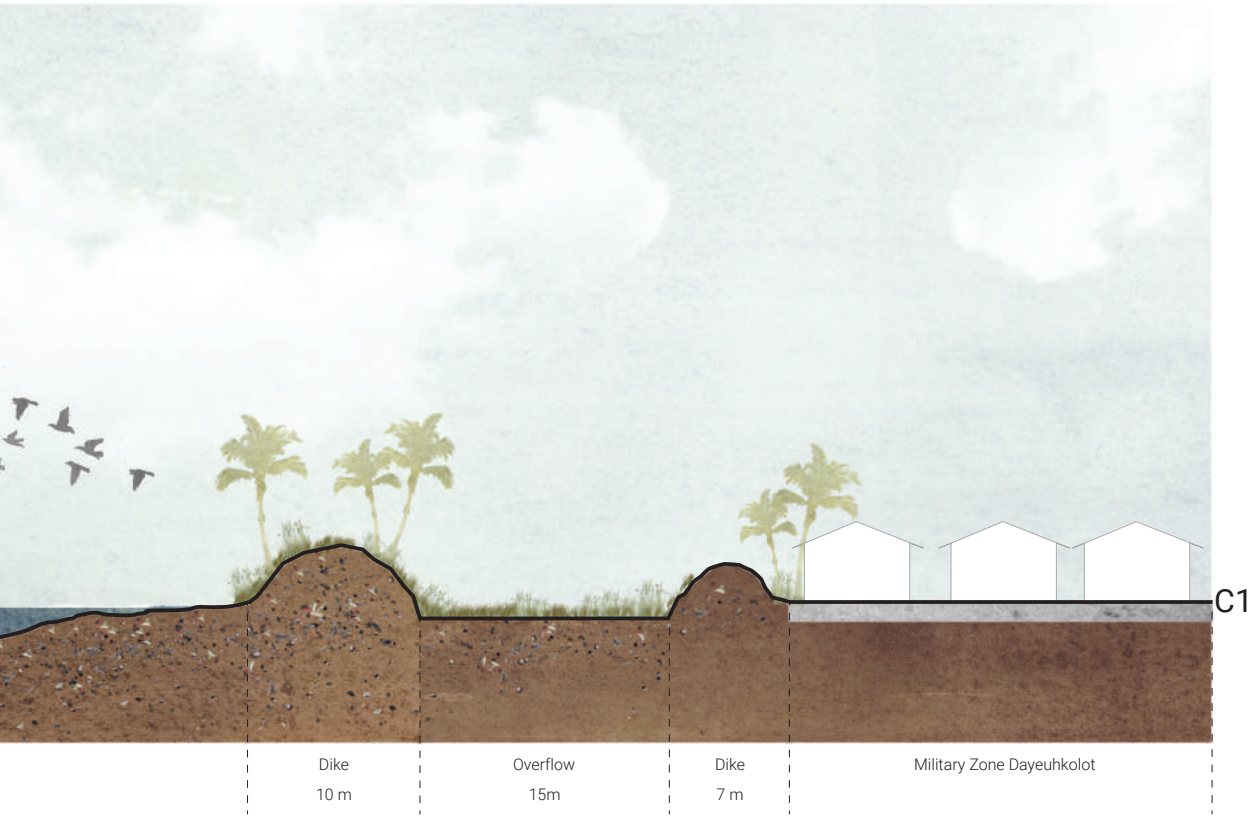

C1
Dike
10 m
Overflow
15m
Dike
7 m
Military Zone Dayeuhkolot

**Figure 48** Unused housing due to flood damage in the military area
Source: Author


**Figure 49** Overflow and pump station in the military area
Source: Author

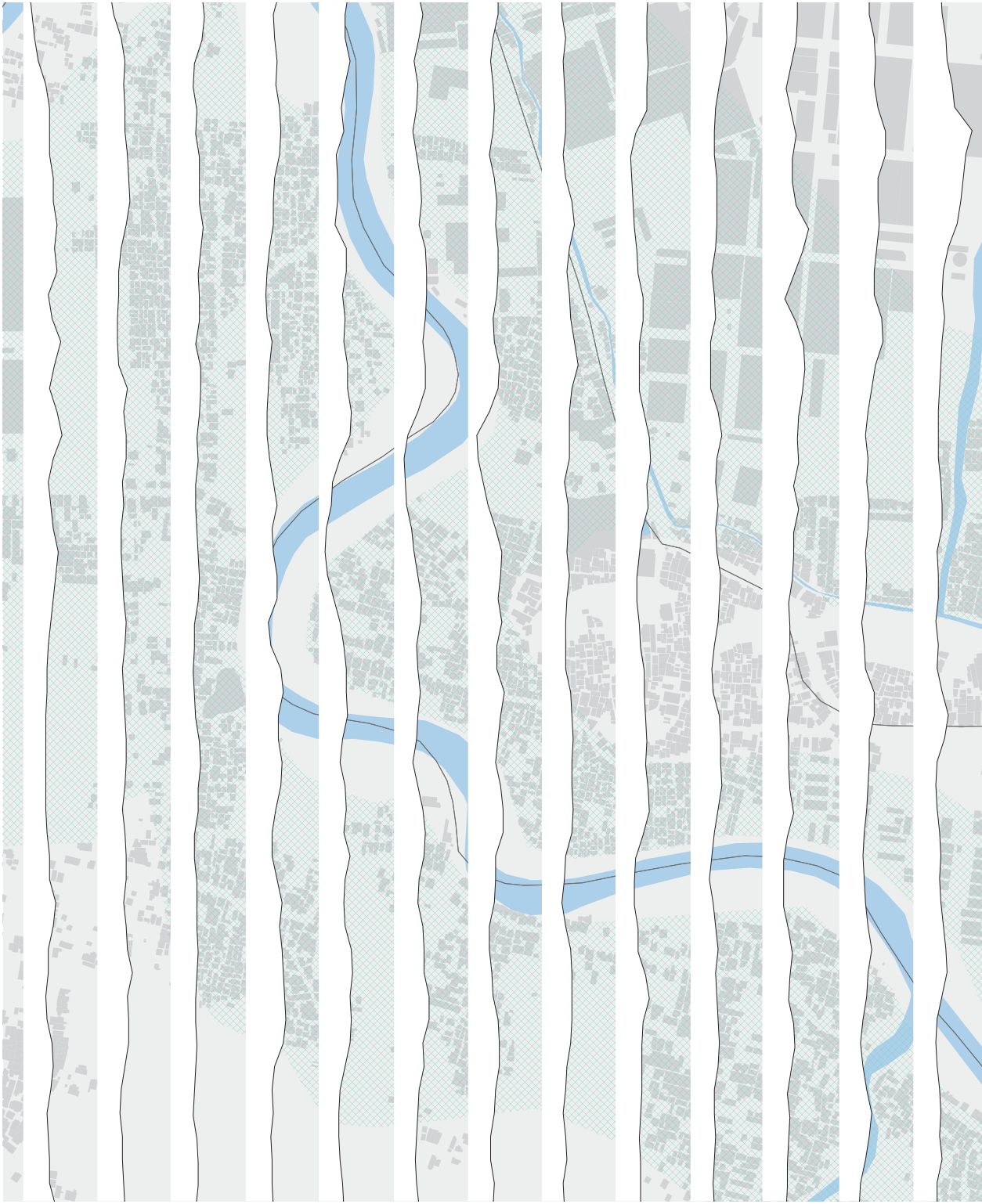




**Figure 50** Topographical Section and Flood Depth 2 year return period. Dayeuhkolot Village
Source: Hamdani, A. (2013). Analysis of flood extend and inundation of Upper Citarum based on hydrodynamic model and geographic information systems, Bogor Agricultural University.

**Topographical Sections and Flood depth of 2 year return period**

The Dayeuhkolot Village is the lowest point in the Bandung Valley. The mean elevation in the area is around 670 meters, where the lowest point is 640 meters and highest 690 meters. Previously, the area was used for agricultural purposes with developed irrigation system and few settlements. However, the rapid urbanization growth of the city of Bandung which came with new opportunities for industrial expansion the border areas like Dayeuhkolot and Cimahi were transformed in to modern industrial areas. The topographical specifics, combined with the previously built irrigation system and the close proximity to the Citarum river are increasing the probabilities of flood hazards. Additionally to that, the densely build urban environment and severe ground water extraction are exposing many people who live and work there to annual floods. The elevation is not creating any natural barrier for the water to flow into the urbanized areas. The flood depth of 2 year return period shown in Figure 48 covers mostly half of the Dayeuhkolot Village and is 40 to 80 cm. Yet the interviews with local leaders and civic society are indicating that in recent years those floods are happening at least once a year, which alarms for rapid change in the discharge of water on the island.

Legend

- D Villages
- Urbanized Areas
- Water Bodies
- 0.4 - 0.8 m
- 0.8 - 1.50 m
- 1.50 - 2.00 m
- Topographical Sections

0 250 m

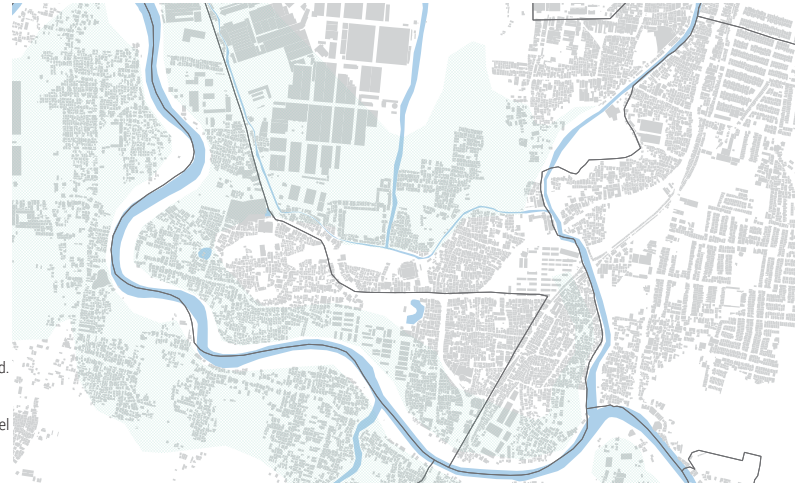


**Figure 51** Distribution and Flood Depth 2 year return period. Dayeuhkolot Village
Source: Hamdani, A. (2013). Analysis of flood extend and inundation of Upper Citarum based on hydrodynamic model and geographic information systems, Bogor Agricultural University. Master Thesis.

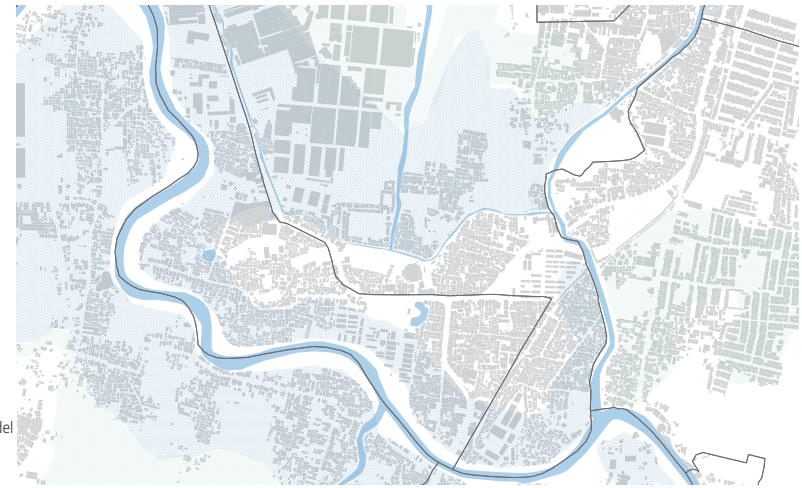


**Figure 52** Distribution and Flood Depth 20 year return period. Dayeuhkolot Village
Source: Hamdani, A. (2013). Analysis of flood extend and inundation of Upper Citarum based on hydrodynamic model and geographic information systems, Bogor Agricultural University. Master Thesis.

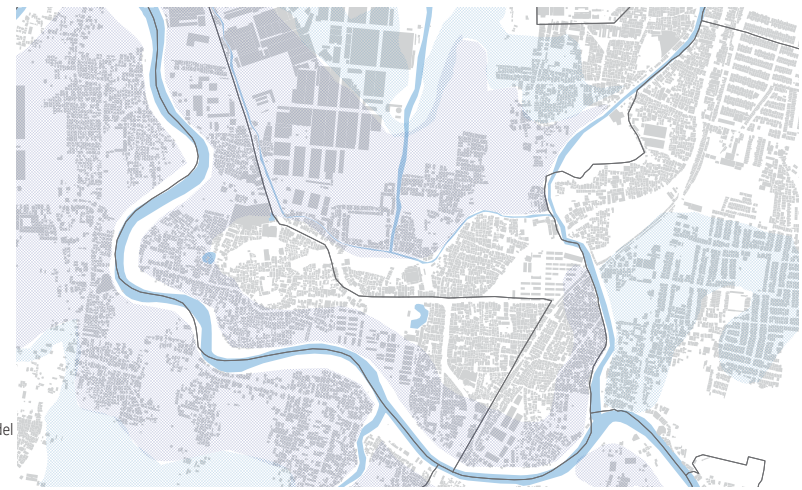


**Figure 53** Distribution and Flood Depth 100 year return period. Dayeuhkolot Village
Source: Hamdani, A. (2013). Analysis of flood extend and inundation of Upper Citarum based on hydrodynamic model and geographic information systems, Bogor Agricultural University. Master Thesis.


**Figure 54** Entrance of the Citeureup Village on 21 April 2019
Source: Martin Muljana

**Figure 55** Dayeuhkolot Village on 21 April 2019
Source: Martin Muljana

**Figure 56** Closest properties to Citarum River 21 April 2019
Source: Martin Muljana




**Figure 57** Flooding in Dayeuhkolot Village, 21 April 2019
Source: Martin Muljana

# 8. Stakeholder Analysis

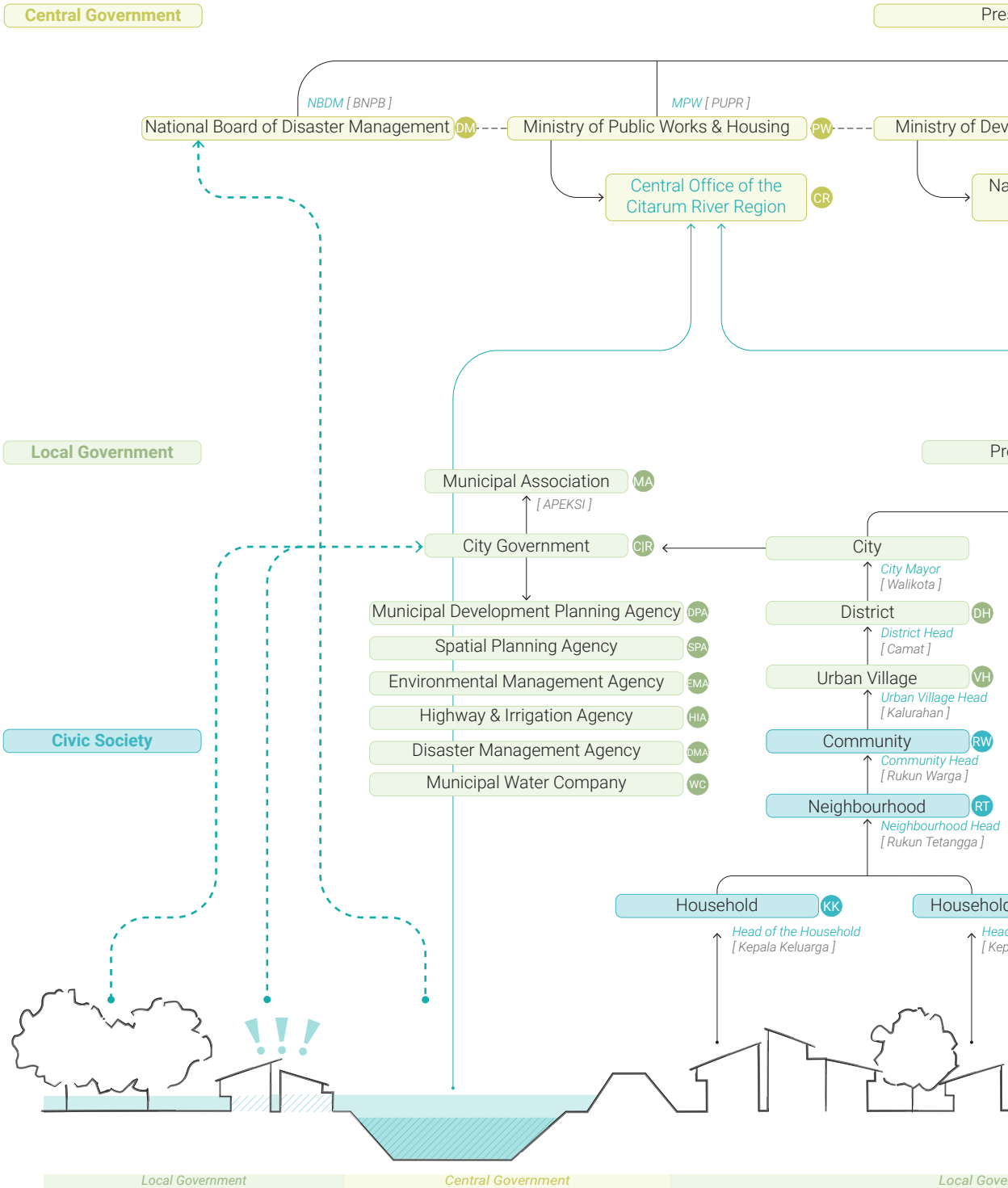
The analytical part of the research continues with conducting a stakeholder analysis. This study is of great importance for achieving the aim of the project. The main reason behind the significance of understanding the stakeholders' attitude and position has been recognised after exploring previous projects; it becomes clear that the role of the stakeholders has been underestimated. A clear example of this is the research of the Japan International Cooperation Agency (JICA, 2010) studying the flood management strategies for the Upper Citarum River tributaries. The JICA has prepared a thorough report for analysing and suggesting the important future steps for providing safety in the region. The expertise and depth of the proposal are promising and the project has been in execution since 2012. However, after conducting a field trip through the area, much more questions arose to the implementation of the suggested interventions and infrastructure (see page 70). A review of recent publications uncovers the issues of the execution of the project. As an example this research takes the texts from the book "Sustainable landscape planning in selected urban regions"(Yokohari, Murakami, Hara, & Tsuchiya, 2017). In this book the authors reflect on the causes of worsening of the quality of water and regular flood events, such as intensive exploitation of the land through agriculture and rapid expansion of the urban settlements without the necessary conservation measures, protection of the water source. The authors' team points out to the newest development initiatives in relation to the JICA report and reflects on their work (Yokohari et al., 2017):

> *"In relation to this, the Indonesian Ministry of Public Works has established management planning for the Citarum watershed (Directorate General of Water Resource 2012) but, so far,* **management of this watershed has tended to be only partially carried out** *(only in certain sectors)* **owing to a lack of mutual understanding among the relevant stakeholders**. *It is likely that the* **absence of common principles that accommodate the interests of all parties** *is a factor behind this situation. In addition,* **the relevant stakeholders do not as yet properly understand such notions as adopting an ecosystem (landscape) approach** *as the basis for watershed rehabilitation. Water managers need to recognize more clearly that there are additional, but no less critical, issues beyond the watershed itself—issues of a sociological, ecological, and also political nature"*

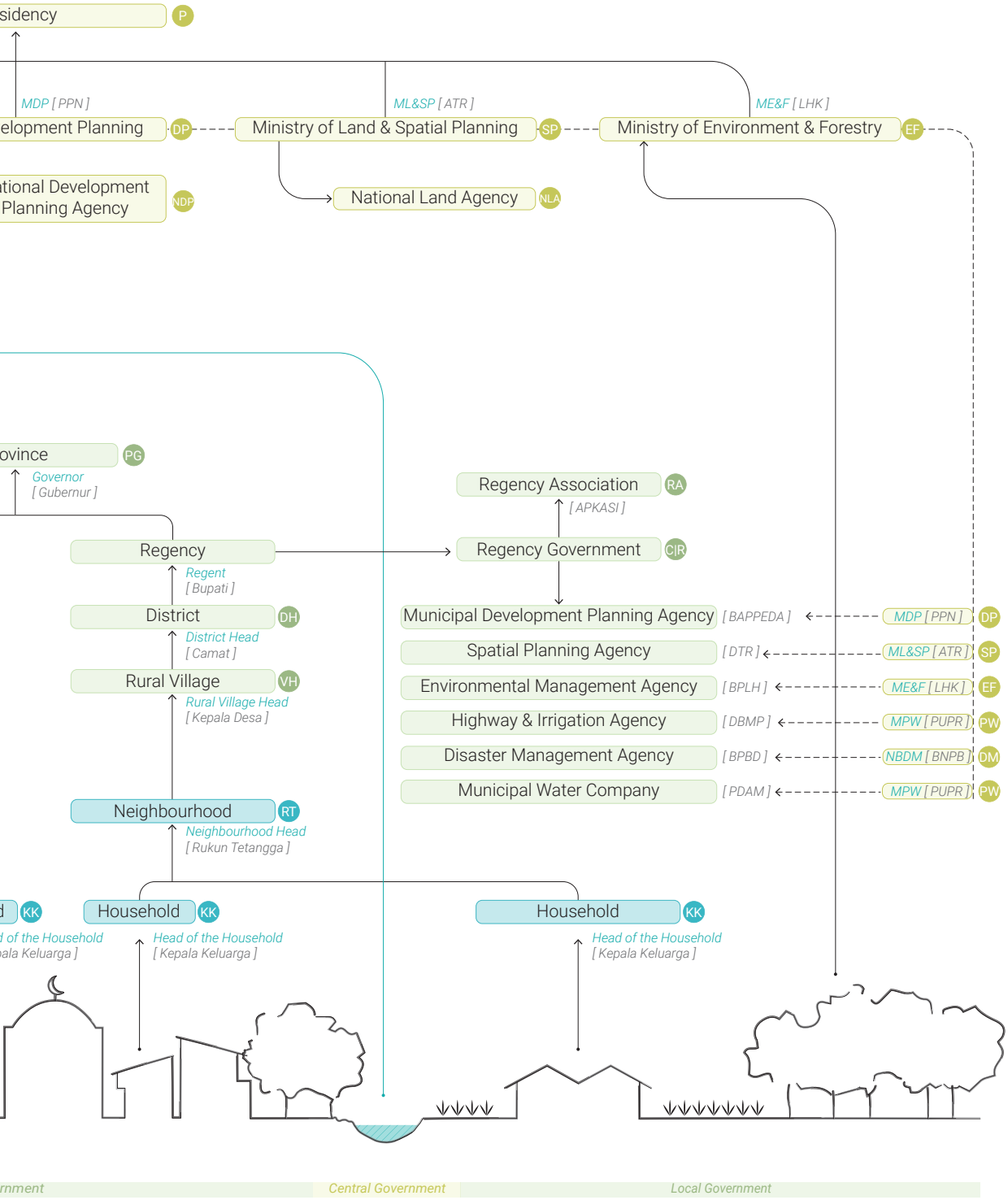
This text suggests a well-defined understanding on the reality that was seen as controversial after the observations on site. It calls attention to the importance of the stakeholder involvement in the process of decision making as without it many of the assigned actions meet resistance in their implementation. Moreover, the ability of the stakeholders for understanding and valuing some ecosystem based measures needs support from the relevant authorities.

## 8.1. Methodology

This graduation project uses a developed methodology for arriving at the answers needed from the stakeholder analysis. It uses several research practices and follows four steps towards the end result. The **first step** is: understanding the general structure of the governance system in Indonesia. As this project is an exploration of the regional scale Bandung metropolitan, this calls for actions from the higher authorities. Therefore, exploring the governance system helps identifying and positioning the relevant figures of the central and local authorities and their links to the civic society. The **second step** follows a research by Rebecca Yang commenting on the perspectives of the stakeholder analysis within the urban development projects (Yang, 2014). It facilitates the process of identifying the stakeholders in the project, prioritising them by introducing key actors in the study and then positioning them by using their attitudes and interests. The **third step** is directly related to the end result of the stakeholder analysis and it uncovers the desired state of the key actors. The study needs to make assumptions on the ground of previous research and combine it with its objectives in order to assign a new position to the key stakeholders. Sometimes this movement might suggest increasing the power or interest of a certain actor, or to decrease them, depending on the direction of the end goal. The final **forth step** of the methodology is the creation of the engagement strategies based on the all previously acquired knowledge. It represents the specific actions that are needed for moving the stakeholders from their current state (step 2) towards a position which would be the most beneficial for the realisation of the project (step 3). This step would suggest interaction between different actors, creating incentives or low reinforcements for achieving the wanted position. In the next paragraphs, these actions are followed on the case study of the project.




91 **Figure 59** General Structure of the Governance System in Indonesia
Source: Author


sidency
P
MDP [ PPN ]
elopment Planning
DP
ML&SP [ ATR ]
Ministry of Land & Spatial Planning
SP
ME&F [ LHK ]
Ministry of Environment & Forestry
EF
tional Development
Planning Agency
NDP
National Land Agency
NLA
ovince
PG
Governor
[ Gubernur ]
Regency
Regent
[ Bupati ]
District
DH
District Head
[ Camat ]
Rural Village
VH
Rural Village Head
[ Kepala Desa ]
Neighbourhood
RT
Neighbourhood Head
[ Rukun Tetangga ]
Regency Association
RA
[ APKASI ]
Regency Government
CIR
Municipal Development Planning Agency
[ BAPPEDA ]
MDP [ PPN ]
DP
Spatial Planning Agency
[ DTR ]
ML&SP [ ATR ]
SP
Environmental Management Agency
[ BPLH ]
ME&F [ LHK ]
EF
Highway & Irrigation Agency
[ DBMP ]
MPW [ PUPR ]
PW
Disaster Management Agency
[ BPBD ]
NBDM [ BNPB ]
DM
Municipal Water Company
[ PDAM ]
MPW [ PUPR ]
PW
KK
of the Household
ala Keluarga ]
Household
KK
Head of the Household
[ Kepala Keluarga ]
Household
KK
Head of the Household
[ Kepala Keluarga ]
rnment
Central Government
Local Government

## 8.2. General structure

Indonesia suffered from an economic crisis in 1997, which led to several major reforms in the country's intergovernmental system. One of these reforms was the decentralization of the governance structure, in order to regulate better the power and responsibility of the central government towards local management of the economic developments (Holzhacker, Wittek, & Woltjer, 2015). This change triggered a variety of relationships between the central and recently empowered local government (Figure 59). The ministerial offices created specific agencies which work in a municipal association or regency association, depending on the type of region – predominantly urban or rural. The collaboration between the local representatives and the ministerial agencies form the City or Regency Governments. The main difference between the authority of the central and local government is the scope of their actions and scale of developments. As depicted on Figure 59 spatially the central administration regulates assets of regional or above regional importance. These can be rivers, forests, irrigation systems, etc. and the entire adjacent infrastructure connected to them. On the other hand, the local direction controls the settlement areas and agricultural land in their region. This rigid separation of responsibilities creates imbalance in situations where joint actions are needed for improving the current situation.

> **"Under decentralization, urban governance is fragmented and lacks cooperation at the regional level" (Holzhacker et al., Decentralization and Governance in Indonesia, 2015)**

In the case study of this research project, the extreme events of flooding are an evidence for this fragmentation and imbalance. In case of river overflow the actions that are taken follow the same strict physical boundaries of responsibility. The central government focuses their attention towards the maintenance of the infrastructure, while the local government is required to assist in recovery of the built environment. However, sometimes this creates gaps in the execution of the needed measures. The lack of central vision in overcoming the consequences of such risks creates repetition in gathering information, work, and implementation or sometimes mismatch of the actual needs and realisation. However, the study finds a large opportunity for reducing the negative effects of this mismatch in the face of the traditional social structure in the country. The hierarchical connections between the civic society all the way to the president are very strictly defined. Every person on the chain has his/her position and responsibilities which are outlined by the law. For instance, in every family there is a leader (KK) (usually the man in the household) whose position is stated in the passport. A group of families choose their neighbourhood head (RT), after which a couple of neighbourhoods come together and elect the community head (RW). This continuation creates the perfect conditions for a communication channel, through which all stakeholders can participate, or have a representative in the decision making. This specific social structure of Indonesia is the perfect base on which social engagement can be built upon.

## 8.3. Power - Interest Diagram

A large part of understanding the positions and roles, in which different stakeholders have connected to flood mitigation and adaptation project, is first locating their current point of view. The method that is used in this study is the Power – Interest diagram, which positions the relevant stakeholders within four quadrants of "subjects", "players", "crowd" and "context setters" (Figure 60). In addition to that, the study uses a third parameter – the attitude of the actors, which is regularly seen in the three-dimensional stakeholder mapping (Murray-Webster & Simon, 2007). These three attributes create the profile of the actors, which can inform the strategies that the project undertakes later. The first attribute, the power, refers to the potentials of the stakeholder to influence other stakeholders or the project itself. The power can be from different sources like special expertise, political influence, regulatory capabilities or financial means. The second attribute, the interest, indicates the willingness to act upon the proposed project or plan, thus, usually it is measured by being "active" or "passive" stakeholder. And the third attribute, the attitude, signifies whether the actor would have positive or negative position upon the proposed measures, to what extend will they support (back) or resist (block) the project. As a final point, the objectives of the power-interest-(attitude) diagram are to establish the communication links and relationships between the stakeholders and to project how those will affect the design (Tugra Demir, Bryde, Fearon, & Ochieng, 2015).

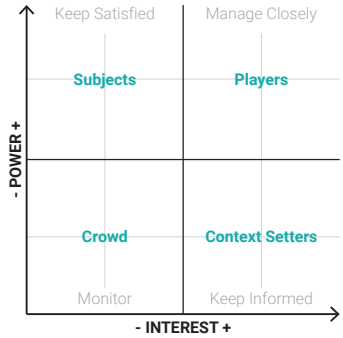



**Figure 60** Power Interest Diagram
Source: Adapted from Tugra Demir et al., 2015

The following pages show the power-interest map on two scales within the case study – the regional scale of the Upper Citarum River (Figure 61) and the local scale of Dayeuhkolot Village (Figure 62). In order to depict the relationships and positions of the stakeholders in a clear and understandable way, the third attribute – the attitude, is described in text in the following paragraphs. The maps represent the current state and position of the actors with solid colours, but also the future desired state for this project, with lighter hatch.

**List of Stakeholder Abbreviations**

TI Textile Industry
MI Metal Industry
FI Food Industry
PI Plastics Industry
LI Leather Industry

S Schools
H Hospitals

RW Community Heads [ RW ]
RT Neighborhood Heads [ RT ]
KK Household Heads [ KK ]

PA PusAir
D Deltares
J JICA
ITB Bandung Institute of Technology

ADB Asian Development Bank
WB World Bank
UN UNESCO
EPA Environmental Protection Agency (USA)

PW Ministry of Public Works
CR Central Office of Citarum River Region
DM National Board of Disaster Management
SP Ministry of Land & Spatial Planning
DP Ministry of Development Planning
EF Ministry of Environment & Forestry
P Presidency
NDP National Development Planning Agency
NLA National Land Agency
M Military

PG Province Governor
C|R City / Regency Government
DH District Head
VH Urban / Rural Village Head
MA Municipal Association
RA Regency Association
DPA Municipal Development Planning Agency
SPA Spatial Planning Agency
EMA Environmental Management Agency
HIA Hughway & Irrigation Agency
DMA Disaster Management Agency
WC Municipal Water Company

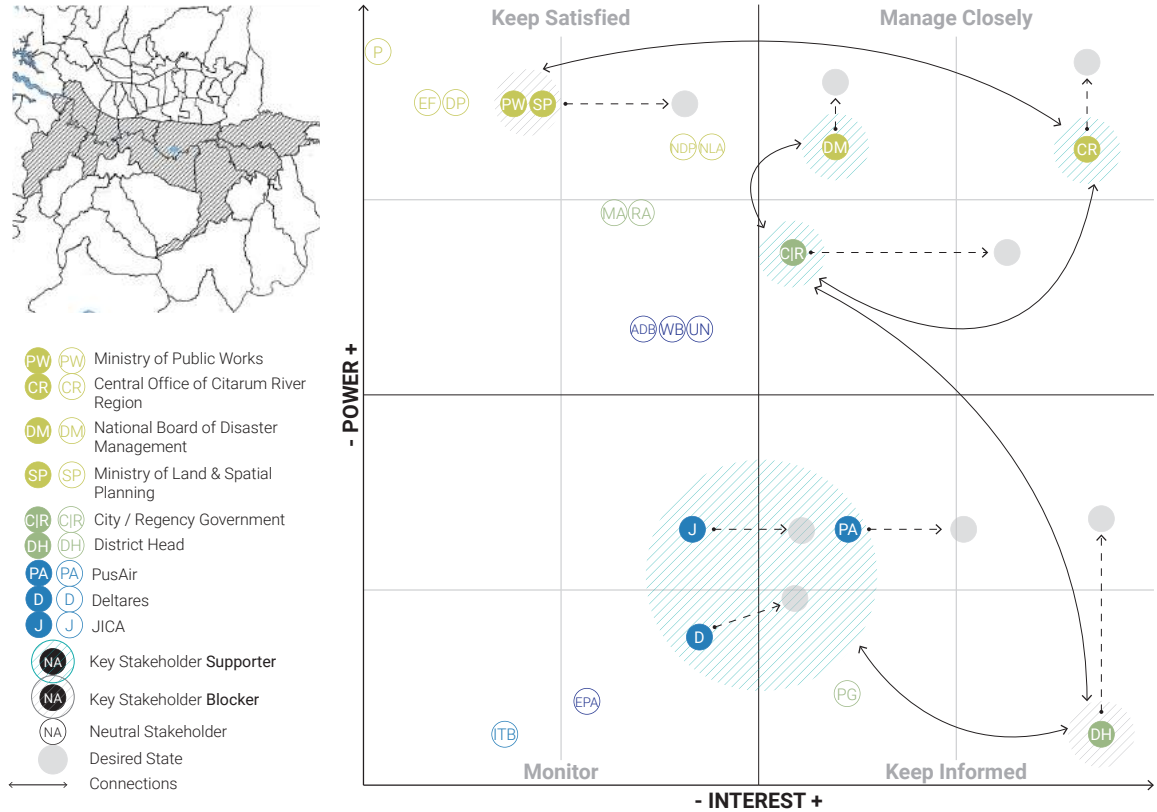



**Figure 61** Power-Interest Diagram Regional Scale
Surce: Author

### Regional Scale

The actors with the highest power like the Ministries of Public Works and the Ministry of Spatial Planning could not focus their resources and attention only on one specific area like the Citarum basin. Their scope of interest rests on the whole country; hence the Citarum basin is only one of the many critical points. Therefore, in recent years the power over the area is delegated to the Central Office of the Citarum River Region. Nonetheless, the budget of the organization is still controlled by the Ministry of Public Works, which has to distribute the finances to a number of courses. Thus, the future aim for the Central Office should be to acquire control over its own budget. For this a communication and mutual agreement between these two authorities is crucial for the creation of resilient strategies and their implementation.

Another key stakeholder in the large scale is the National Board of Disaster Management. Similarly to the Ministry of Public Works, their scope is much larger than just the Citarum River. However, the Board is focusing resources and efforts in this region every year, due to the annual flood events. The aspiration for this institution could be to connect better with the Local government layers (especially with the City or Regency Government). This would help the quicker response to disaster and increase the possibilities for adequate measures in the affected areas.

One main point in the analysis shows the importance of the local representatives, in this case the District Heads. The assumption is that they will be positive about changes in the area towards a safer environment. Yet, in previous proposals for implementing new flood measures, their realisation has been postponed and hampered due to disregard to the opposing opinions of the relevant stakeholders. Therefore, there is a need for earlier inclusion of the local communities in the process of decision making.

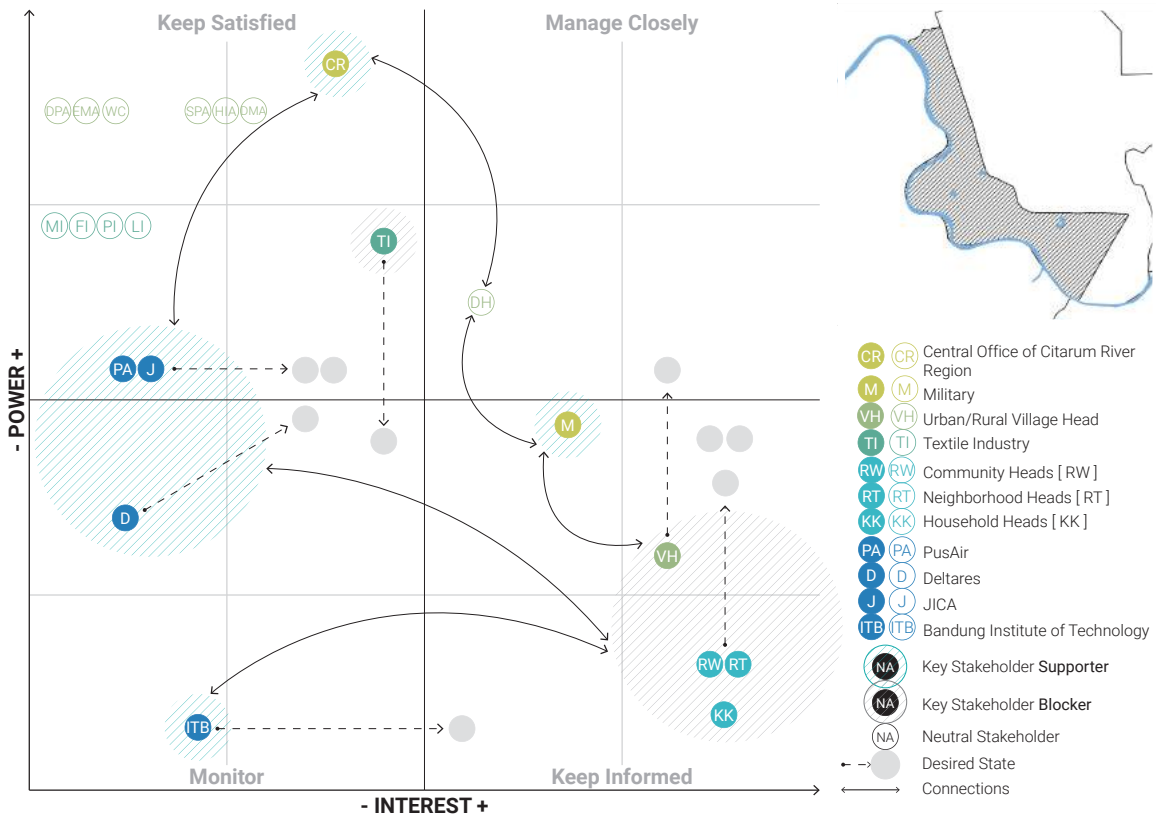



**Figure 62** Power-Interest Diagram Local Scale
Surce: Author

### Local Scale

The Central Office of the Citarum River Basin is still a key stakeholder in the local scale as in the regional one. The Central Office has high power still and in order for it to be able to understand the needs and concerns in the area there should be an improved connection to the local communities. This would enhance the possibilities for better acceptance of new proposals and likelihood for positive response.

There is a general assumption that in the case of Dayeuhkolot Village, the industries are not fairly interested in the initiated changes in the area, because they already have needed infrastructure for pumping out water in case of flooding. However, they can be a potential blocker, as some of the warehouses are within the restricted 100 meters. Therefore, the plan needs to take into account stronger restriction law regulations in order to lower the power of the industries and create a better prospect of implementing more drastic measures.

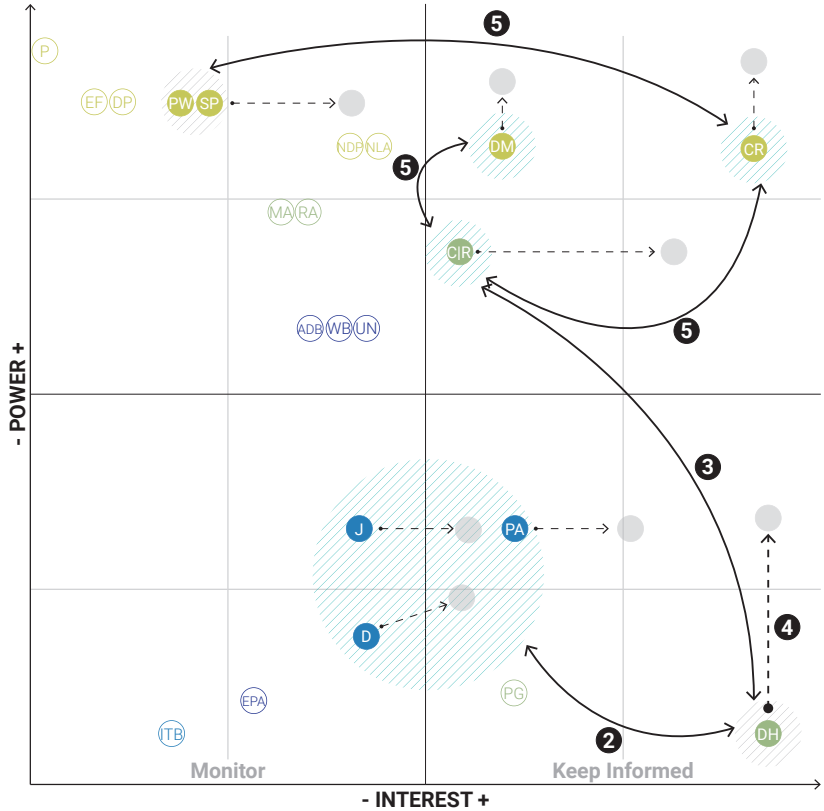
The local leaders in the face of the village head play a central role on this scale, even though their power is very low. In some cases, their potential negative attitude towards a plan or a project can block the execution. However, if the plan has a greater support from the local communities, there is a better chance of carrying it out. There can be two sides – first, enhancing their power through enhanced local participation, and second, better understanding of notions, plans and measures that are designed.  Empowering the lower levels of governance can promote local inclusion in decision making by making use of the traditional social structure. Another way is to make the universities a catalyst for communication between experts and locals, as students and academics can easier create links and engage them in conversation. This can improve the understanding between them and fill in potential knowledge gaps.

## Conclusions

> **"[T]he created governance system is most effective when it is not solely based on top-down initiatives, but relies instead on the involvement of whole set of institutions spanning regional, national, and local governments, relevant stakeholders, and civil society" (Holzhacker et al., 2015)**

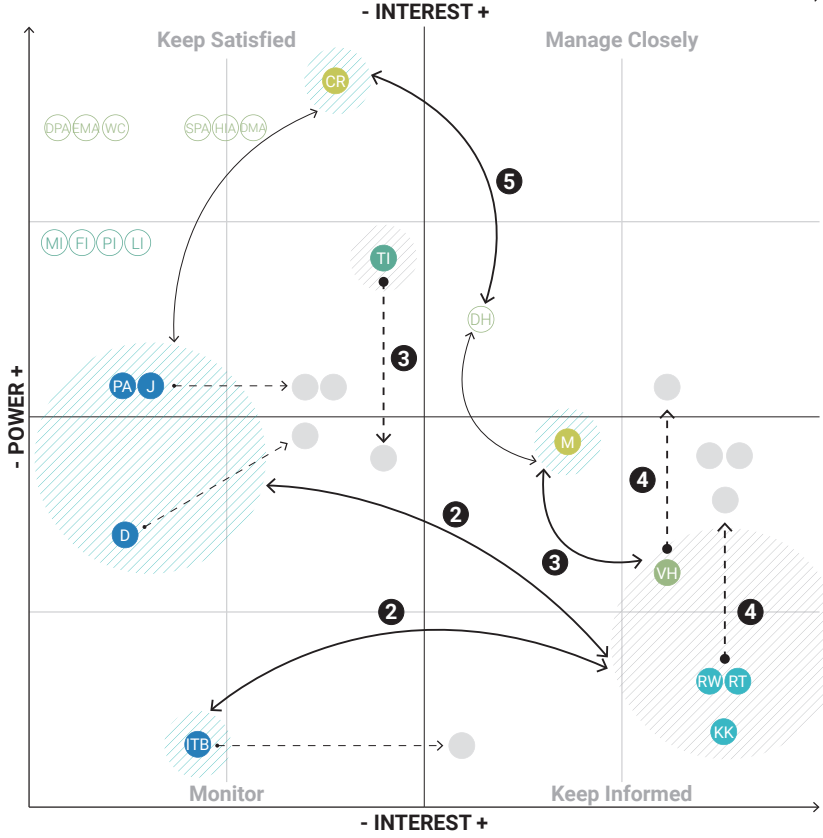
The creation of a relevant vision for the uncertain future of Bandung Region, it is urgent to establish a connection between the needs and the response, but even more important to create awareness and acceptance in the relevant stakeholders. It is a well-known fact that without the support of the local communities and lower levels of governance, projects can easily fail to deliver the needed improvements.

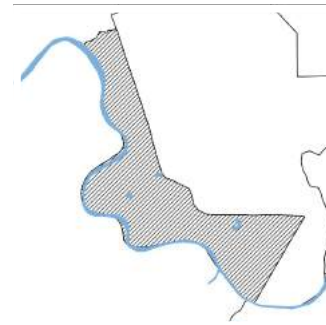
The stakeholder analysis for the case of Bandung was conducted as an answer to issues that surfaced in previous projects for this area. It identified the key actors like the Central Office of Citarum River Basin, the City/Regency Government, the Research and Design experts, the local representatives and civic society itself. Through identifying their position in the power-interest diagram and studied their possible attitude, the analysis created a prediction of their desired state within the project limits and the needed connections between them. In the final stage of the stakeholder analysis, the focus is on the actions that have to be taken in order to achieve the links and communication between the chosen stakeholders (Figure 63). The following paragraphs elaborate on the strategies for engaging and involving them in the process of decision making for accomplishing the aim of the study.




Engagement Strategies

1. New Platform for Cooperation
2. Knowledge building
3. Regulation Constrains
4. Utilizing the potential of the Governance Ladder
5. Building capacity for Regional Scale Strategy



Engagement Strategies

1. New Platform for Cooperation
2. Knowledge building
3. Regulation Constrains
4. Utilizing the potential of the Governance Ladder
5. Building capacity for Regional Scale Strategy

**Figure 63** Engagement Strategies Map
Source: Author

## 8.4. Engagement Strategies

**1. New Platform for cooperation**

Working towards a better stakeholder involvement requires a base system to guide this process. The application of a new platform for cooperation unfolds in two sets of actions – the ones that are preparing the stakeholders, institutions and organisations for creating the connections, such as knowledge building, acceptance, regulations, etc.; and the ones that are facilitating the strategies of engagement like utilizing the potential of the governance ladder in Indonesia. This platform would establish the means for both to happen, by promoting horizontal and vertical coordination between the actors. This will span the cross-border communication and collaboration, taking into account municipal or regional borders, but also spatial boundaries of authority on the lower scale. In the following Chapter 10 the establishment of this strategy is further explored within the steps of development of the Dynamic Adaptive Policy Pathways method.

**2. Knowledge building**

Knowledge building is a strategy which focuses towards establishing preparedness of stakeholders, regarding the work of the plan, the measures that are taken, the benefits that can be acquired and the ways in which they can participate. To achieve the aims of the study the public needs to be actively involved in the decision making, but also to be capable of understanding this process. This awareness can be built with the help of the experts for understanding the advantages and disadvantages of certain design in short and long term; or through the governance scale for better acceptance of the measures that are planned.

Within the general knowledge of types of plans and designs, the strategy works for increasing the awareness of the general public towards new approaches that are used and the responsibilities that come with them. An example of that can be the need of waste management strategy, which was not successful until now partly due to lack of awareness of environmental protection, partly due to unavailability of specific facilities. This objective can be supported by the local universities as they can create easier and more trustful connections with the locals.

**3. Regulation constrains**

This engagement strategy is working with incentive and disincentive measures which are mostly focused on strengthening of already existing laws and regulations. The two types of measures are balancing each other, creating strong regulatory framework and ensuring benefits for the stakeholders. The incentives are aiming towards conservation of the physical and natural environments with guidelines for organisation and preservation of resources. The disincentive, or law reinforcement, acts towards violation of waste management regulations. These can be restricting harmful actions and practices of industries and households for waste disposal in the rivers or creating unregulated landfills.

These measures can be supported by giving more regulative power to the military around the most vulnerable places. Another example is the encouragement of open ground preservation, for better absorption and re-charging ground water. The restrictive law, which is already in use, concerns all development within the first 100 meters from the main riverbed. This regulation needs full support and understanding from stakeholders and the control authorities, as these areas are proved to be the most affected ones in case of extreme rainfall.

**4. Utilizing the potential of the governance ladder**

The governance system in Indonesia is a very strong advantage with its ladder of power. This asset can be used as a base for inclusion of all relevant stakeholders in the process of decision making. Through the local leaders the communities can present their ideas or give their response for governmental proposal. This is an important step in the development of a strategy for the region as the stakeholders can and should influence the formulation of strategies. The inclusion of all relevant parties in making choices is not a practice for ensuring the successful implementation on the plan, but moreover, to be able to represent accurately the needs of the local communities of the planned areas. On the same line of thoughts, the exploration of the potential in the local governance level should be developed further. The choices made on a higher governance level need to have the required response in the lower levels, but also the other way around.

**5. Building capacity for regional scale strategy**

Building the capacity throughout all governance levels and inclusion of civic society creates the possibility for better understanding and support of future plans and proposals. Including all relevant stakeholders and better cooperation platform needs to be implemented. The creation of communication channels for increasing the understanding of the civic society towards the plans and proposals can benefit the coordination and implementation of the design. The lack of reach to the financial resources on the regional level discards the idea of decentralisation of the governance system. The local governments and agencies need to be able to build their own capacity through experts and management as they stand on the middle ground between central government and local participants. They need to be able to defend their positions and be accepted as equally capable of making informed choices.

# Design

IV

## Table of contents

# 9. Phasing And Spatial Implementation

In order to address the uncertainties in the natural and urban systems in Indonesia there is a need of a new planning paradigm. Configuring new types of spatial conditions as absolute entities might not be enough for accommodating the future changes. Instead, the new measures should be flexible and adaptive, having a variety of duration and activation periods. The Dynamic Adaptive Policy Pathways (DAPP) is a method able to sustain alterations in the urban and natural systems, while giving space for further adjustments. It assumes that policies and spatial actions should co-evolve along with the changing conditions by creating an understanding of the long-term change (Zandvoort, Kooijmans, Kirshen, & van den Brink, 2019). This method is a goal oriented planning platform, which uses scenarios over time and a sequence of actions supporting this goal (Haasnoot, Kwakkel, Walker, & ter Maat, 2013). Scenarios are the changing conditions in a system, which in the case of Indonesia are built upon the predictions of climate change and population growth. By estimation of the vulnerabilities in the different scenarios there is a point in time (a tipping point) in which the current systems could not sustain the risks or their adequate performance, thus additional actions need to take place. These actions can be long-term and short-term, depending on their robust capabilities, which creates possibilities for connections and continuations. For instance, when the tipping point of a short-term action is reached then it needs to be augmented by more robust action. By keeping several options open the method avoids "lock-in" situations and assists in achieving the end goal (Haasnoot et al., 2013). The method determines various actions by considering the relevant stakeholders, their needs and attitude. The stakeholder involvement is a key element in the DAPP. The method can be used for fostering conversation with the public and, furthermore, facilitating connection between the stakeholders and the projects through an intuitive visual expression, easily understandable and triggering participation.

The Dynamic Adaptive Pathways method is chosen for this research due to its possibilities for flexibility and adaptation in the chosen measures, but also because it reflects on the urgency of engaging the stakeholders in the decision making. And yet, the implementation of the method in the current research meets certain limitations which need to be acknowledged for better understanding. The DAPP method requires the usage of computational experiments in order to create the needed scenarios, evaluate the chosen actions and develop the pathways. On the other hand, it needs further exploration of the attitudes and reactions of the relevant stakeholders as an answer to the created DAPP map. However, considering the finite time of the research and computational possibilities, the method is developed by using assumptions and making informed guesses

based on the qualitative research – literature review, analysis of policies and planning documents, collecting interviews, etc. Therefore, the illustrated example of a Dynamic Adaptive Policy Pathways map for the case study of Bandung provides useful insights and possible conclusions, with the remark that it needs further computational models and reflection from the public.

## 9.1. Methodology

The present urban and natural systems are under a great pressure from rapidly evolving trends like climate change, population growth, vast urbanisation and others. Thus, in recent years the attention to pathways has been increasing rapidly since they are seen as one of the tools for dealing with uncertainties in the future.

> *"Pathways are strongly embedded in policy-making for climate adaptation and water management, adaptiveness in environmental-planning-related sciences, and transition management" (Zandvoort et al., 2019).*

The Dynamic Adaptive Policy Pathways promotes the usage of pathway thinking for creating adaptive solutions connecting all domains in the urban and natural realms. The recognition of this method leads to variations and examples for the development of the adaptive pathways. However, in essence, the method uses six basic steps and further each variation can differ in the implementation and detailing of each step. This graduation project uses the example developed by Deltares with authors Marjolijn Haasnoot, Jan H. Kwakkel, Warren E. Walker, Judith ter Maat in their publication "Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world". The steps are illustrated in Figure 64 and further explained in the following paragraphs.

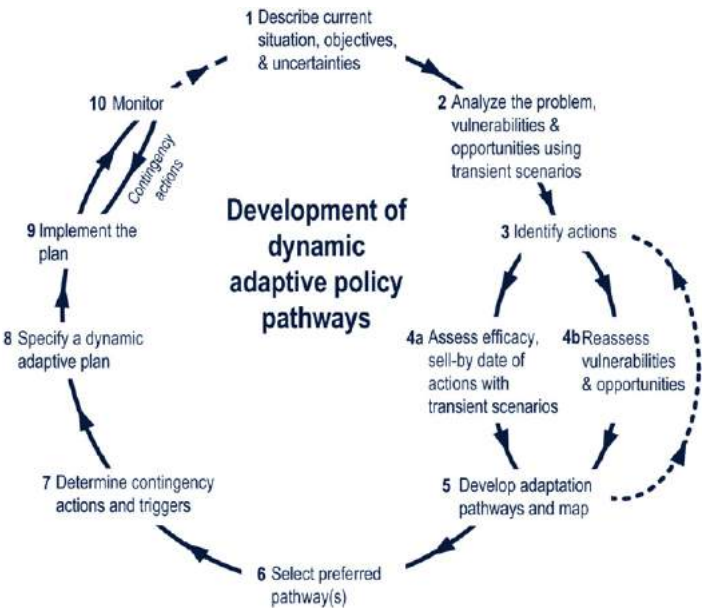



**Figure 64** The Dynamic Adaptive Policy Pathways approach.
Source: (Haasnoot, Kwakkel, Walker, & ter Maat, 2013)

**Step 1 & 2: Current situation and problem analysis**

The first step defines the key elements of the system that are most affected by changes and uncertainty. It explores the state of vulnerability and defines the limitations and opportunities of the system at risk. Through scenario building, the critical moments are defined and located the tipping points in time – the terminals of current or future conditions. The result of the step is a "definition of success", which can be seen as the goal of the plan, the end target of the scenarios. Through it, the next steps are evaluating the performance and potentialities of the chosen actions.

**Step 3: Determine actions**

Consequently, based on the pre-established conditions, the specific actions needed for reaching the goal of the plan are determined. The actions are selected possible adaptation responses, considering the appointed opportunities and limitations of the scenarios. This step provides a rich palette of actions for different perspectives of the problems in the current or future situations.

**Step 4: Assess efficacy and opportunities**

The next step evaluates the formed actions and their effects on chosen factors. The assessment criteria is based on both the outlines of the scenarios and the "definition of success" – from the first steps. It can be an assemblage of performance measures such as flood reduction, cost-effectiveness, social equity, spatial quality, additional benefits, negative side effects on other levels of the system (van Veelen, 2016). The multi-criteria analysis uses a mark for each performance measure and the final estimation sets a score for each action. This determines the plausibility of using certain actions in the further steps.

**Step 5: Develop pathways**

Once the actions are identified the pathways can be designed. Developing the different pathways relies on determining the tipping points (terminals) of the actions, thus creating alternatives for reaching the goal of the plan. These terminals are grounded in points in time where the change in the systems is so big that they cannot meet the societal or nature objectives anymore. The substitution actions are usually more than one and they are chosen by being more robust than the previous one, having longer sell-by date. The outcome of this step is the adaptation map, which is used as a tool for engaging stakeholders and identifying their needs and attitudes towards the plan.

**Step 6: Select preferred pathways**

The last step in for configuring the DAPP is to select the preferred pathways with the assistance of the relevant stakeholders. This creates the structure of the dynamic adaptive plan for the specific project. In the Figure 64 there are further steps that are aiming at implementation of this plan and adjusting it in the future scenario.

## 9.2.The Case of Banding Region *(Step 1 & 2)*

**Current situation and problem analysis**

The first and second steps of the DAPP method have been widely described in the previous chapters of the graduation thesis. The main issue that emerges is an increased vulnerability to flooding in both physical and social spheres in the urban realm of Bandung region. Decision making and implemented solutions are biased and do not reach the needed performance qualities or spatial conditions for coping with the increasing pressures. The consequences are critical living conditions – both health-wise and safe-wise, and deepened inequalities in the society. Therefore, the objectives are to minimise the occurrence of extreme flood events and overcome their effects without creating further socio-spatial segregation.

The DAPP method suggests that through observations and analysis of the current policies and practices in the case study, different objectives and performance value indicators will emerge. However, in reality, it is proved to be rather difficult to create clear actions through these limit values. Hence, instead using value indicators, the project will focus on creating policy and practice objectives through more generic goals (van Veelen, 2016). Accordingly, the **"definition of success"** will be:

> **"The plan will be successful if no floods occur, and if both the physical and social vulnerabilities are overcome. It will not result in negative impacts on nature or socio-spatial inclusion".**

Constrains may include negative attitudes of different stakeholders that could block the progress of the plan, as acknowledged in previous project attempts for the area. Thus, there is a need for including an additional target, which advocates for stakeholder involvement in decision making:

> **"all related parties should be recognized and their opinion noted within the plan's creation and execution".**

**Global trends projections**

Bandung region is an area with constant fluctuations of climate conditions due to its tropical setting. This trend has been increasing in the recent years due to global changes in the climate resulting in severe storm surges and sea level rise. In the case of Bandung there is no threat coming from the sea as the region in inland, but the risk of rivers overflowing is a continuous concern in the region. The existing situation presents several measures that have been applied to the area for improving the safety levels. In spite of this, the results from the interviews, observations and documents' review show that these measures are not able to achieve flood safety even now. For the upcoming year 2050 the projections propose an increase of the rainfall with at least 300mm (for the annual estimation) (I. Bappenas, 2009). This, in combination with the inadequate protection measures taken in the past, creates immense risks in the studied areas.

Furthermore, the population at risk is growing as the urbanisation processes are advancing. The urbanisation trend has been progressing tremendously after the colonisation period in Indonesia. The population living in cities has increased to more than 60 % in the Province of West Java and the projection is for a steady increase of 80 % by 2045 (B. Bappenas, UNFPA, 2018). Thus, the cities need to prepare for the future changes by either expanding their land or densifying the existing urban areas. With this in mind, the issue of flood risk becomes even more critical than now. The growth of the population may endanger critical mass of people in the vulnerable areas of the region.

Based on the predictions from the two dynamic global trends, the thesis will explore two scenarios within the Bandung region. Both of the scenarios take into consideration the highest peaks of climate change and population growth as a given. The differences come from the availability of resources. In the first scenario, the region of Bandung is able to acquire the needed resources for building or maintaining the needed infrastructure, or to complete housing projects or recovery necessity. The second scenario, assumes that the region would not have the unlimited amount of means, therefore would need to adjust the plan to utilize only part of the measures. Through the constructed scenarios, there are 3 main tipping points in time represented on the time line in Figure 65.

## 9.3. Pathways Design

**Determine actions** *(Step 3)*

For the purpose of creating a better understanding of the main actions that could be taken, the DAPP plan will consider the case study of the Bandung region and the actions that are directly affecting the definition of success in this area. With this in mind, there are actions that work outside of the focus area, for example, creation of reforestation zones in higher areas suitable for stimulating slow rainwater runoff (delay), and by this preventing the occurrence of floods in the valley.

The conclusion of the socio-spatial analysis shows the effects that rising flood vulnerabilities have on many areas in Bandung region. The amount of discharged water is increasing due to extreme storms, but also high runoff percentage. Either t**he rainwater delay** needs to be improved or there must be wider floodplain area provided. To slower the runoff, the  areas where the rain falls need to be able to sustain it. As most of those areas were prone to vast deforestation practices they need to regain their land cover with policies which are promoting **re-forestation**. In order to expand the floodplain area, it is necessary to provide more open spaces for the riverbed, which will inevitably result in demolition of many residential neighbourhoods and industrial buildings. Provided the fact that in Bandung region there is deficiency of housing due to the high percentage of rural-urban migration and additional predictions for increase of the population, **expansion of the riverbed** can happen in only fine amount of places. This action can be used as a complementary one, but would not create a large enough capacity without actions

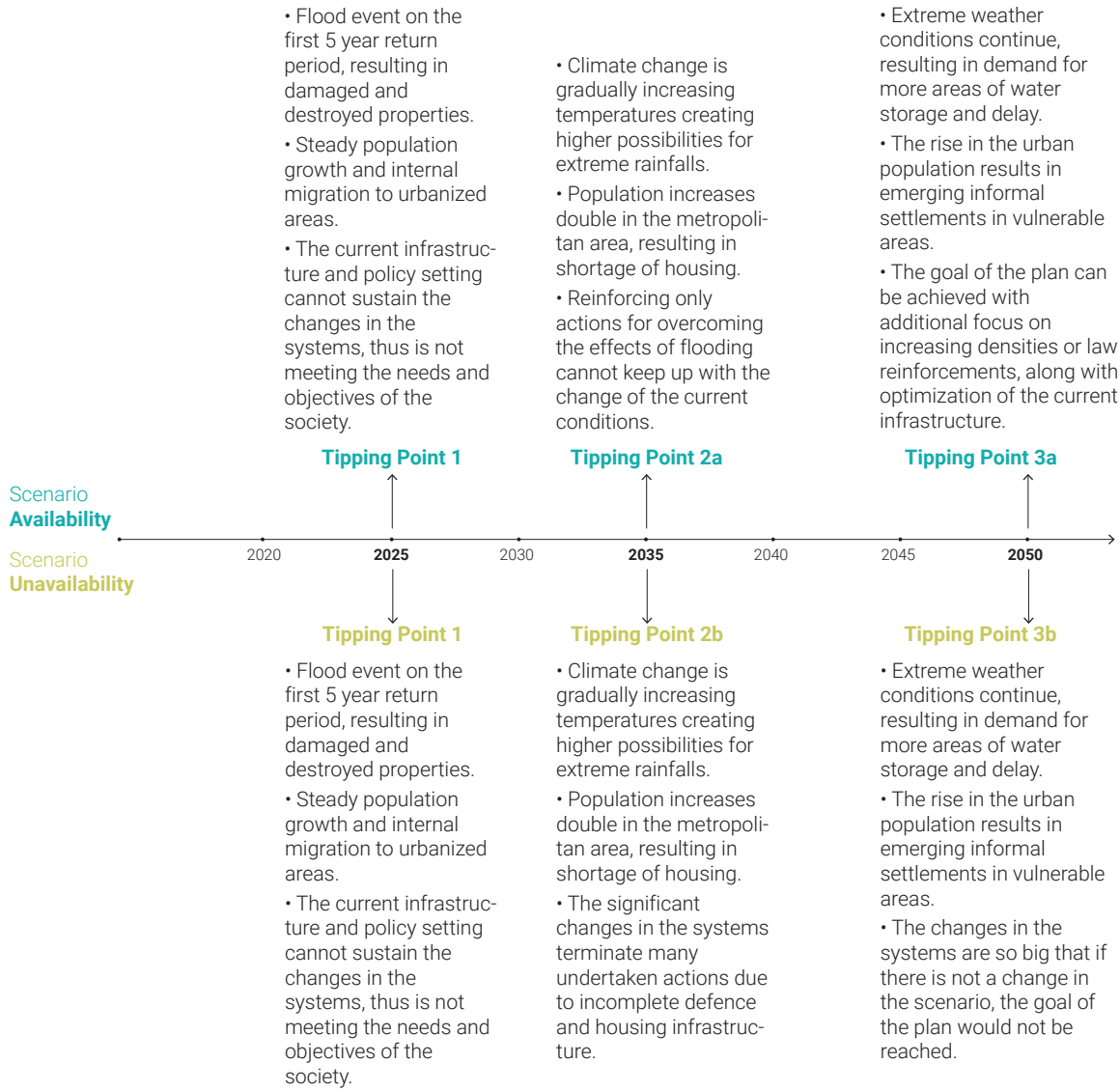



**Figure 65** Tipping points in the Scenario Availability and Scenario Unavailability
Source: Author

like water delay or retention. There are still public spaces for creating **water retention** areas like a retention ponds. This action has been already proposed and implemented near the Dayeuhkolot Village, but it does not serve to the public fully as it is completely mono-functional. The aim of the plan is to create potentials for socio-spatial integration, which could happen by expanding the uses in these facilities for retaining water and keep the areas open for the public as it is now.

The analysis presents the after-effects of continuous deforestation upstream, which triggers faster sedimentation processes downstream. This phenomenon increases the level of the riverbed, thus spreading the flood area. If the action of re-forestation is undertaken that would mean that **dredging** the accumulated sediments would have to be done once every 30 years, or else the riverbed would need attention regularly for preventing flood events. This extra deposit of material in the rivers is a natural process, however, due to weak regulation system, there are many cases of water and soil pollution from households and industries waste disposal in the Citarum River. The pollution is both solid waste and waste waters, thus in order to ensure healthy urban environment there is a need of initiated **remediation and waste management** actions. Moreover, to ensure that these actions would have a continuous effect on the region, then additional **conservation zones in combination of law reinforcement** are required.

As previously identified, the context of Indonesia deals with a large internal-migration pattern, from rural to urban areas. This, in combination with the fast population growth rates creates probabilities for rising informalities, which are most likely to appear in risk prone areas. The law in Indonesia prohibits urbanization of areas 100 meters from large rivers (which is the case of the Citarum River running through Bandung region). From the analysis of the distribution and flood depth in different return periods (see page 85), can be seen that the floods occur most frequently within the scope of these 100 meters. However, in many cases in the region, this law has not been respected. This exposes both physical and social spheres to immense flood risk.

Based on these facts, there is an urgency for either providing a better, alternative re-settlement strategy for the people living within the borders of the 100 meter restriction area, or ensure safer living and working environment. As already noted, the first option is hardly achievable because of the increasing urban population. This leads to most probable undertaking the second action of re-structuring the built environment to provide the needed qualities. With that in mind and also working towards the extreme scenario of climate change the plan suggests building an **urban dike** (or so called super levee) in the most vulnerable and highly populated areas – like Dayeuhkolot Village: "[t]he concept of a super levee is designed especially for extreme events in a highly dense urban area" (Graaf, R. d. and F. Hooimeijer, 2008). Moreover the importance of this choice is grounded in the multi-functionality and flexibility that the urban dike provides. The urban dike is a stable defence system that provides not only protection but also usable land for housing and commercial purposes. It can support the creation of **new community housing** estates,

which are much needed based on the predictions for population growth in the region. This action uses as a base the existing dike system in the area. It will reassure **strengthening** and proper **maintenance** of the out-of-date, incomplete or damaged infrastructure.

The creation of an urban dike can stimulate **re-charging of the ground water** level. This action is crucial as the analysis show that in the region there are many problems with subsidence due to over exploitation of the ground water. Creating permeable paving or increase the green blue infrastructure in the areas suffering from subsidence can contribute for the purposes of this action.

A big investment is required for the completion of the entire urban dike plan with the additional maintenance actions. The current forecasts for adopting such a large expense are very uncertain due to the political and financial situation in the country. Therefore, depending on the future changing conditions in the context, there is a need of creating an additional set of actions, balancing the possibilities for flood mitigation in a limited budget conditions (the Unavailability Scenario). If this is the case, the plan proposes using only the materials available on site (dredged material from the riverbed) for executing half or 1/3 of the intended urban dike. This still keeps the possibilities for future development of the project to its fullest potential. With this, additional adjustments to the existing built environment are required for reaching the aim of the plan – having a safe and healthy urban environment. The **adaptation to floods** (retrofitting) of estates is in order, such as retrofitting existing buildings like dry-proofing or wet-proofing. Additional actions like adjusting an **evacuation plan** or **retreat** for the more vulnerable areas along with **higher protection level of the critical infrastructure**.

Some of the proposed actions would use the current infrastructure in its original state or make small improvements. Others would require much larger upgrading interventions or even complete replacement. Therefore, depending on the availability of resources in the future, the chosen actions might differ.

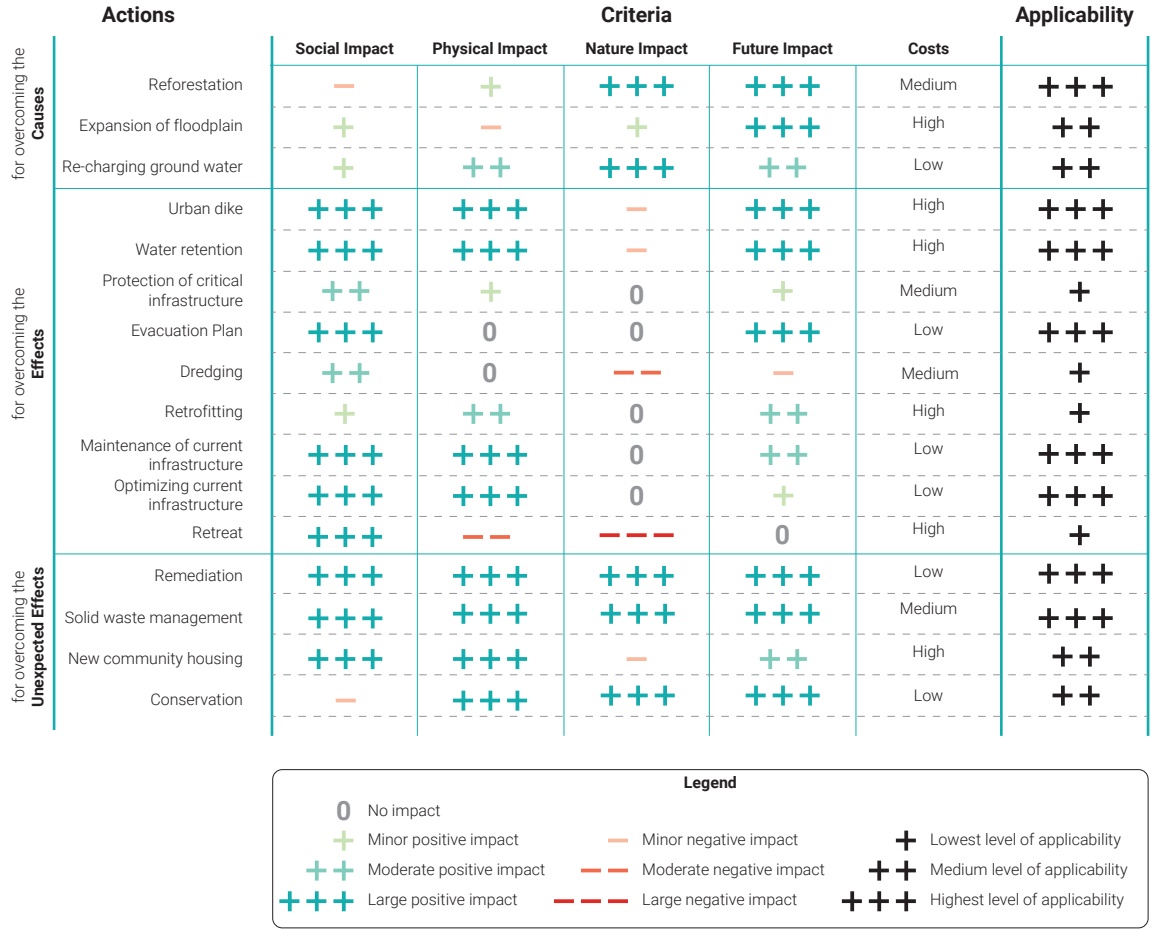



**Figure 66** Actions and assessment of their applicability performance on the base of Social, Physical, Nature and Future Impacts
Source: Author

### **Assess efficacy and opportunities** *(Step 4)*

In order to assess the efficacy and applicability of the actions in the plan there is a need for creating an assessment criteria (Figure 66). The project generates the criteria by looking into the interrelation between domains of the conceptual framework of the project (see page 28) and is also grounded in the "definition of success" of the plan. The multi-criteria analysis sets out five aspects related to the main topics considered throughout the project. The actions are assessed on the basis of their ability to improve the social inclusion conditions of the area – Social Impact; to improve the spatial quality – Physical impact; to balance the performance of the natural systems – Natural Impact; and to create possibilities for future adaptation – Future Impact. The additional fifth aspect is evaluating the costs for each of the actions (based on assumptions), which indicate the relative implementation and maintenance costs. After all the actions have been estimated there is a final evaluation on the applicability on the particular case.

**Develop pathways** *(Step 5)*

The creation of the pathway map has been a process of continuous experimentation with different combinations of interactions or substitutions between the chosen actions. This was done for achieving better understanding of how these actions influence each other or where they limit each other. The two scenarios with their specific tipping points created the framework for this exploration of possibilities. Based on the assessment the actions were assigned a sell-by date, which defined their robustness to the future change. Actions like re-forestation, expansion of the floodplain or waste management and remediation, leave tangible marks for improving the performance of the natural systems, creating benefits for the society and built environment. Such actions are assumed as priority measures, without which both scenarios would not fulfil the "definition of success", set in the beginning. The plan follows the hypothesis that if any of these actions fails there would be enough supplementary actions which can be used together to overcome the future changes.

Commenting on the adaptation pathways maps (Figure 68 and Figure 67) created on both scenarios, there are few points that need special attention. First is that the start and end of each action depends on the future scenarios tipping points and what triggers the change. There are cases like the action "Evacuation Plan" in Scenario Availability, which continues along the whole time line, but terminates and starts multiple times. This is as a result of external activities that trigger or need the Evacuation Plan activated again. In this case the action cannot be presumed as urgent, however it is still of great importance to the plan. Another addition is the dependencies of actions to one another. In the case of Scenario Unavailability, the action Reforestation supports the action Dredging, which means that the second appears once every 20 years if necessary. The Reforestation helps stabilising the sedimentation processes, which creates much less need for clearing the river bed very frequently. And the third point that is worth mentioning is the outcome of the Unavailability scenario. In it, the possibilities of several actions for continuation along the time line terminate much earlier than what would be the goal of the plan. In the adaptive pathway map for this scenario there are two proposals, which can be possible only under the condition of additional funding or availability of resources created. The action of new community housing development and the further execution of the urban dike are the probable solution to alock-in of the plan and forced retreat.

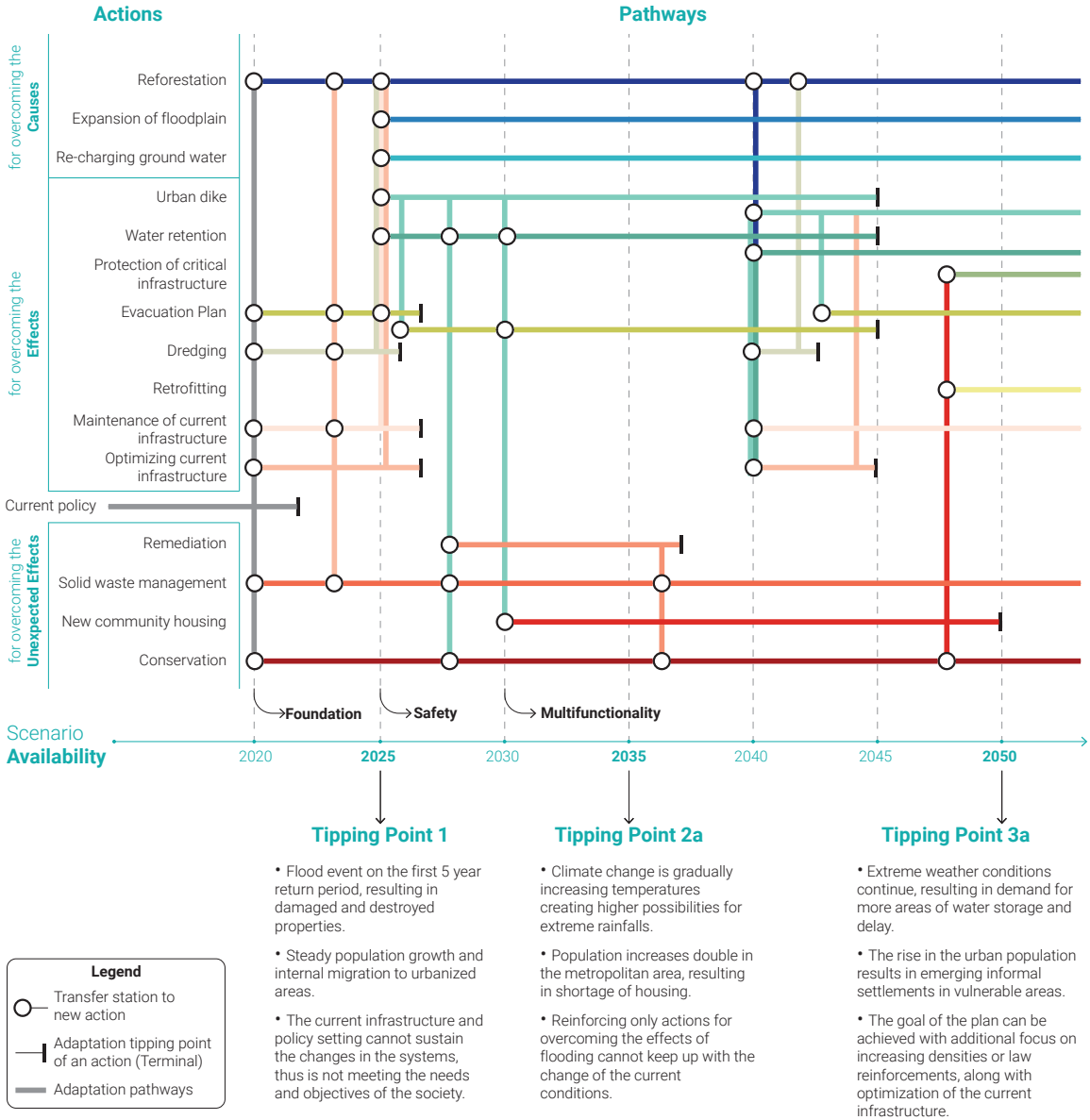



**Figure 67** Adaptation pathways map for the Scenario Availability
Source: Author

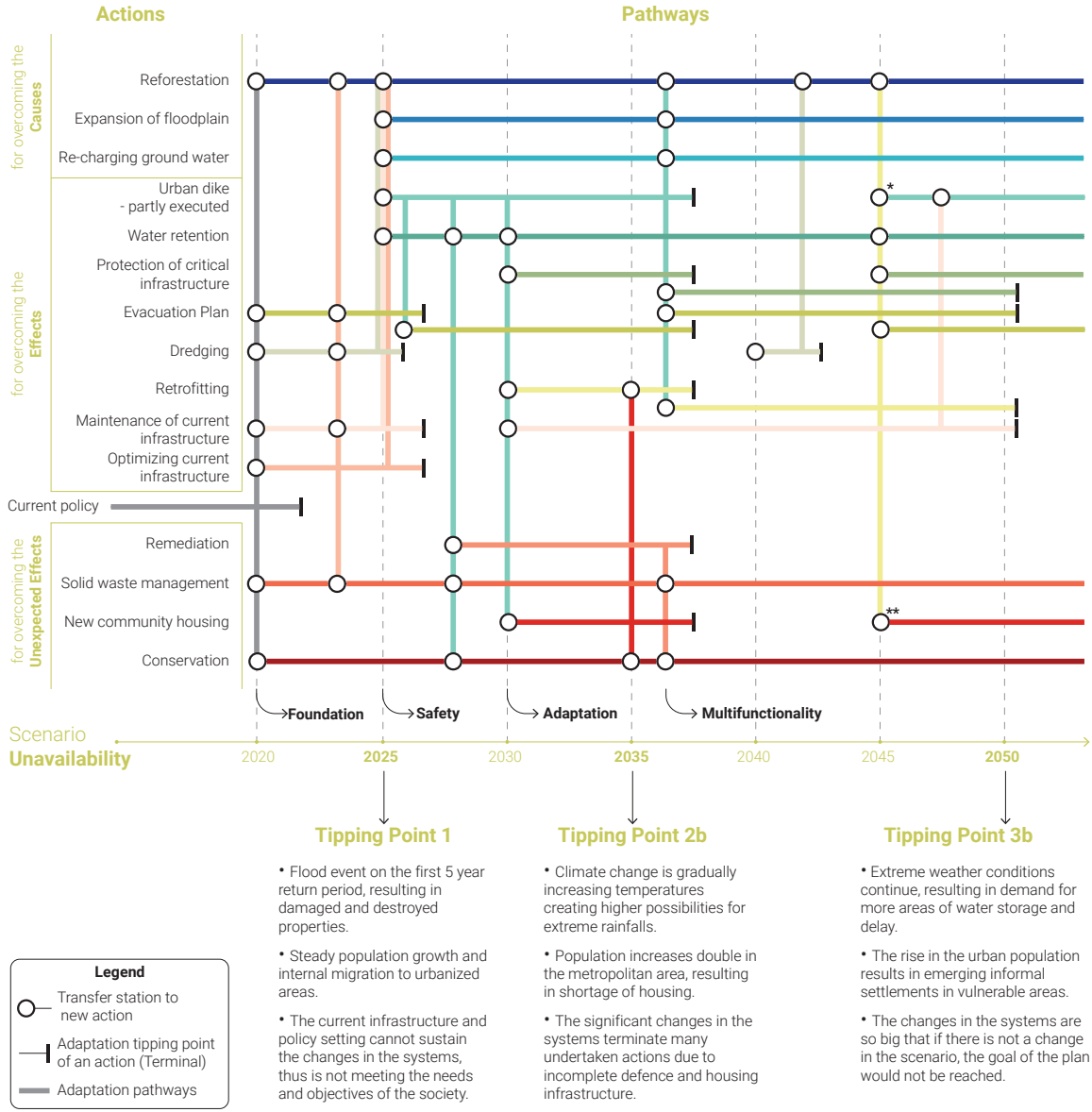



**Figure 68** Adaptation pathways map for the Scenario Unavailability
Source: Author

***** The action of further building and finishing the whole structure of the urban dike is possible only under the condition that additional availability of resources, external funding or change in the governance is made.

****** The action of new community housing depends on the creation of the urban dike, which makes it possible only if there is further availability of resources.

**Test pathways** *(Step 6)*

After the development of the adaptive pathways maps the plan needs to be tested. In reality this would suggest reaching to the relevant stakeholders, seeking their interests and evaluation of the plan. Here an important note is in order, the involvement of the stakeholders in the process of decision making and creation of the actions and further of the map itself, has to be constant pursue of the designers. Thus, the next engagement of the public for evaluating the project would be more transparent and expected to have fewer objections.

In the current situation of the graduation project, it is hardly possible for this interaction to happen due to time and position issues. Therefore, there have been several assumptions made based on previous interviews and analysis of the needs and attitudes of the related stakeholders. "Decision-makers or stakeholders may have a preference for certain pathways, since costs and benefits may differ" (Haasnoot et al., 2013). Three general profiles have been tested in this project, which represent a collective image of the civic society with their local representatives, the municipal association of the local government and the higher authority power in the face of the central government (Figure 69). The Civic Society (SC) values improvement of the health conditions in the area, which inevitably includes increasing the safety. There would be a big interest in redevelopment of the area with the creation of new housing. The Local Government (LG) would have a preference over the actions that are more locally realized so that it can actively participate and also be able to grasp the effects. These are mostly the local implementation of the urban dike action or the investment in water retention areas. The Central Government (CG) is taking responsibility for larger infrastructural projects, which drives the choices for the most robust and long lasting projects, which also need the most law enforcement like reforestation or expansion of the flood plain. Some of the preferred pathways are overlapping. The points in which these start to diverge are the ones that can be considered as the decisions (Haasnoot et al., 2013).

The stakeholder participation in the planning of the DAPP plan and evaluating it afterwards can make clear the potential oppositions. An example of that is the conflict between the interests of the local community to push forward actions that preserve the complexity of the local villages, whereas the local and central government are looking more into the larger picture, supporting bolder decisions. This step would be the first attempt towards the formulation of the engagement strategies for their further implementation.

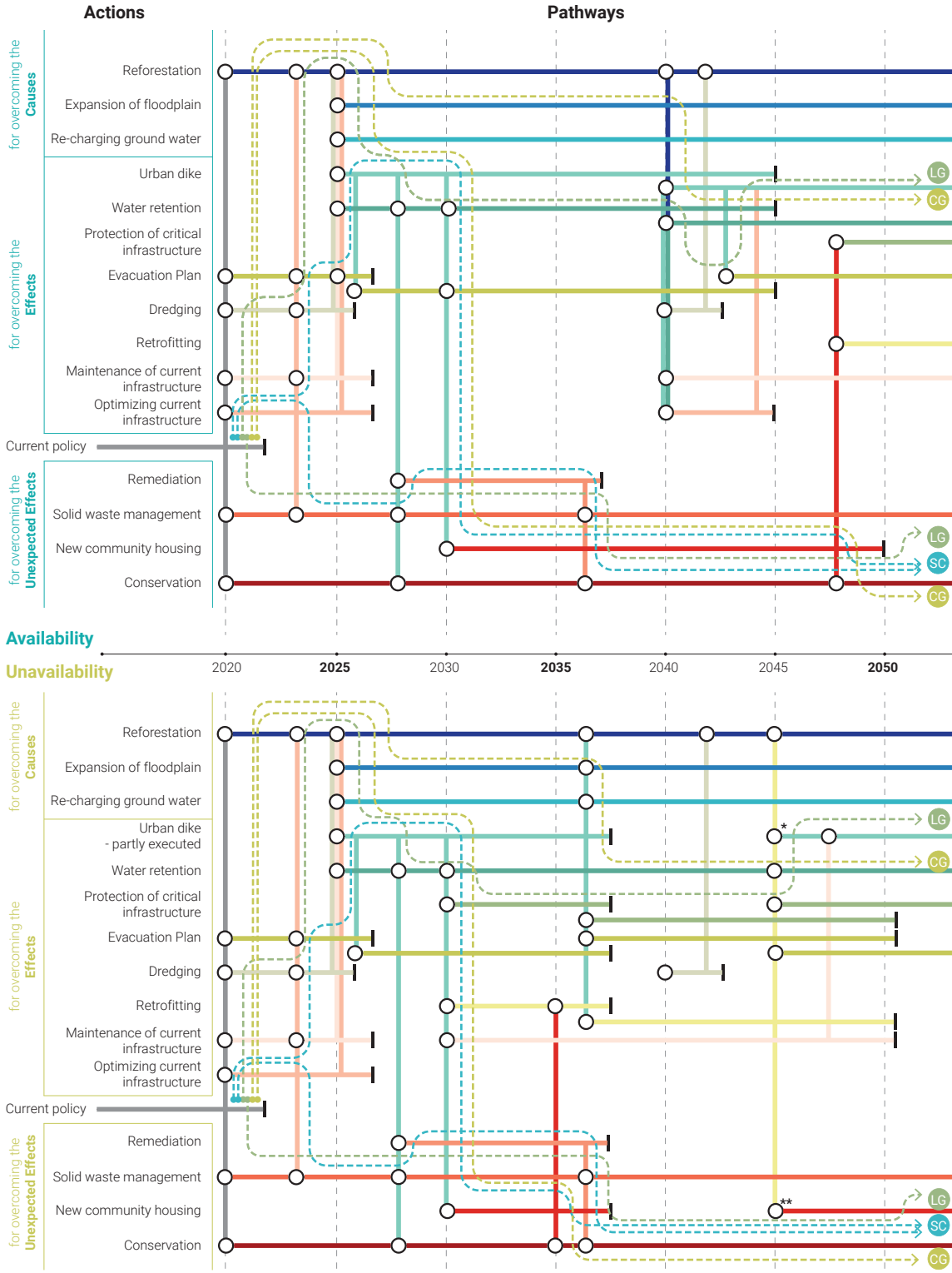



**Figure 69** Adaptation pathways map with preferred pathways for three different perspectives.
Source: Author

## 9.4. From Pathways towards Adaptive Design

The generation of the Dynamic Adaptive Policy Pathways acts as the first step towards diving into the creation of the design. It establishes a frame for the further development of the possible spatial strategy and design interventions. These would not appear as a final solution, a fixed plan; moreover, they will represent a transformation line and the consequences on the area. Part of the generation of the DAPP method has been to determine where actions fit best and which combinations are most desirable. However, there is another side of the promotion of adaptive pathway thinking, which helps understand the added value of such interactions and arrangements of actions through time. In his doctoral dissertation, Peter van Veelen uses similarly the DAPP method and finds an important question, whose answer can help drawing conclusions for the process and outcomes of the method:

> **"Which pathways to resilience provide flexibility and deliver added value in the long run?" (van Veelen, 2016)**

As argued previously in this thesis, adaptation can create additional social and natural benefits. For creating the assemblage of actions, the method suggested clustering the actions in groups. It is noticeable that for overcoming flood risk are needed much more actions than just ones dealing with the after effects. By incorporating measures that cope with the causes, after-effects and also unexpected consequences, the plan sets the basis for the additional benefits to emerge. This is possible through the creation of multifunctionality of actions that are not necessarily conditioned to it. For example hard infrastructural decisions like retention ponds or dikes – these are easily becoming new open ground for community activities or new space for dense urban life. Another important factor of this plan is that it is designed to look beyond the common. It integrates actions which look forward to possible consequences, based on previous experiences, but also future predictions. Example of that are the conservation restrictions, which bring about the topic of preservation of resources and restoration of the balance in overexploited nature.

However, the future scenarios of the region cannot be informed only by the generation of the adaptive pathway map. There is a need of the spatial perspective on to the entire sequence of adaptation measures through time and the required cooperation and involvement of the stakeholders. In order to develop these spatial visions the thesis follows four possible stages for implementation of the Dynamic Adaptive Policy Pathways plan – Foundation, Safety, Multifunctionality and an additional one Adaptation (see page 113). In the next chapter these four stages, with the specific stakeholder engagement strategies will be further explored.

The **stage "Foundation"** focuses on the preservation actions in the DAPP method. It has the ambition of restoration of the natural balance by re-naturing areas with high potential of containing storm water or restricts further pollution. In this stage the plan also develops the idea of optimising the already existing infrastructures with possibilities for upgrading.

The second **stage "Safety"** deals with more infrastructural solutions for flood mitigation. It preserves most populous areas and builds upon coping strategies for managing evacuation or retreat. Although this stage seems extremely monofunctional, it establishes the base for the next stage with mixture of activities and uses.

The third stage **"Multifunctionality"** overcomes the limitation of the land by creating possibilities for experimentation with multiple uses. It is the one that triggers the most additional value of the plan. It provides a lot of benefits for the local communities, which are not usually present in a conventional flood mitigation strategy.

The final **stage "Adaptation"** comes within the scenario Unavailability where the possible future creates a need for adjusting to living with the extreme weather conditions. It presents the activation of measures which allow seasonal water overflow (living with water) and proposes new spatial configurations which can accommodate change.

# 10. Strategic Framework

## 10.1. Regional Strategy

The regional strategy is a natural continuation of the planning process. After agreeing on the specific actions within the different scenarios, there is a need of transforming them into spatial perspectives. These will explore the physical boundaries and needed modifications in the measures for applying them best to the context. They will also show where those actions take place, which are the relevant stakeholders in this area and how do they interact. The regional strategy is founded in the Dynamic Adaptive Policy Pathways (DAPP); therefore, it needs to be seen as a flexible and adaptable assembly of actions which are interchangeable within the unpredictable future unfold. And this is the main strength of the strategy as it focuses its attention to three main locations of the interventions, but these can be easily translated in any other settlement in the region if needed. The high transferability of the actions is due to their simple nature and possibility to reinforce multifunctionality. Another benefit of the strategy to be transferred in another area is the possibility to re-assess the actions towards new different stakeholder needs and attitudes. The DAPP method allows multiple evaluations on the proposed measures, their sequence and time expectancy. Thus, new strategic frameworks can appear if needed.

To focus on the specific Regional Strategy of the Bandung Basin area, it is important to mention the key role of the stakeholders. In the chapter 8 the study proposes five important engagement strategies which are used for obtaining the goal of the project. They are put into action in building the strategic framework by considering what the spatial reflection of the stakeholder involvement is in the region. The strategy suggests multiple links and adjustments to the already existing practices of involving stakeholders in the process of decision making.

## 10.2. Spatial Perspectives and Stakeholder Involvement

In the following paragraphs the stages of the Regional Strategy are going to be further explained. As mentioned previously the stages represent a construction of complimenting each other actions and engagement strategies. However, this does not require them to be consecutive in the time frame. The measures and their order can change over different possibilities in the future.

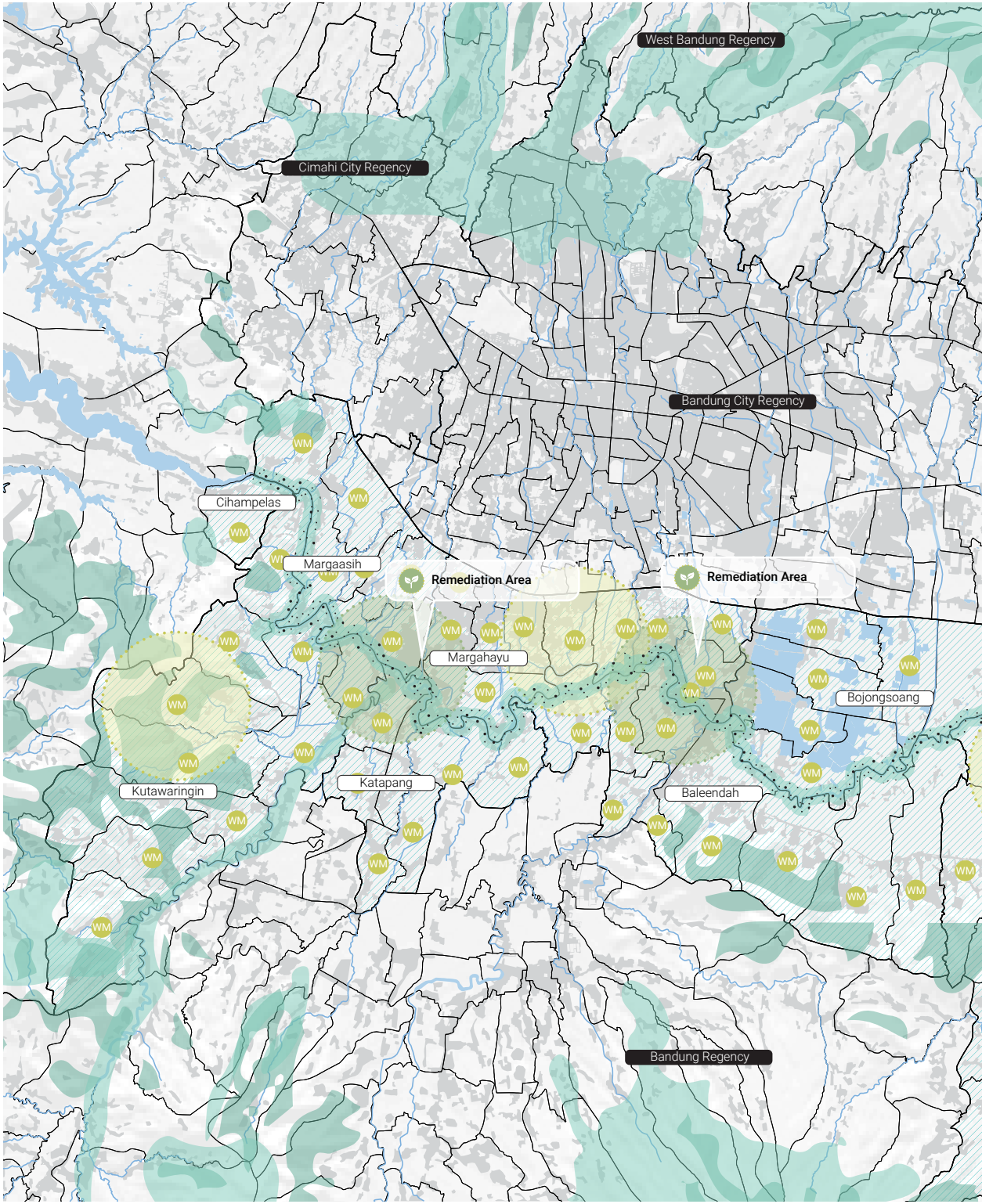


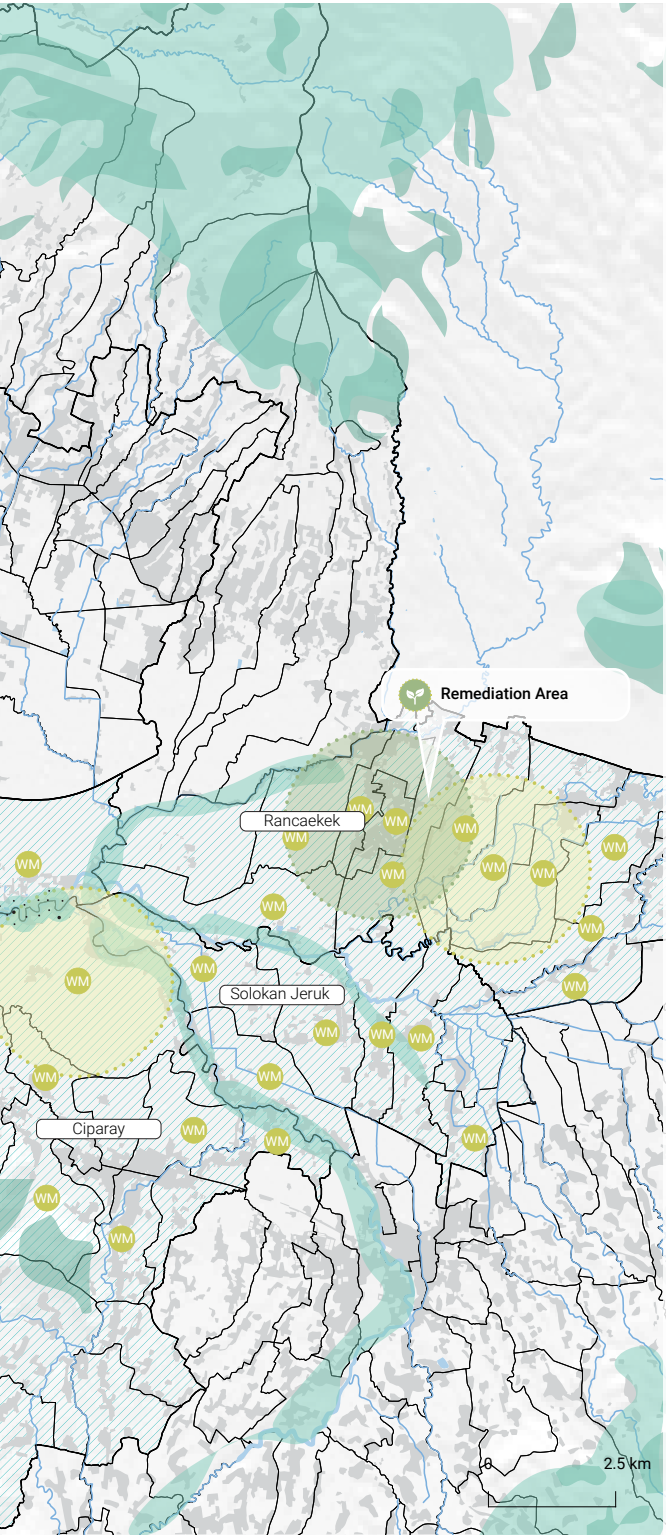



**Figure 70** Spatial Perspective [ 1.Foundation ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Foundation

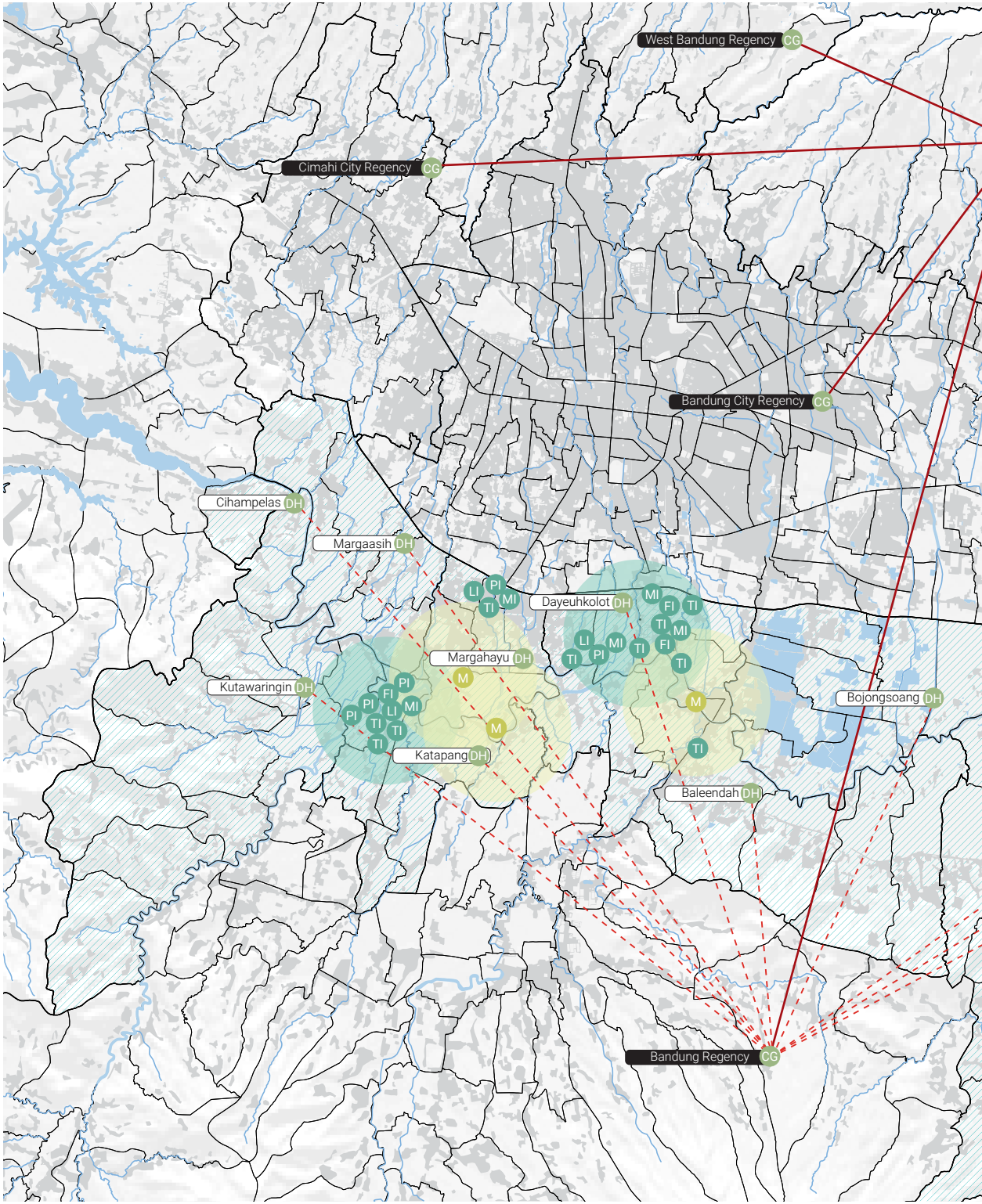
The basis of the project is established within the first few years of implementation. In this stage, the spatial perspectives are focusing on restoring the natural balance of the region. It considers strategies towards stabilisation of the quality of the physical environment which derives measures like solid waste management and remediation of polluted open soil. These two strategies are the centre actions that need to be taken in order for other continuation of the project to be possible, such as open recreational areas near the waterfront and seasonal activation of the floodplain. Other crucial points in this stage are the conservation and reforestation areas. They are chosen strategically for restoring the natural absorption of the soil and preventing run-off storm water.

The Foundation stage requires engagement strategies of that prepare the public and institutions for creating the needed links and connections. It facilitates the first steps towards acceptance of the proposed measures, which is combined in the strategies of “knowledge building” and “building capacity for regional scale strategy”.



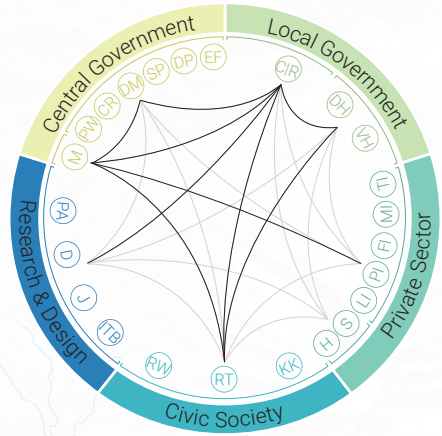

Legend

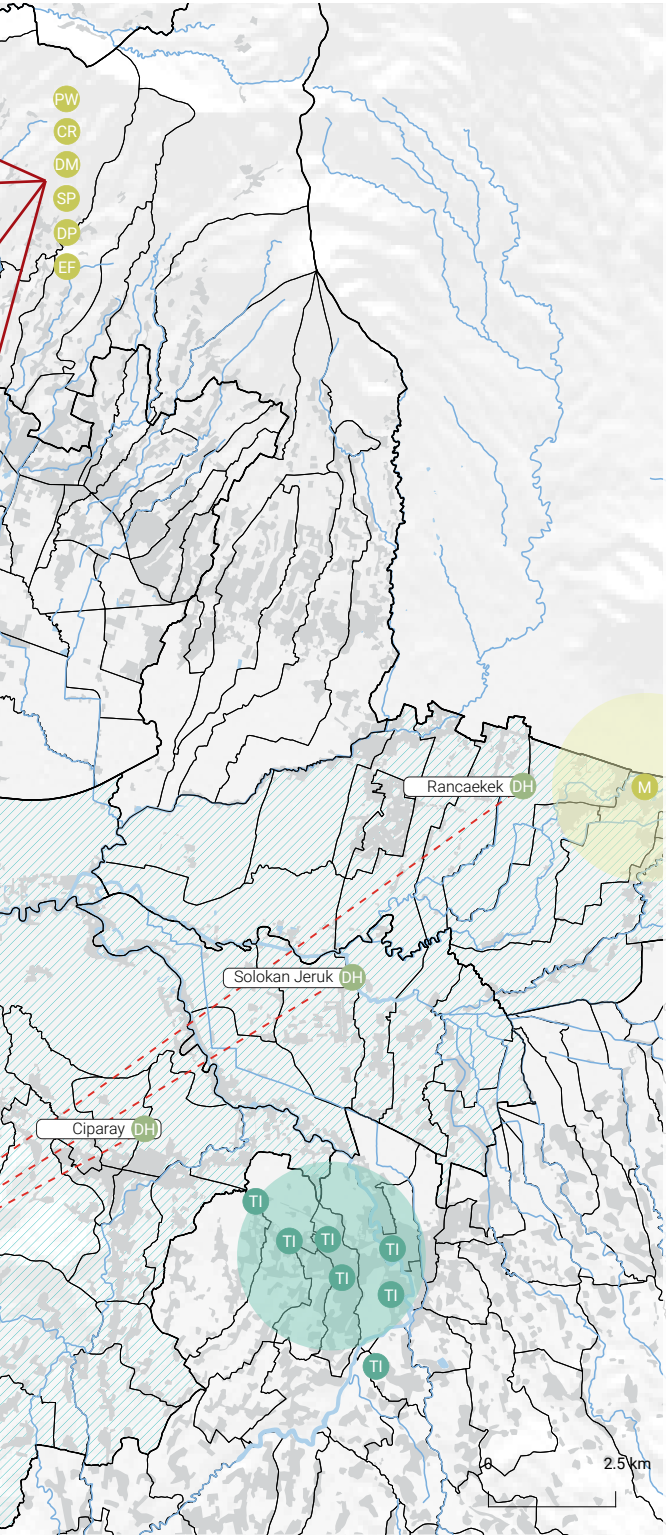
- Regencies
- Districts
- Urbanized Areas
- Water Bodies
- Flood Prone Districts
- Regency Boundaries
- Village Boundaries
- Conservation Areas
- Reforestation Areas
- Solid Waste Management
- Water Retention Areas
- Dike System
- Waste Management Stations
- Waste Management Base Points
- Remediation Areas
- Urban Dike Areas
- Urban Dike & Adaptation Areas
- Bottleneck Expansion Areas
- Retention Area
- New Urban Typology
- Critical Infrastructure Protection
- Evacuation Plan
- High probability of flooding
- High population density
- Perspectives for growth
- High possibility of subsidence
- Community Housing
- Retention Pond
- River Expansion Area
- Seasonal Activities
- Remediation Area
- Critical Infrastructure




123 **Figure 71** Stakeholder Involvement [ 1. Foundation ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Foundation




### Legend

- Regencies
- Districts
- Urbanized Areas
- Water Bodies
- Flood Prone Districts
- Regency Boundaries
- Village Boundaries
- Textile Industry
- Metal Industry
- Food Industry
- Plastics Industry
- Leather Industry
- Schools
- Hospitals
- Connections
- Industrial Area
- Area under Military Supervision
- Military
- Ministry of Public Works
- Central Office of Citarum River Region
- National Board of Disaster Management
- Ministry of Land & Spatial Planning
- Ministry of Development Planning
- Ministry of Environment & Forestry
- City / Regency Government
- District Head
- Urban / Rural Village Head
- PusAir
- Deltares
- JICA
- Bandung Institute of Technology
- Community Heads [ RW ]
- Neighborhood Heads [ RT ]
- Household Heads [ KK ]

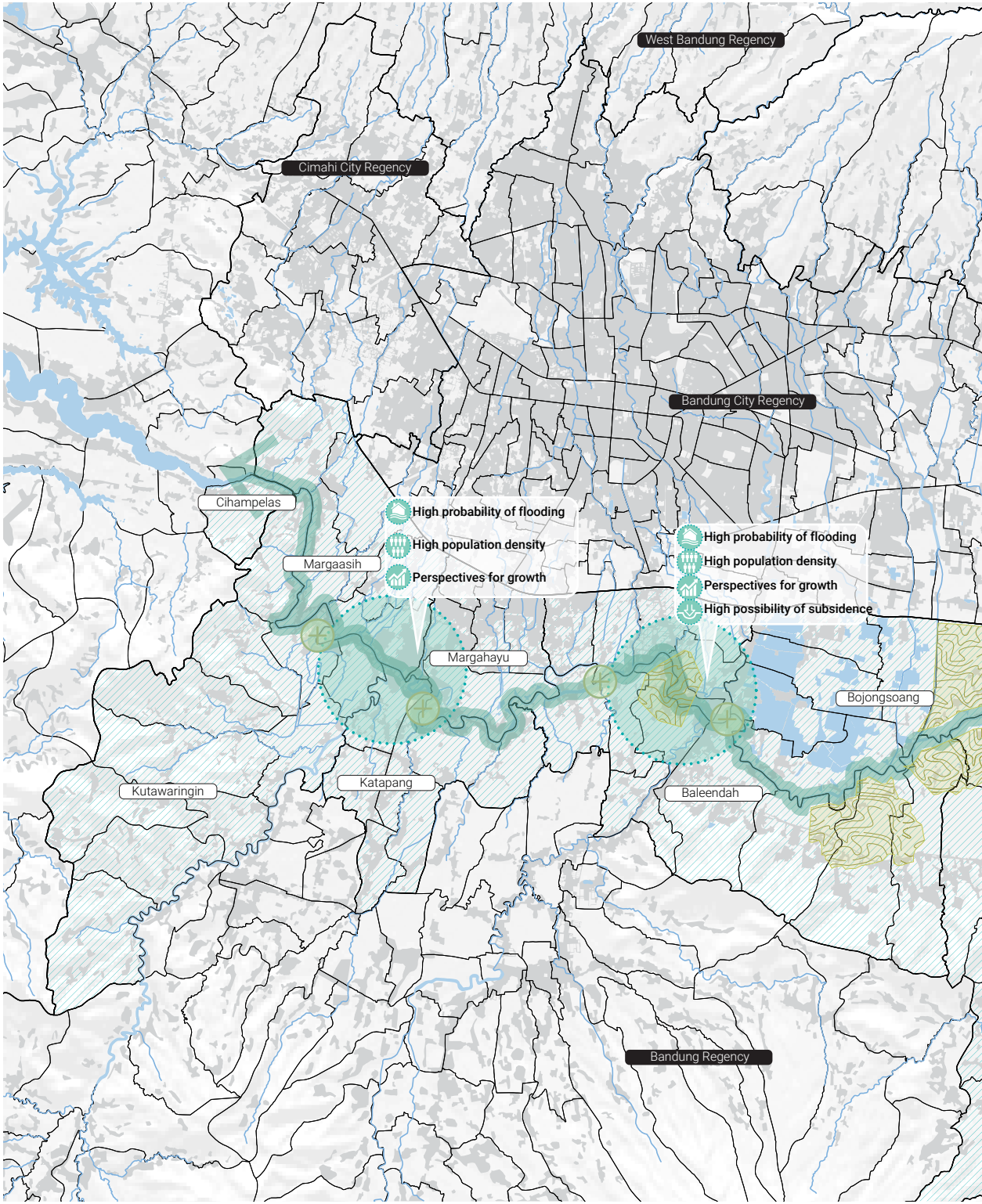


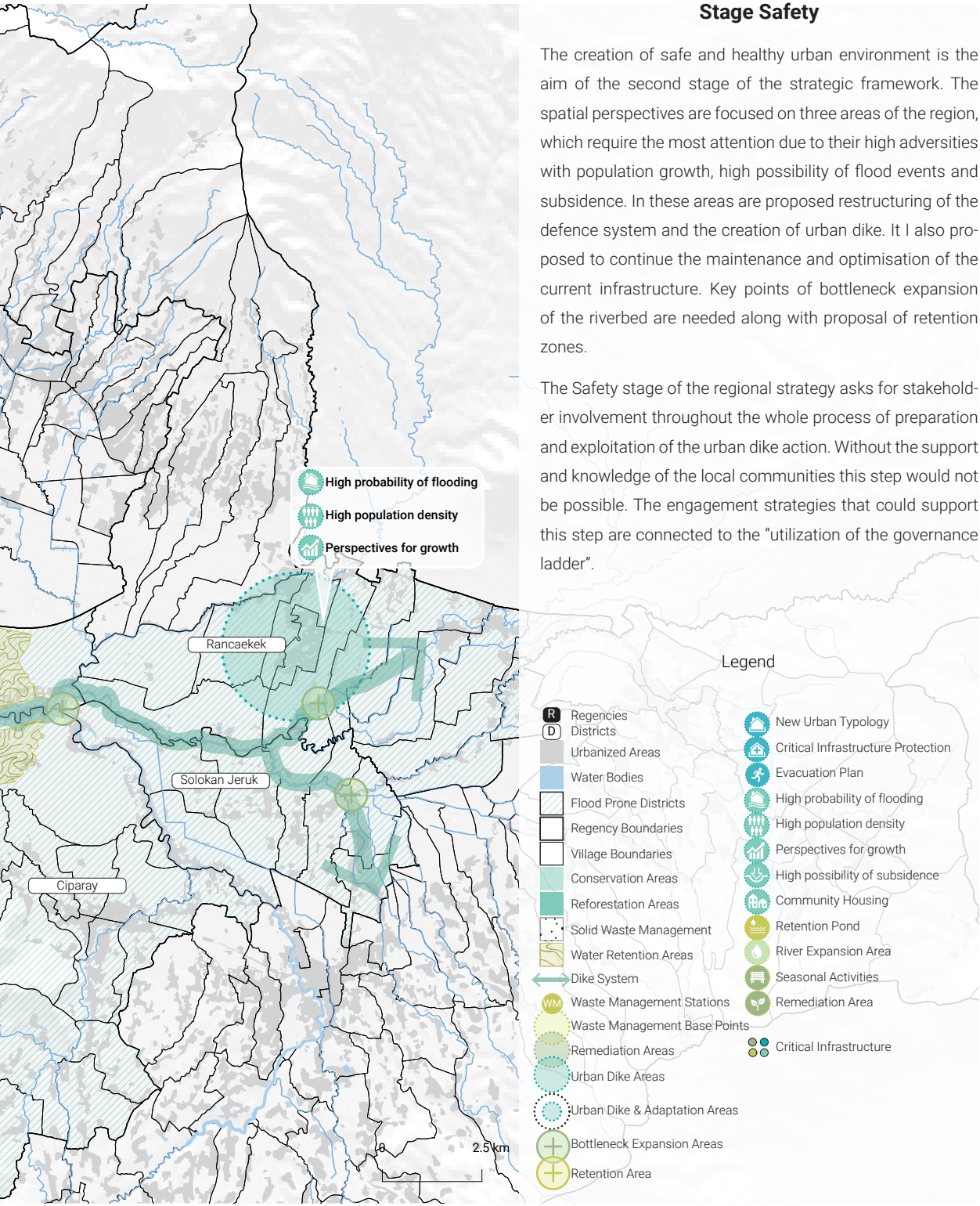



**Figure 72** Spatial Perspective [ 2.Safety ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Safety

The creation of safe and healthy urban environment is the aim of the second stage of the strategic framework. The spatial perspectives are focused on three areas of the region, which require the most attention due to their high adversities with population growth, high possibility of flood events and subsidence. In these areas are proposed restructuring of the defence system and the creation of urban dike. It I also proposed to continue the maintenance and optimisation of the current infrastructure. Key points of bottleneck expansion of the riverbed are needed along with proposal of retention zones.

The Safety stage of the regional strategy asks for stakeholder involvement throughout the whole process of preparation and exploitation of the urban dike action. Without the support and knowledge of the local communities this step would not be possible. The engagement strategies that could support this step are connected to the "utilization of the governance ladder".



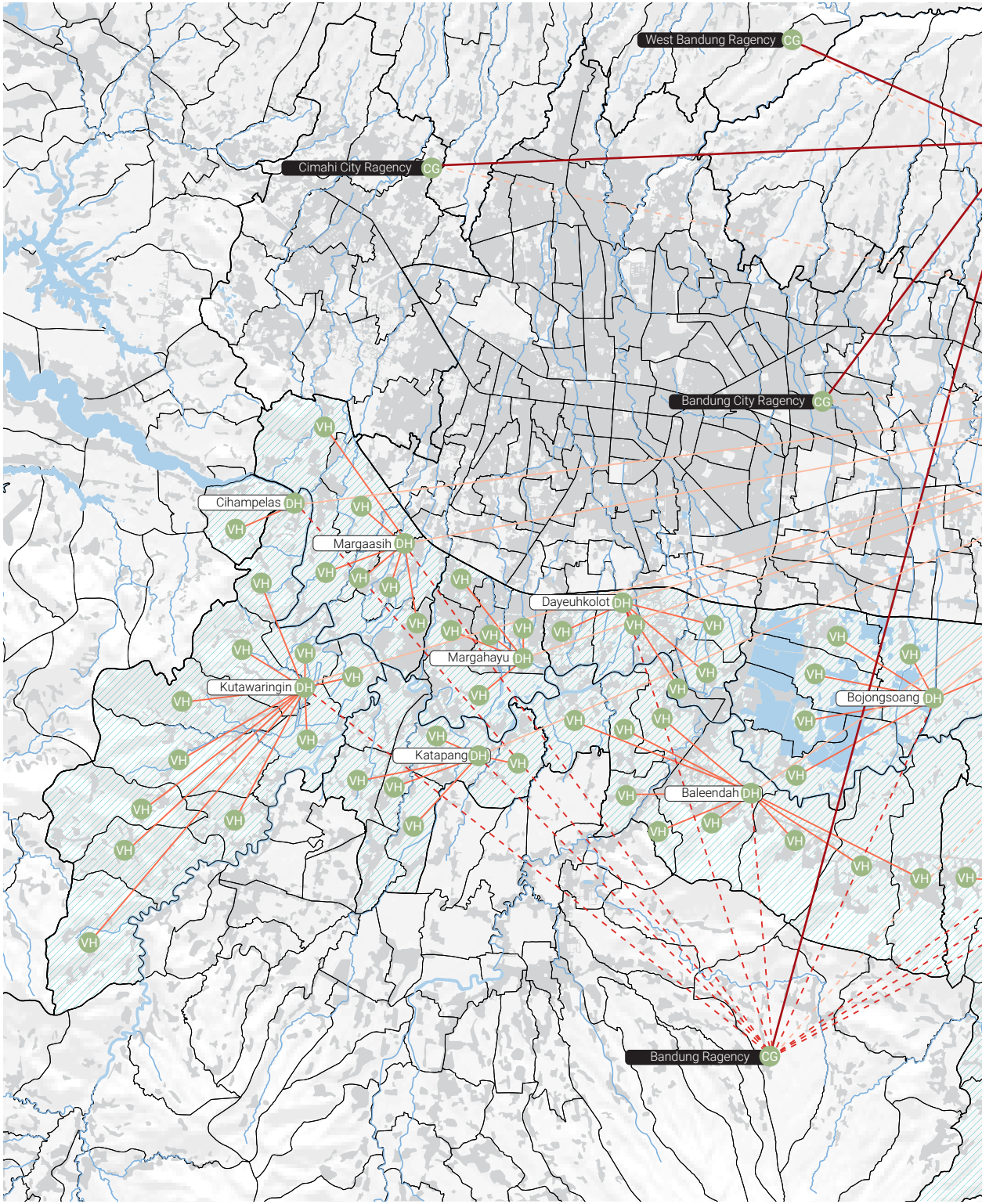
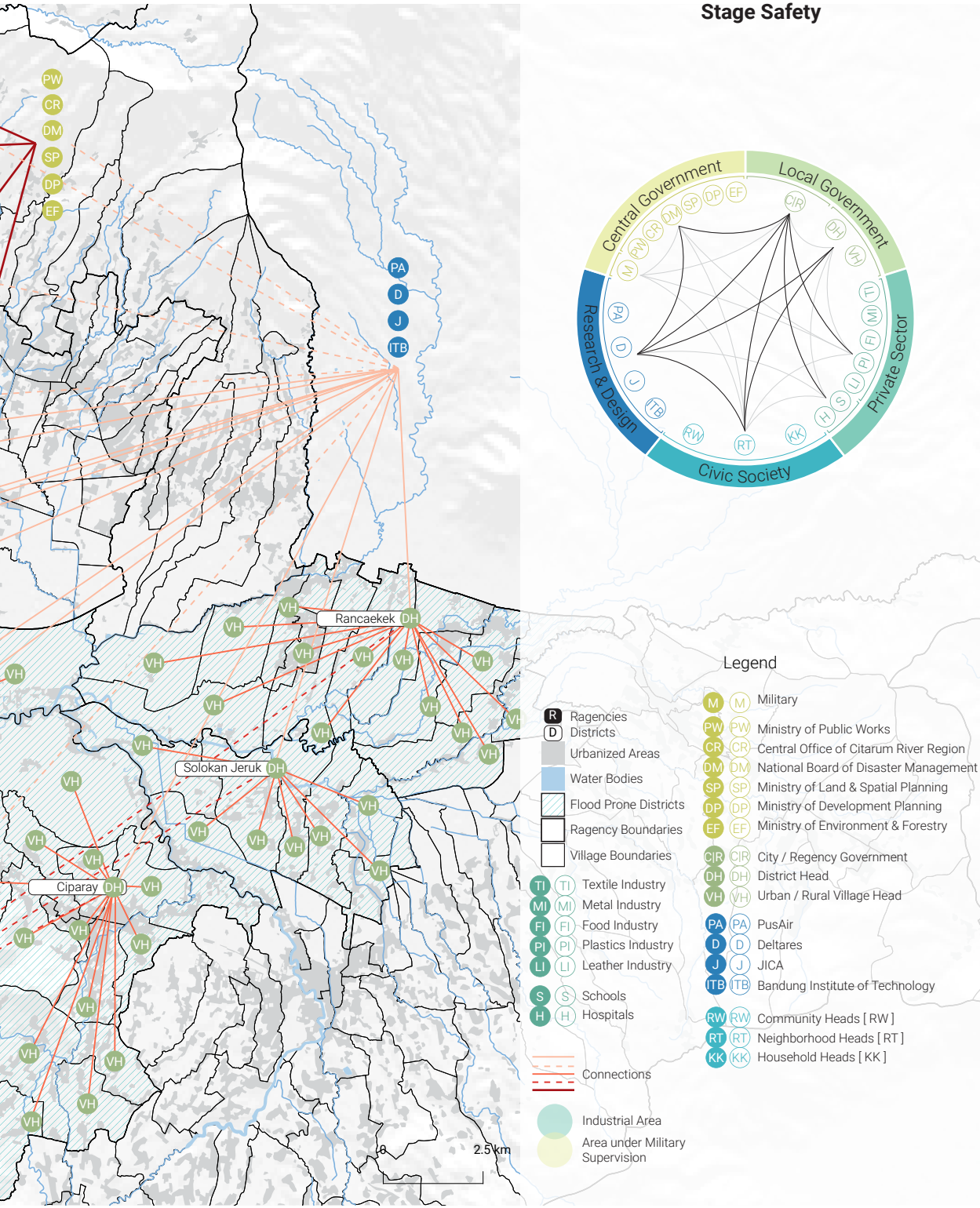





**Figure 73** Stakeholder Involvement [ 2. Safety ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Safety



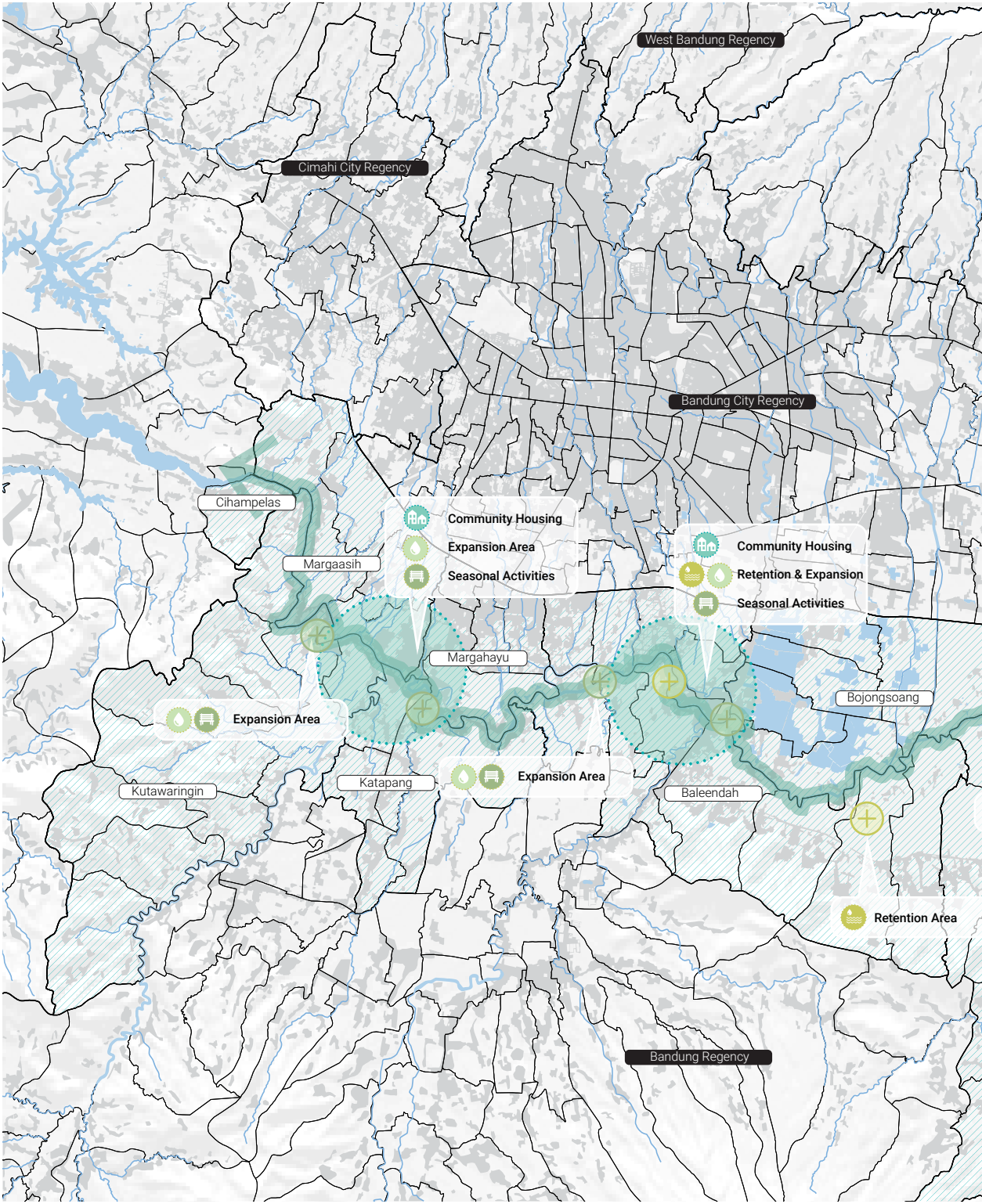


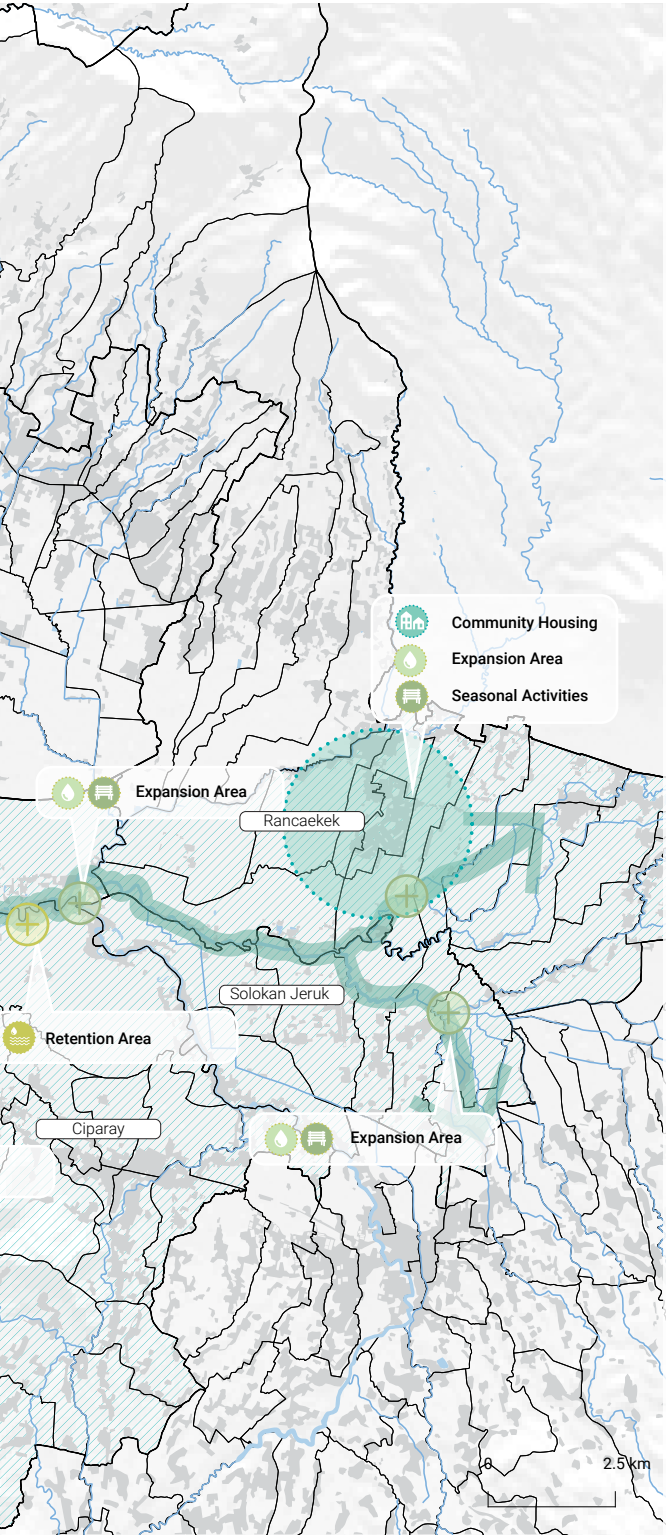



**Figure 74** Spatial Perspective [ 3. Multifunctionality ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Multifunctionality

The Multifunctionality stage of the strategic framework establishes the possibilities for obtaining the additional benefits that the previous actions set the base of. Multiple uses are the upgrade of measures like the urban dike, by establishing community housing areas, the creation of more room for the river, by seasonal activation of the expansion, the water retention areas, by adjusting them as parks and open spaces for the community. These actions come into play in areas where not much investment happens, due to the kampong setting of the settlements. However, this stage tries to build upon the need of provision of basic human rights to all citizens of the region.

The stakeholder engagement strategies are connected with the preservation of the build amenities, by encouraging the locals to take part of the responsibilities for the development, hence maintenance of the common spaces. These strategies could be the "regulation constrains", which activate the needed attitudes through both incentives and disincentives.




Legend

- Regencies
- Districts
- Urbanized Areas
- Water Bodies
- Flood Prone Districts
- Regency Boundaries
- Village Boundaries
- Conservation Areas
- Reforestation Areas
- Solid Waste Management
- Water Retention Areas
- Dike System
- Waste Management Stations
- Waste Management Base Points
- Remediation Areas
- Urban Dike Areas
- Urban Dike & Adaptation Areas
- Bottleneck Expansion Areas
- Retention Area
- New Urban Typology
- Critical Infrastructure Protection
- Evacuation Plan
- High probability of flooding
- High population density
- Perspectives for growth
- High possibility of subsidence
- Community Housing
- Retention Pond
- River Expansion Area
- Seasonal Activities
- Remediation Area
- Critical Infrastructure

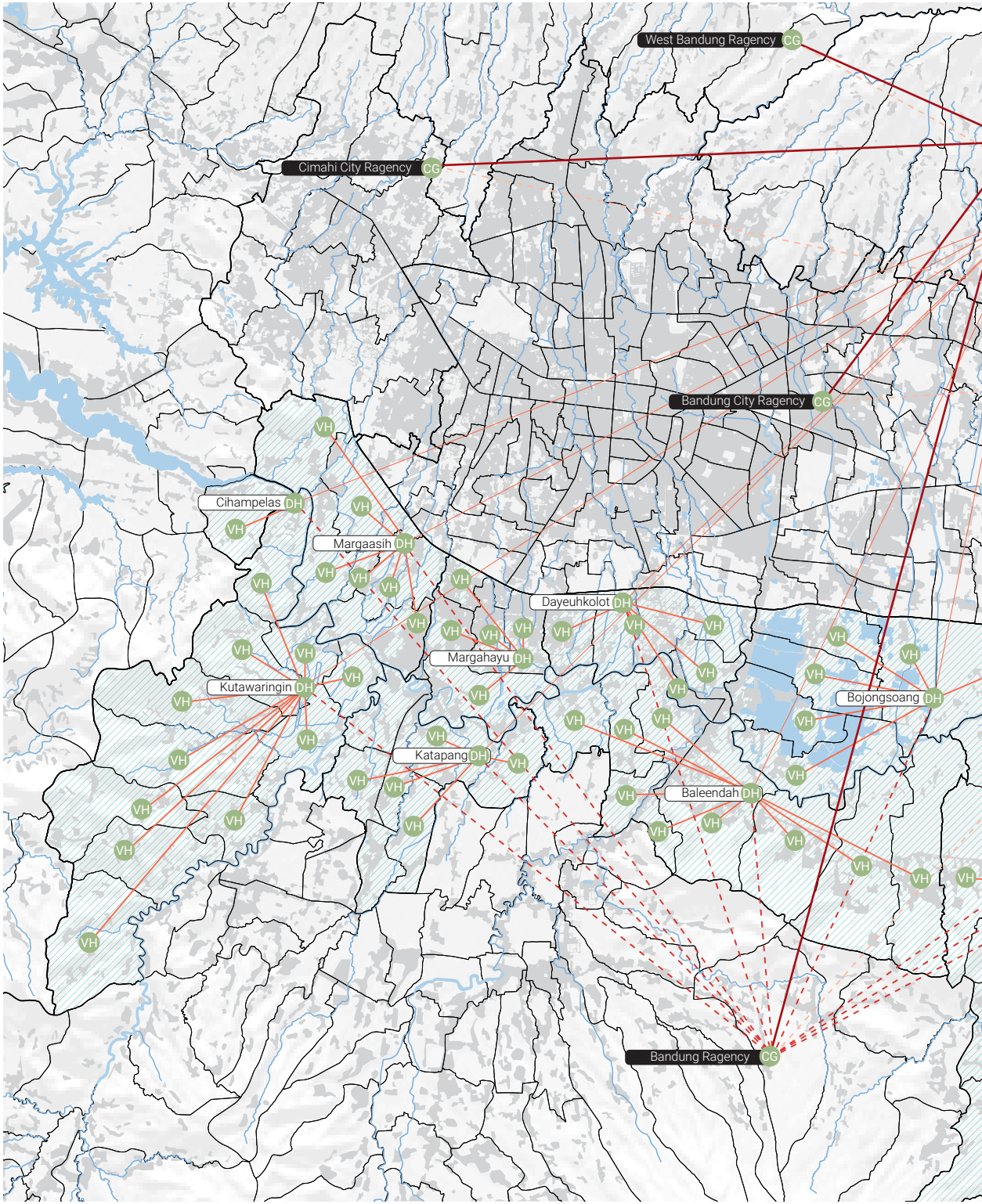
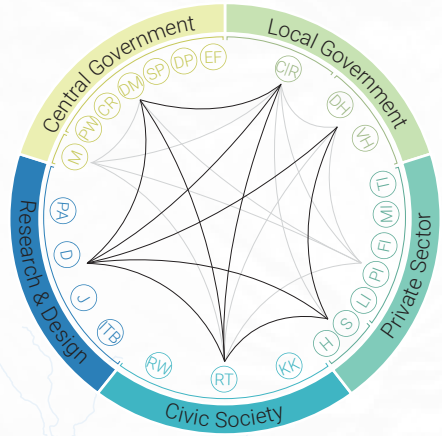
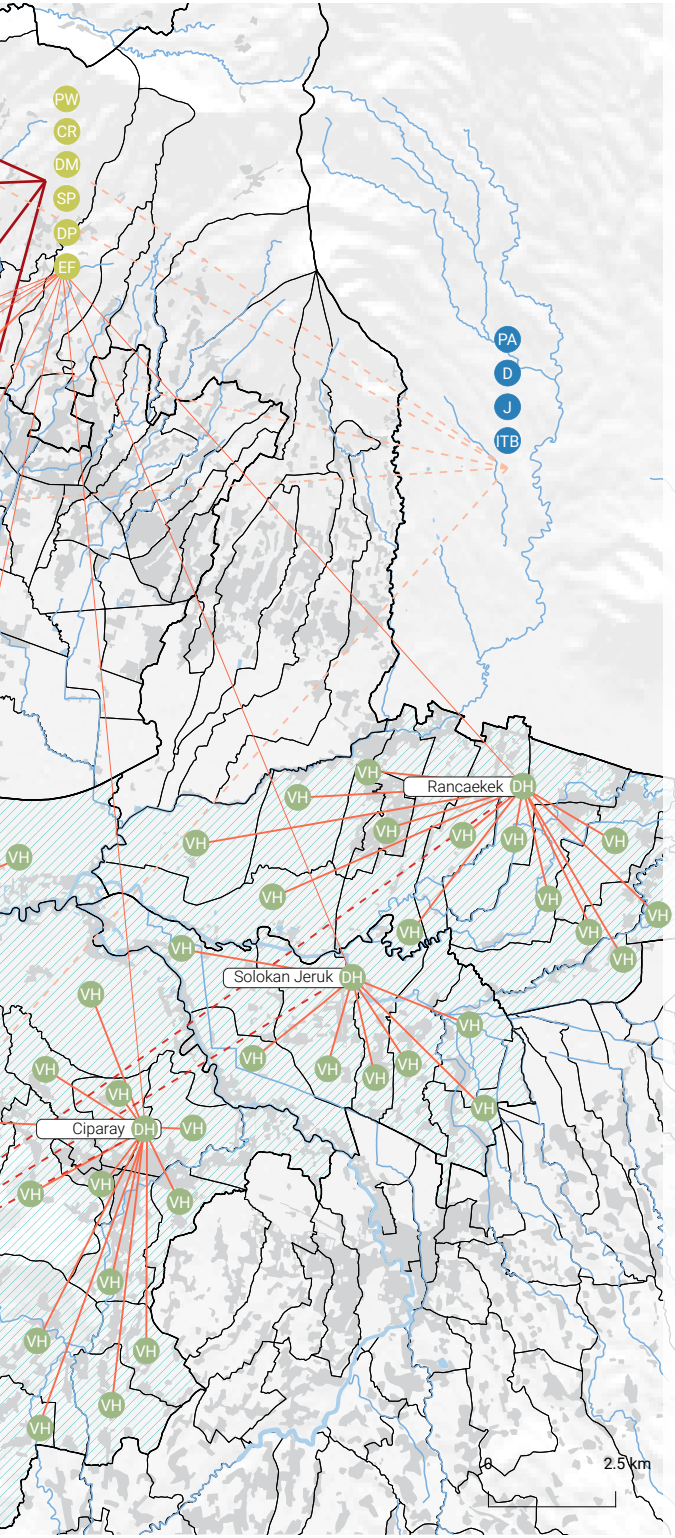





**Figure 75** Stakeholder Involvement [ 3. Multifunctionality ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Multifunctionality




### Legend

- Ragencies
- Districts
- Urbanized Areas
- Water Bodies
- Flood Prone Districts
- Ragency Boundaries
- Village Boundaries
- Textile Industry
- Metal Industry
- Food Industry
- Plastics Industry
- Leather Industry
- Schools
- Hospitals
- Connections
- Industrial Area
- Area under Military Supervision
- Military
- Ministry of Public Works
- Central Office of Citarum River Region
- National Board of Disaster Management
- Ministry of Land & Spatial Planning
- Ministry of Development Planning
- Ministry of Environment & Forestry
- City / Regency Government
- District Head
- Urban / Rural Village Head
- PusAir
- Deltares
- JICA
- Bandung Institute of Technology
- Community Heads [ RW ]
- Neighborhood Heads [ RT ]
- Household Heads [ KK ]

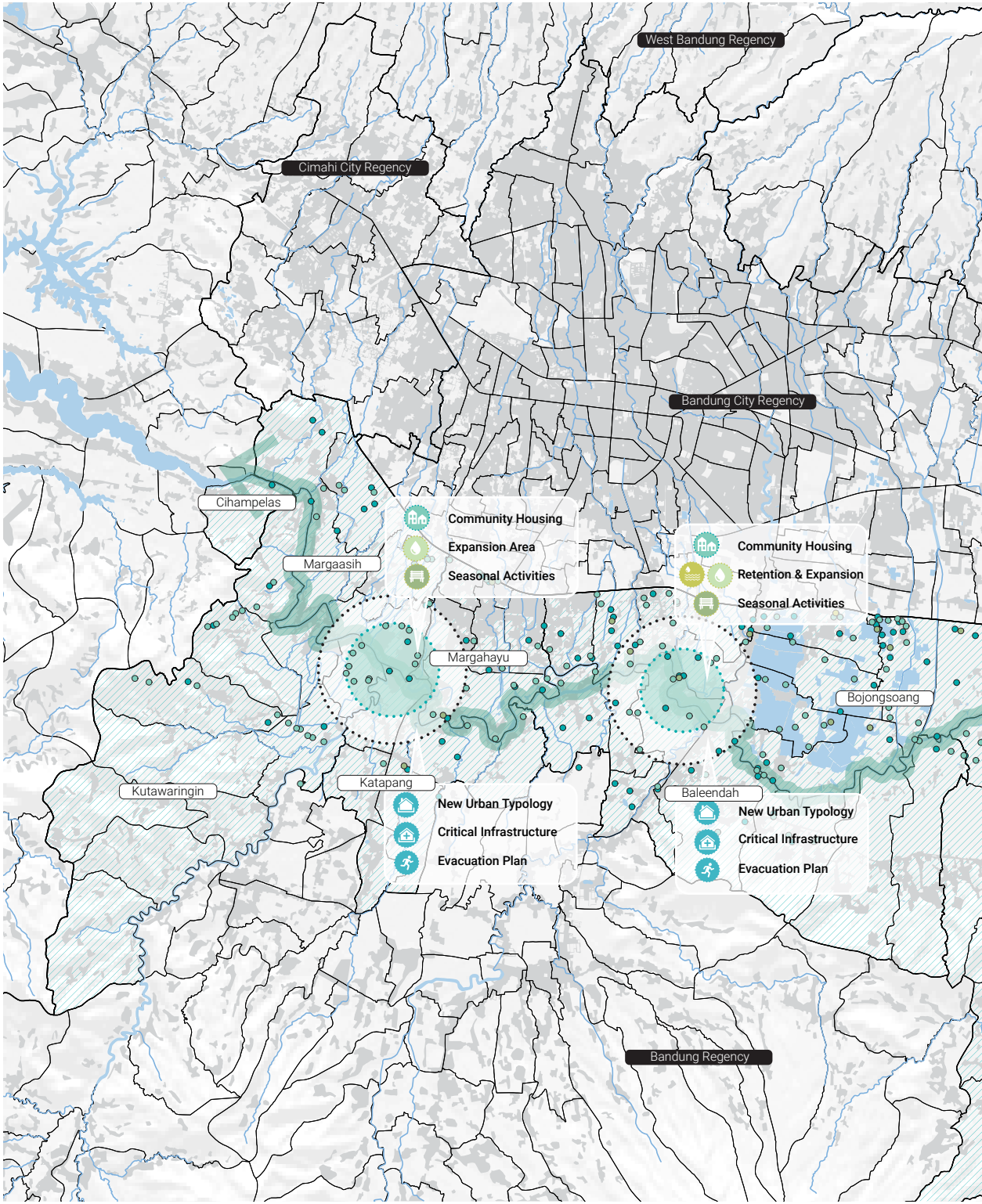
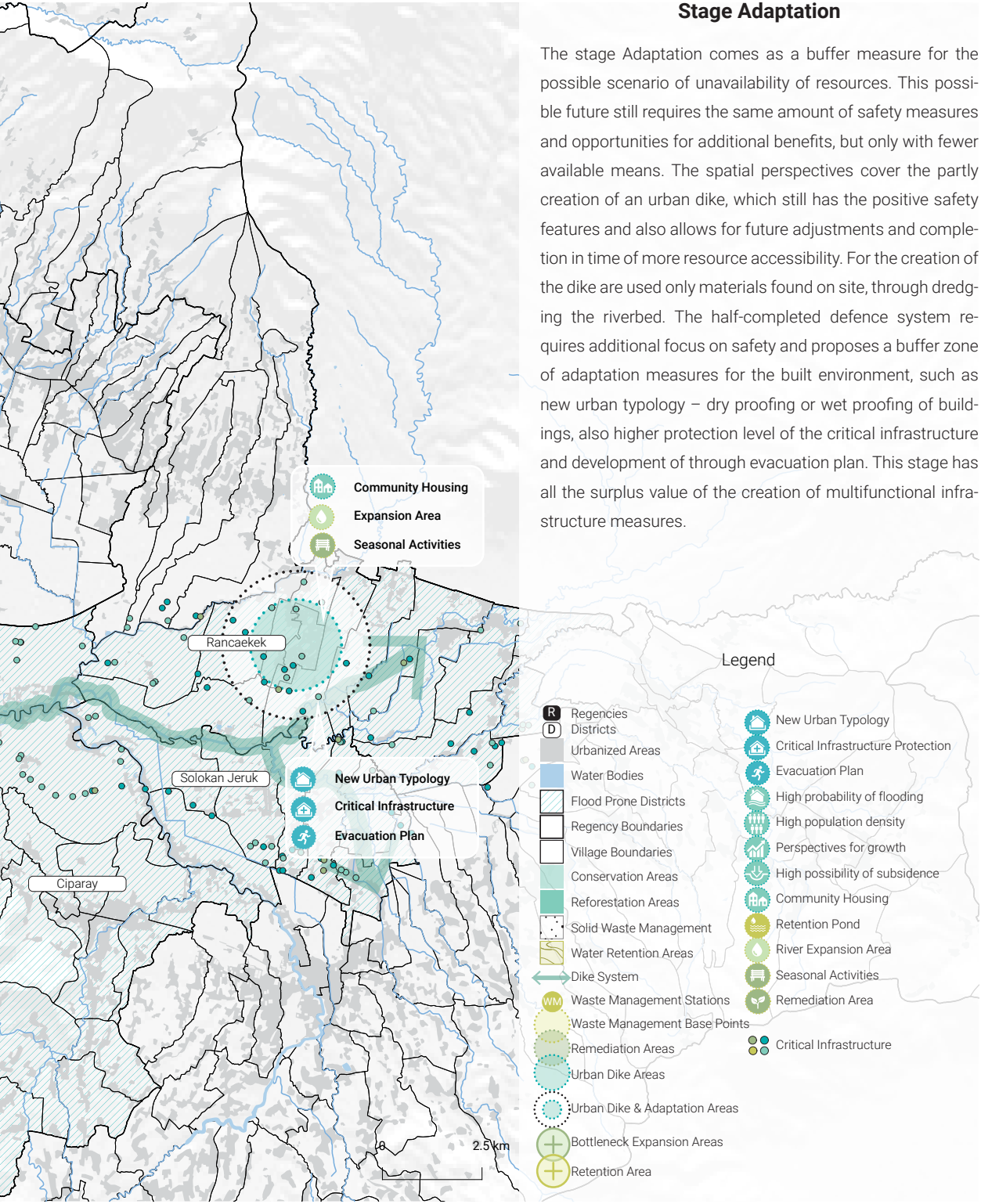





**Figure 76** Spatial Perspective [ 4. The New Normal ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Adaptation

The stage Adaptation comes as a buffer measure for the possible scenario of unavailability of resources. This possible future still requires the same amount of safety measures and opportunities for additional benefits, but only with fewer available means. The spatial perspectives cover the partly creation of an urban dike, which still has the positive safety features and also allows for future adjustments and completion in time of more resource accessibility. For the creation of the dike are used only materials found on site, through dredging the riverbed. The half-completed defence system requires additional focus on safety and proposes a buffer zone of adaptation measures for the built environment, such as new urban typology – dry proofing or wet proofing of buildings, also higher protection level of the critical infrastructure and development of through evacuation plan. This stage has all the surplus value of the creation of multifunctional infrastructure measures.



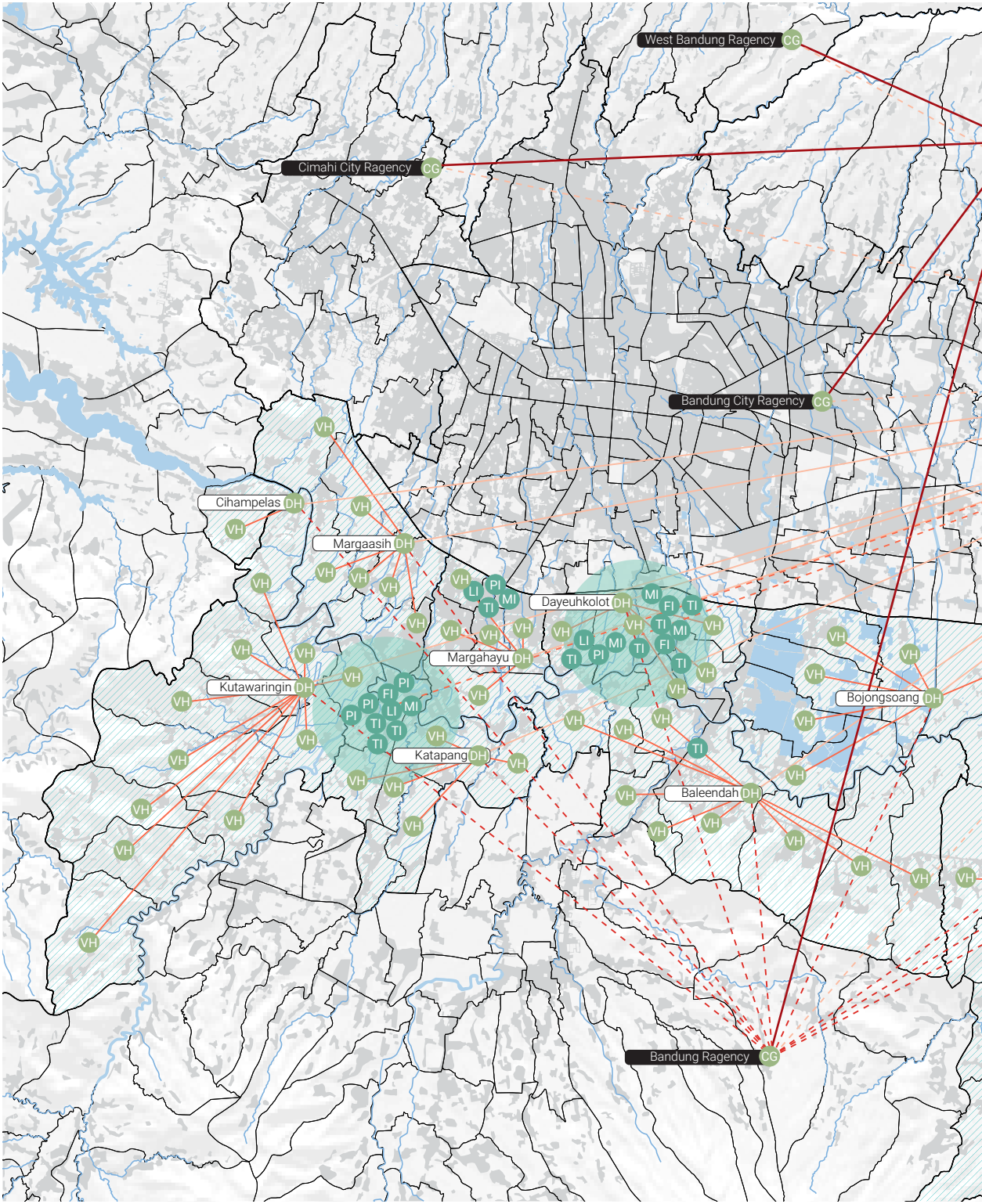
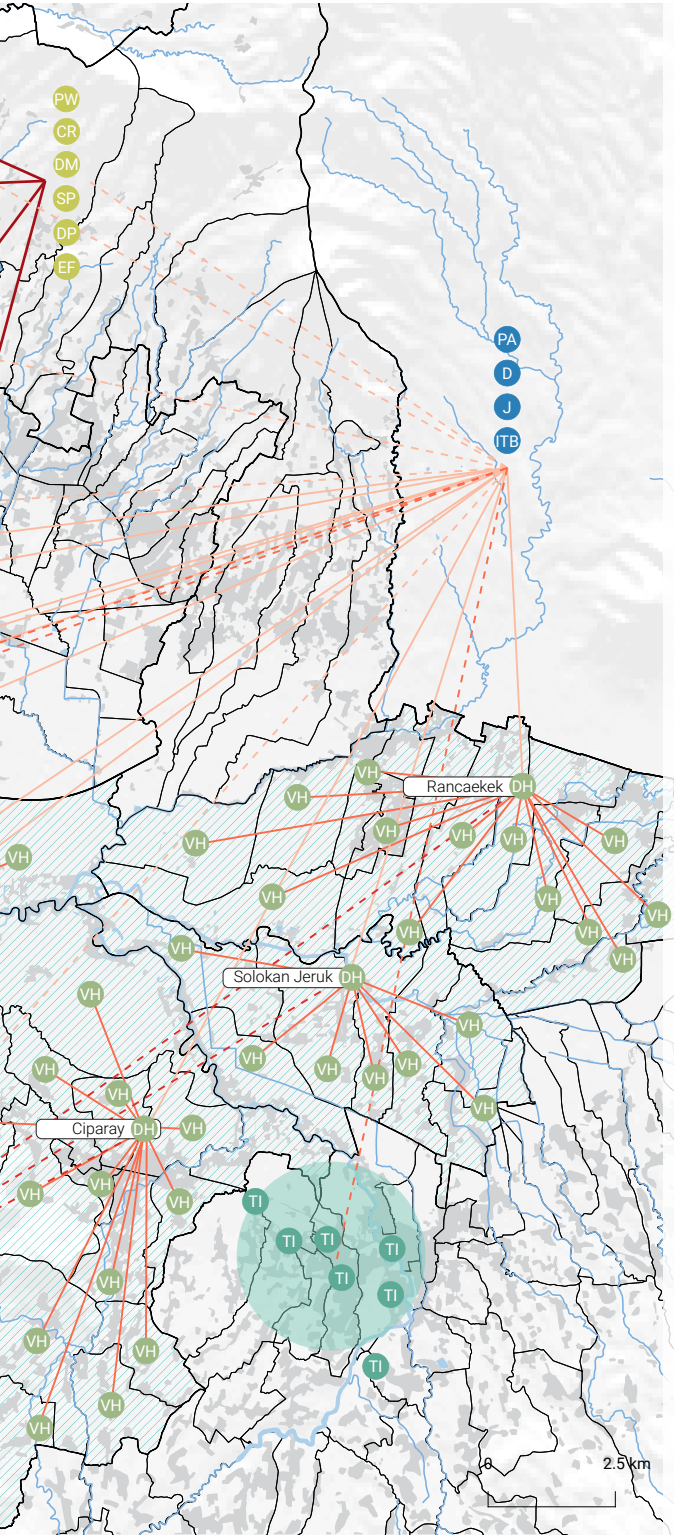
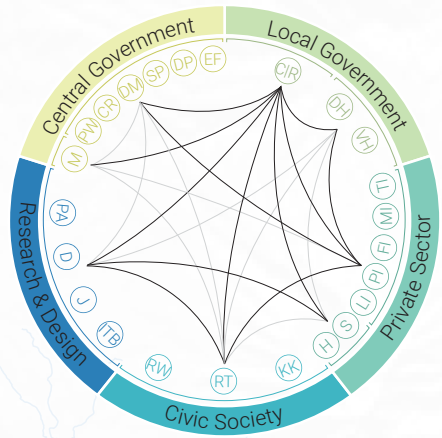





**Figure 77** Stakeholder Involvement [ 4. The New Normal ]
Data Source: Badan Informasi Geospasial (National Mapping Agency of Indonesia)

## Stage Adaptation




Legend

- R Ragencies
- D Districts
- Urbanized Areas
- Water Bodies
- Flood Prone Districts
- Ragency Boundaries
- Village Boundaries
- TI Textile Industry
- MI Metal Industry
- FI Food Industry
- PI Plastics Industry
- LI Leather Industry
- S Schools
- H Hospitals
- Connections
- Industrial Area
- Area under Military Supervision

- M Military
- PW Ministry of Public Works
- CR Central Office of Citarum River Region
- DM National Board of Disaster Management
- SP Ministry of Land & Spatial Planning
- DP Ministry of Development Planning
- EF Ministry of Environment & Forestry
- CIR City / Regency Government
- DH District Head
- VH Urban / Rural Village Head
- PA PusAir
- D Deltares
- J JICA
- ITB Bandung Institute of Technology
- RW Community Heads [ RW ]
- RT Neighborhood Heads [ RT ]
- KK Household Heads [ KK ]

# 11. Design Interventions

The area that was chosen for further development of the design proposal and expressing the physical outcome of the whole project is the village Dayeuhkolot. This focus zone was proven to be in the spatial analysis one of the crucial places with a concentration of vulnerabilities. However, after conducting the field study, it was also recognised for the activeness of the local communities and their previous attempts for seeking participation themselves.

The design interventions play a key role as a final step in the project, making sense out of the planning and strategic visioning in the region of Bandung. It is a much needed final demonstration of the possible futures of development that this thesis proposes. With the design part, the project is seeking to represent best the spatial qualities and possible stakeholder interactions on the local level, by following the planning process of the Dynamic Adaptive Policy Pathways method and also building upon the stages in the strategy. The design creates the possibility for looking into detail for the application of all the chosen measures on site and also improves potential conflicts by making adjustments and adaptations.

The creation of the spatial interventions in the village Dayeuhkolot has a well-established precondition line of validation. The spatial analysis and conducted observations on site have verified the present issues from previous planning and implementation measures. The mismatch between the needs of the area for safety and the actual execution and effects on the village is worsening the quality of life and well-being of the people. The local communities with their representatives are focusing on improving the situation with waste management solutions and safety measures by reaching to the local government structures (the creation of eight waste-gates around the Dayeuhkolot Village). These actions are the best example for bottom-up initiatives, which can make a difference in the decision making model. However, they are not enough for greatly improving the current situation.

The village experiences floods, even after the implementation of the JICA project in 2016. Only the next year there are already evidences of minor floods up to 40 cm. The mismatch that this project found is created not by intention, but by not considering very strong external factors in the area – such as climate change. The JICA report suggests implementing a dike system in the vulnerable areas. However, the data that they used for predicting water levels is based on previous volumes of the Citarum River and its tributaries (Figure 78). They have also simulated the water levels in the area, without con-

sidering rainfall changes or discharge alterations (Figure 79). After conducting a further research on the method used for calculating the height and width of the future dike, the study found 1 meter of disproportion from the existing situation to the expected water levels, which still were without the consideration of change in the climate. By creating a digital elevation model and cross-sections through the lowest points in the area, it was possible to know the level of the river bed. Thus, by using the simulated water levels, the study established the need of 3 meters additional height of the existing flood protection.

The design follows the already determined paths of the previous plans and projects in the area. It uses them as a base for upgrading. Thus, in the following paragraphs the structural and physical actions of the project are going to be detailed. It will also be specified the key players and how they engage with the future changes in the area.

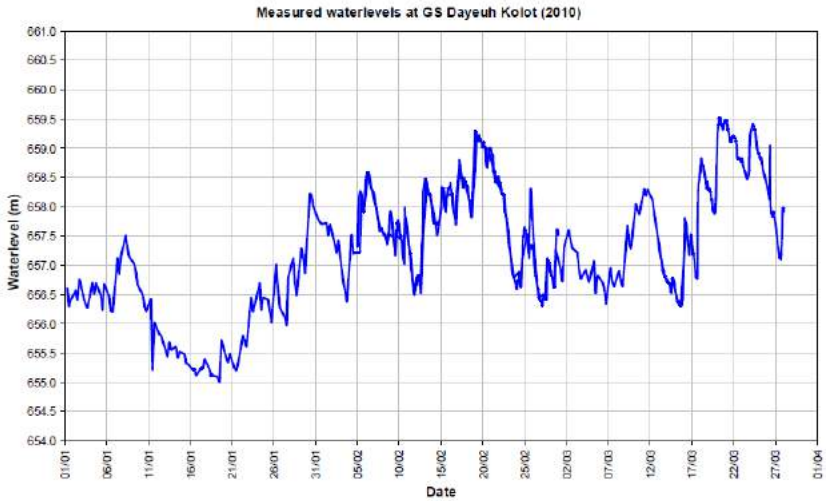



**Figure 78** Measured waterlevels at GS Dayeuhkolot 2010
Source: JICA, 2010

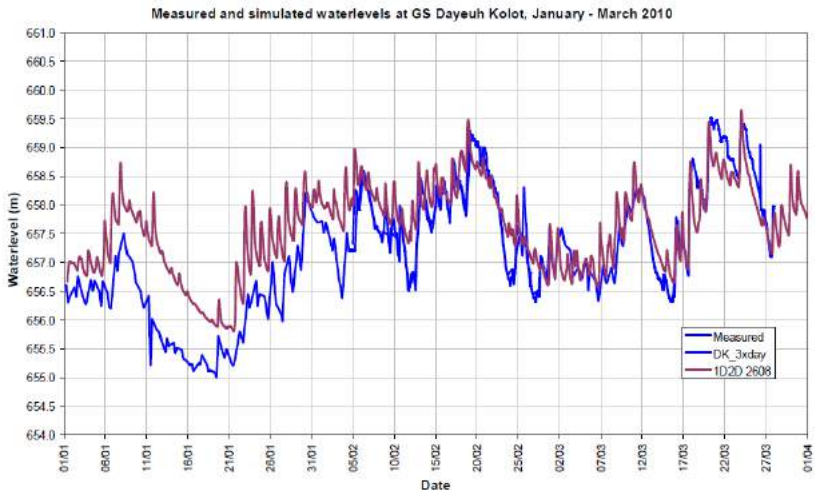



**Figure 79** Simulated waterlevel at GS Dayeuhkolot
Source: JICA, 2010


**Figure 80** Regulation area free of urbanization
Source: Author


**Figure 81** Waste treatment and Remediation strategies in Dayeuhkolot Village
Source: Author

**Design Proposal**

The law of Indonesia about living in close proximity to rivers has strict guidelines prohibiting building inland within 100 meters from large rivers and 10 meters of smaller ones. However, due to rapid population growth and migration processes the urban centres like Jakarta, Bandung and Yogyakarta are experiencing sprawls beyond the regulation. The Dayeuhkolot Village is an example of this sprawl, but also has its own specifics. It is the first historical settlement in this region and was inhabited before the colonial times. Previously an agriculture land, nowadays due to the growth of Bandung, the area has become an industrial zone with many residents outside the standard boundaries.

The zone shown of Figure 80 has the potential to be the design focus of this project. This is due to the rights that the law gives for interference in the first 100 meters from the Citarum river. The buffer zone is densely populated and at highest risk, which asks for urgent measures towards overcoming the vulnerabilities. These two factors (the law regulations and the high density) are contradictory to each other and not easy to grasp due to the large number of stakeholders and interests. However, these two factors can also be seen as the steppingstones of the design proposal. The determined guidelines by the law can be used as the motivation for reconstructing larger residential areas and upgrading existing plans and projects of infrastructure.

**Remediation Strategies**

The proposed design considers three main elements in the outline. The first element (Figure 81) is centred around the recovery of the area in terms of environmental pollution. As mentioned above, due to improper waste management and illegal landfills, the water and soil in the village has been highly contaminated. Accordingly, the undertaken measure is solid waste management in the areas along the riverbed - which has already been undertaken in several cases close to legal settlements. The further remediation strategies have two paths - the remediation strategy of the soil through vegetation and filling with unpolluted soil. The remediation through vegetation is focused in areas where the design proposes access to the river front and the development of future public spaces. The sand filling action is introduced in the areas of the super levee construction. As the levee will require a large amount of soil, hence the strategy of covering the contaminated soil could be faster and more reliable step.

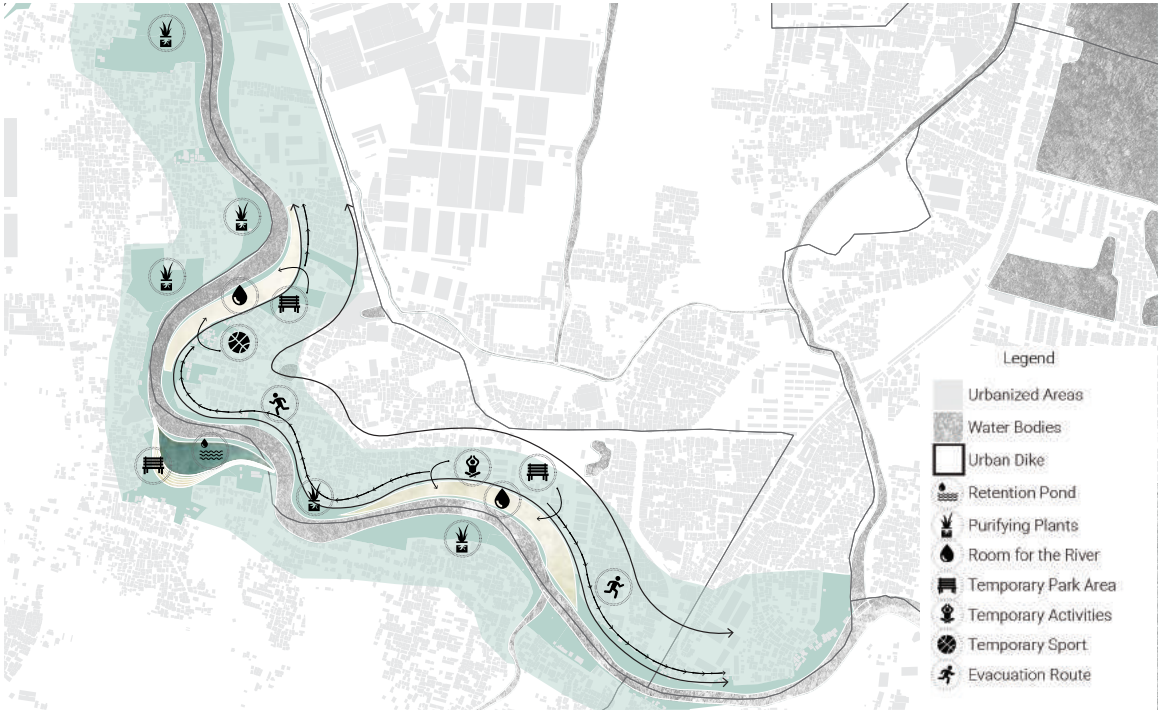



**Figure 82** Infrastructure measures in Dayeuhkolot Village
Source: Author

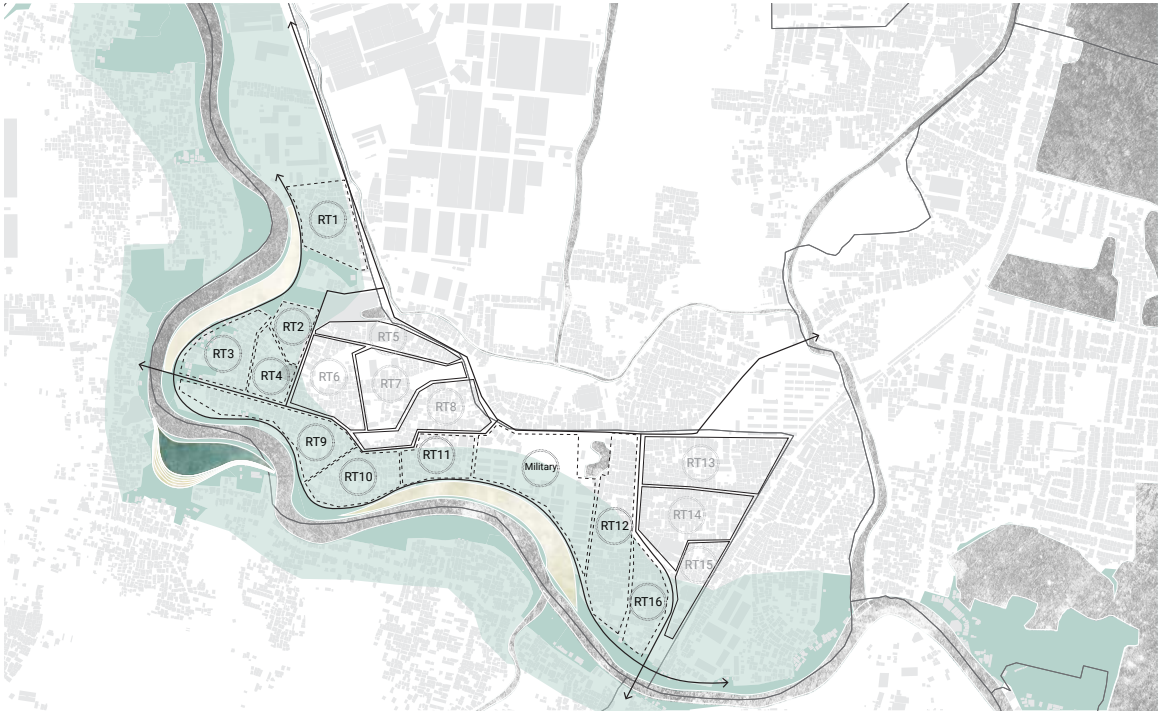



**Figure 83** The neighbourhood structure preservation strategies in Dayeuhkolot Village
Source: Author

**Infrastructure Measures**

The second element of the design of the Dayeuhkolot Village is taking into consideration the current flood infrastructure system as a base for further improvement and enhancing the performance (Figure 82). The idea is to transform several zones of the existing dike along the Citarum river into a super levee. The logic is that the current dike system is proven to be insufficient for the amount of water discharged nowadays, which is predicted to increase with the effects of climate change. These zones are chosen with consideration to the amount of people living and working in the areas, combined with the flood risk factor. Dayeuhkolot Village is one of the most affected areas from flood risk and also accommodates over 20 000 people. The super levee has multiple advances afore the usual dike system.

> *"The concept of a super levee is designed especially for extreme events in a highly dense urban area. "*
>
> *- (Graaf, R. d. and F. Hooimeijer, 2008)*

The super levee is a stable defence system that provides not only protection but also usable land for housing and commercial purposes. The property ownership can remain the same due to the opportunities for construction on it. The gradual slope (1:30) allows for overcoming the feeling of a physical or visual barrier and furthermore restores the contact with the river. As a result of the used materials for ground coverage this type of protection allows ground water infiltration, which is extremely needed in the case of Dayeuhkolot Village, where the extraction of the water created a fragile, subsiding ground level. The strong wide base has the features to withstand overflows and provides with high ground for evacuation pathways. Additional plus of the super levee is that it is highly resistant to other natural disasters like earthquakes and their consequences like liquefaction of the soil, which will be in great support for the frequent earthquakes in Indonesian context *(Graaf, R. d. and F. Hooimeijer, 2008)*.

Another important component of the design is the increase of space for the river. There are several strategic places, which are consciously chosen depending on the elevation and flow of water for widening the floodplain. The design proposes these areas to be multifunctional, thus used all year long, providing more public spaces for the people of the near kampungs and those working in the industrial areas, but also storing more water during the peak rainy seasons.

**Neighbourhood Structure**

The final element of the design covers 8 out of the 16 neighbourhoods in the Dayeuhkolot Village (Figure 83 ). Despite the informal origin of the neighbourhoods, after the construction of the super levee these districts can preserve their identity and street structure for better acceptance from the stakeholders. However, differences would be the larger in between spaces due to safety and health reasons and also in the pubic zones.

**SOLID WASTE MANAGEMENT**

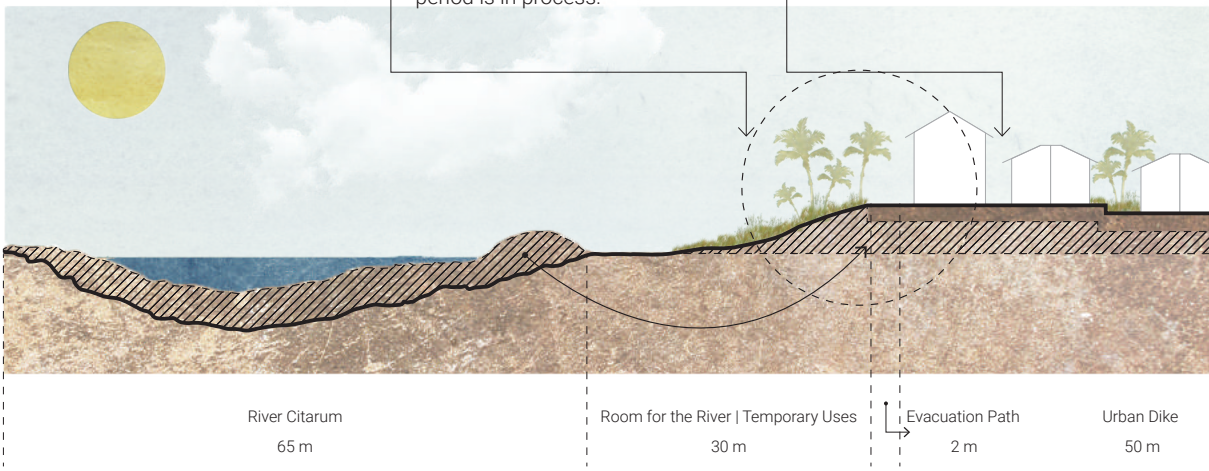
Due to the large amount of solid waste pollution, the design requires measures for dealing with it. An important step is the creation of a management strategy where the solid waste is separated from the soil and further disposed on a regulated landfill.

**REMEDIATION ZONES**

The second type of pollution strategy tackles the heavy metals in the soil, which have been accumulated from the illegal waste water discharge of near industries. The enlarged zones in the floodplain of the river are being treated through natural remediation with different types of plants and trees. These areas are also available open spaces for the locals during the dry season. Elevated wooden paths are installed while the remediation period is in process.

**INTERMEDIATE URBAN DIKE**

For the implementation of the urban dike is needed a very large amount of soil/sand. The design proposes an intermediate step of the desired step which uses the materials that are available in the scope of the village. For this matter the river bed is dredged which ensures the natural flow of the water, but also filling material for the development of the urban dike.

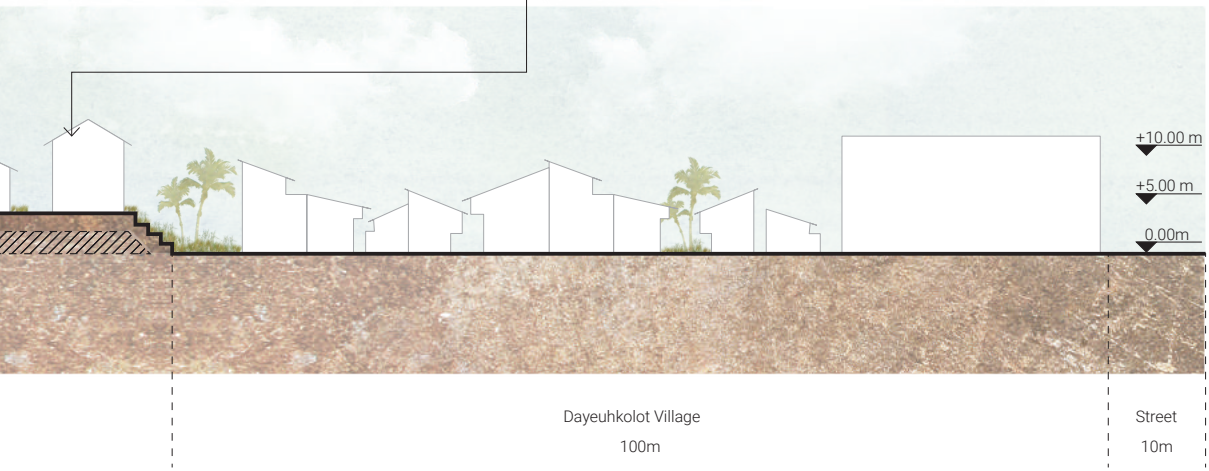


**SAND FILLING**

Since the material that is used for the urban dike is highly polluted with heavy metals, the design proposes a sand filling remediation strategy with clean material for healthy urban environment.

**NEW DEVELOPMENT**

The new development on the urban dike follows the structure of the neighbourhood. However, in the proposal there are more green areas for improving the water infiltration and therefore retention. The community housing is built in collaboration with the local communities, who return to their property with slight adjustments.



**DISCHARGE CAPACITY**

The measures for enlarging the flood plain like dredging and giving more open space for the river enlarges the discharge capacity. This lowers the possibility of flooding in the area of Dayeuhkolot village and the opposite Andir village.

**TEMPORARY USES**

The new obtained open spaces during the dry season are used for temporary recreation purposes.

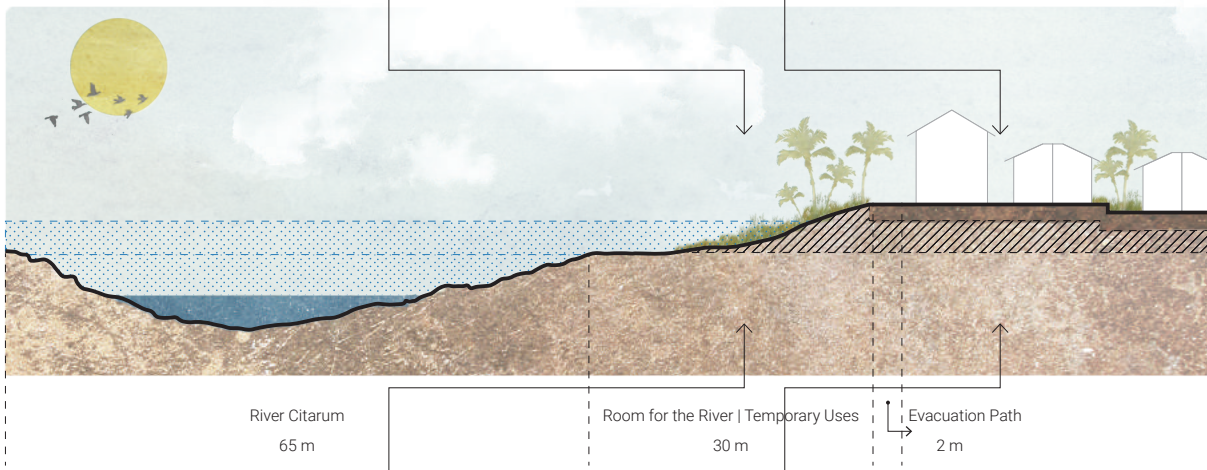
(See visualisation Figure 84)

(See visualisation Figure 85)

**URBAN DIKE FULL EXTEND**

The full implementation of the urban dike needs additional materials that are exogenous of the area. This is the potential future vision of the area and aim in order to ensure flood risk protection in its maximum levels.

Spatial Measures




Engagement Strategies

**RISING AWARENESS**

In order to achieve the objectives of the design there needs to be a careful estimation of the potential supporters and blockers among the stakeholders. The creation of communication channels for increasing the understanding of the civic society towards the plans and proposals can benefit the coordination and implementation of the design.

**KNOWLEDGE BUILDING**

Building upon the knowledge of waste management can reinforce the good practices in the areas. Education of local communities is crucial for applying the waste management and remediation strategies. This objective can be supported by the local universities as they can create easier and more trustful connections with the locals.

**REGULATION CONSTRAINS**

This engagement strategy is working with disincentive measures. Restricting harmful actions and practices of industries and households for disposing waste in the rivers or creating unregulated landfills.

**OPEN SPACES**

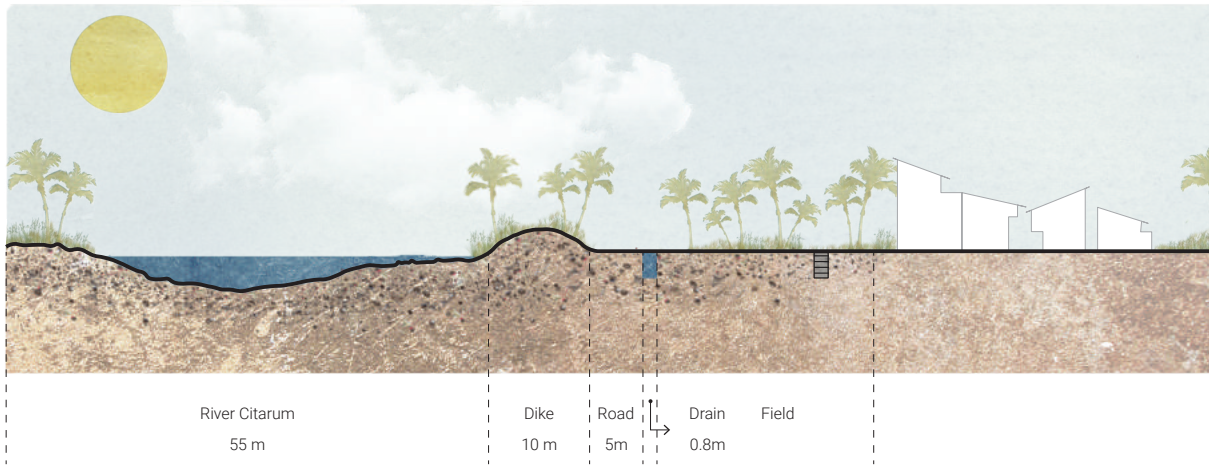
The open spaces in the area of the urban dike are equipped with permeable materials to provide better infiltration. As an added value this generates healthier and more hospitable urban fabric for the local citizens.

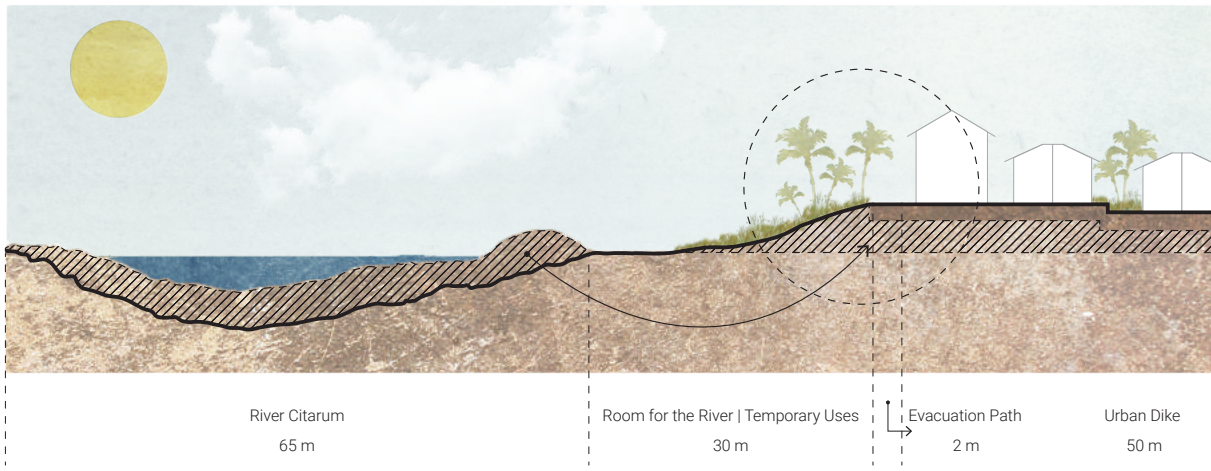

**UTILIZING THE POTENTIAL OF THE GOVERNANCE LADDER**

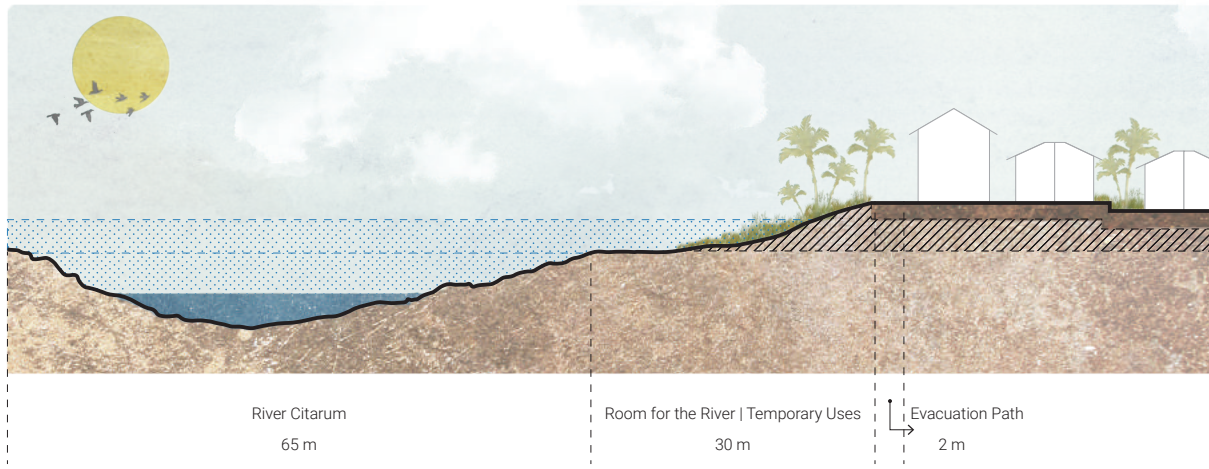
The governance system in Indonesia is a very strong advantage with its ladder of power. This asset can be used as a base for inclusion of all relevant stakeholders in the process of decision making. Through the local leaders the communities can present their ideas for their areas or give their response for governmental proposal.

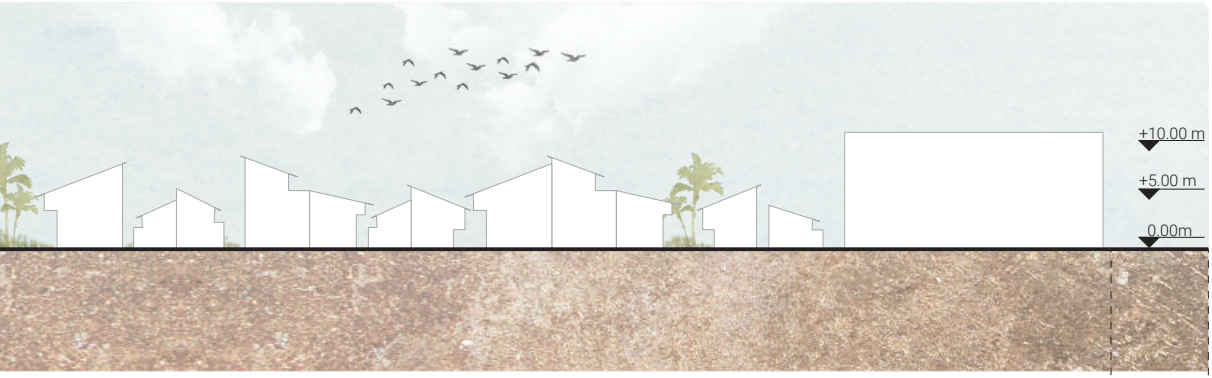
**BUILDING CAPACITY FOR REGIONAL SCALE STRATEGY**

Building the capacity throughout all governance levels and inclusion of civic society creates the possibility for better understanding and support of future plans and proposals. Including all relevant stakeholders and better cooperation platform needs to be implemented.


River Citarum
55 m
Dike
10 m
Road
5m
Drain
0.8m
Field

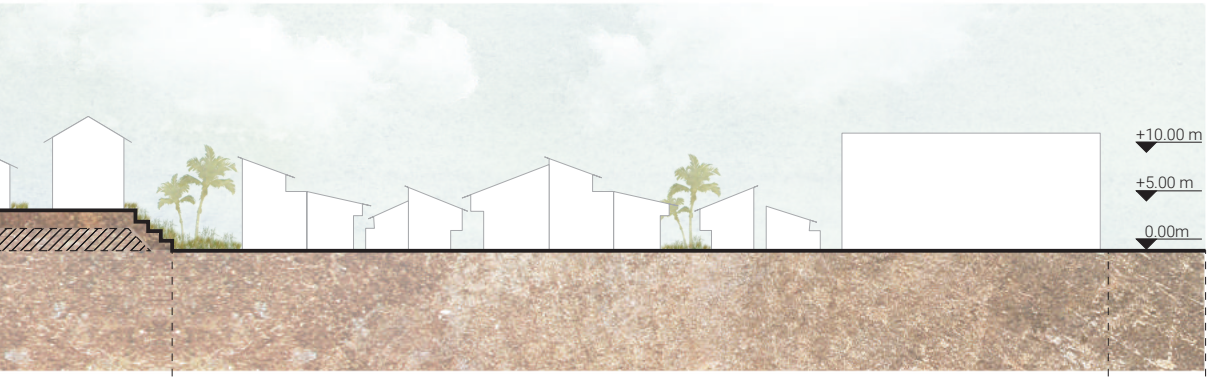

River Citarum
65 m
Room for the River | Temporary Uses
30 m
Evacuation Path
2 m
Urban Dike
50 m


River Citarum
65 m
Room for the River | Temporary Uses
30 m
Evacuation Path
2 m




Dayeuhkolot Village
150m

Street
10m




Dayeuhkolot Village
100m

Street
10m


Urban Dike Dayeuhkolot Village
150m

Street
10m

**Figure 84** Design impression: Room for the River areas during dry-season
Source: Author


**Figure 85** Design Impression: Room for the River areas and parts of the Urban Dike during wet season
Source: Author

# V

# Conclusion and Discussion

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# 12. Conclusion

The graduation thesis is exploring a region on Java Island in Indonesia which has many areas with high percentage of vulnerability to flooding. The natural disasters affect the social and spatial realms with higher pace than ever before due to the global trend of climate change. This, in combination with the effects of rapid population growth has created social segregation, limiting infrastructure accessibility and pushing communities towards settling in the most dangerous and dilapidated areas.

Recent studies suggest flood depths of 2 meters with return period of 5 years, however the conditions change rapidly and the current state of the surveyed areas shows same extend of flooding but with return period of 1 year. This leads to many abandoned houses or properties for sale of those who have the means for moving to safer areas. On the other hand, the ones who do not have the resources, or whose identity is strongly bound to their surroundings, are forced to adapt to these extreme conditions.

The specifics of the area and largely the adaptation threshold of the local communities framed the research towards an understanding of adaptive resilience strategies. The aim is to create an environment and society which have the ability to overcome the effects of extreme events by minimizing the risk, creating capacity to cope and have efficient response mechanisms, and essentially to build upon the adaptiveness of these systems.

The main question of the study is creating a hypothesis of the ability of flood risk adaptation strategies to overcome both the physical and social vulnera¬bilities while sustaining healthy and just urban environments. This assumption is further explored with the help of the additional sub-research questions and later tested within the design proposal. The sub-questions are linked to the domains driving future (re)developments – spatial planning, urban design and engineering, as the equilibrium between them is used as an assessment model later in the thesis. Their relationships and most importantly the possible counteractive effects that they cause to one another are in the focus of the investigation. These questions are looking closely to these clashes between the domains – asking how to avoid future negative effects in both social and physical realms. In the next paragraphs this chapter will discuss the results of the thesis findings through answering to the research questions and understanding its limitations.

## How can the flood risk adaptation strategies overcome both the physical and social vulnerabilities while sustaining healthy and just urban environments?

The answer of this question could be quite straight forward if understood as a matter of overcoming flood risk. Thus, the answer would be as simple as creating more defence infrastructure or relocation of the vulnerable population. However, a key in setting the research question is aiming at "sustaining healthy and just urban environments". This creates the need for a more comprehensive approach, which can lead to allowing multiple values to be obtained through one project. The graduation thesis adopts the concept of Adaptive Resilience for the formation of this approach. It responds to the main issues uncovered by the research – tackling flood risk management and response, and transforming the systems in order to accommodate future adversities. Moreover, it facilitates a possibility for acquiring additional benefits for the local society and physical quality of the urban environment. This advantage of the concept of adaptive resilience can be transferred to reality through multipurpose spatial design and flexibility in decision making. The project uses the Dynamic adaptive policy pathways (DAPP) method which can connect several design actions and achieve the multifunctionality objective, while being used to encourage stakeholder involvement along the process. Thus, the main research question is answered by the design proposal in the chosen case study, through building upon flood risk adaptation actions that create additional value for improving the quality of the built environment along with the integration of different societal groups.

# 13. Discussion

## 13.1.Limitations

### Limitations of the study

The graduation thesis has a strong base of methodological approach which tries to balance the limitations or validate the results by combining different methods with others (see Figure 10). However, sometimes this substitution can be not enough or even producing false expectations. This can be related to the limited availability of up-to date data such as location of infrastructure or informal settlements. Particularly these two examples have played a crucial role in previous projects that were examined in this thesis research. The aim of this exploration was to validate such gaps through site observation and interviews. Nevertheless, the certainty of completing representative samples of such large area extend would be hardly possible.

Another constrain of the study was the lack of computational models that were supposed to be used in the creation of the adaptive pathways (see page 113). The absence of these models was substituted by creating general assumptions for the attitude and needs of stakeholders or by using the previously obtained knowledge through literature review, policy analysis, interviews, etc.

There were also some practical limitations like time or language barrier. These facts unfolded in different ways, for example the possibility of interviewing and consulting stakeholders. There was no opportunity for real involvement of actors during the creation of the project. This need has been seen mostly in Chapter 10 where consultations and reflection on the project would have been very beneficial for the creation of the actions and pathways and their further implementation in the strategy and design.

### Limitations of the applications

The possibility of testing this graduation thesis in real life also comes with certain limitations. The first that need to be mentioned are the contextual barriers. These represent the likelihood of undertaking this project, which looks at the issues in the area with the perspective of more western approach. These constrains might be due to cultural differences or difficulty in acceptance. The support from stakeholders should not be taken for granted and if there is no critical mass, then a whole project can fail. These limitations also can be due to absence of strong political will and many times planning and design through bottom-up approach is not capable of resolving such issues. This is strongly related to the amount of resources available for certain physical transformations.

### 13.2. Recommendations for Further Research

This graduation projects explored the implications for flood adaptation strategies to facilitate safe, healthier and integrated urban environments. This was tested in the case study of Bandung, Indonesia. However, as many other regions in the country are vulnerable to flooding, it would be interesting if this case and approach can be tested and compared to others. This can build upon the effectiveness and applicability of policies and practices presented in this thesis.

Through the development of the project an unexpected gap has been revealed. This was the role of the governance system structure within the separation of spatial responsibility in terms of issues like flood risk. As much of the theories point out the positive sides of decentralisation of the governance system (Holzhacker, Wittek, & Woltjer, 2015), there has been less critique and detailed examples of the possibilities for improving the system and upgrading it. This aspect needs more empirical research to be done to assess the opportunities and challenges of the current system for enhancing the performance and inclusion of different stakeholders in the decision making.

There are also questions that arise from the spatial analysis of the area. Issues with the entire water cycle can be addressed through viewpoints of pollution and waste management, drinking water supply and subsidence or water treatment. This graduation project touches upon some of them as it recognises the urgency of these problems. An example of this can be the reach of pollution strategies which are not able to expand the actions and designs towards a complete waste management plan and need additional investigation. The exploration of these topics can improve or change some of the actions proposed by this thesis, or even completely discard some of them, replacing them with innovations. An integrated research on the whole water cycle can bring advantages of more multifunctional actions and create synergies within the urban and natural environments. It can bring forward additional benefits that were locked by looking at the cycle only from the perspective of flood risk mitigation.

On a separate note, there is a strong necessity for research on the possibility of "retreat" in the most vulnerable areas. As this graduation project has a defined time limit in its future predictions, there is a great possibility that there will be a need for new areas of development for accommodating the new citizens or protecting the ones that are in danger. More research should be done on the places and ways of approaching this topic as it can receive resistance from the relevant stakeholders.

# 14. Reflection

**The relationship between research and design**

The job of urbanists is in its core a continuous loop of researching, taking decisions, trying out designs and then widening the scope for further research. Despite the acquired benefits of a comprehensive design, it is unlikely to answer all questions put forward by the research with the same depth. Commonly used, the theory-based and context-based researches complement each other by developing a detailed idea of the explored space. Yet, they also help generating more questions for the design. This favours the nature of our professional work to the phase of constant reflection and further exploration.

The reality suggests far less possibilities for this repetitiveness as it has to face the urgency of the context. However, it allows for making more concrete assumptions with direct impact on the imaginable futures. As I am being a foreigner to the context of Indonesia, this has played an important role in the project. It brings limitations for understanding the site with the dynamics of its systems, but it can also allow for a better focus over the essentials forming the context. With this in mind, the starting point of the context research was found in data analysis and literature review. This refers to historical overview of Bandung Region, socio-economic specifics, nature of ecological systems and role of spatio-temporal dynamics. Essential part of understanding the extent of complexity of those findings in reality was the site visit. It brought the facts and figures of the abstract analysis to the eye level and showed the identity of the place. Both analytical and empirical studies allowed me to grasp the advantages and constrains of the context for the next steps towards the design.

Understanding the context pushed forward concepts and theories which were further explored using the theoretical research. Recognising the socio-spatial vulnerabilities created by the flood risk exposure drove the theoretical exploration. The empirical research made me recognise an important characteristic of the local people living in the informal settlement around Banding, who were experiencing the highest flood risk, their high adaptive capacity threshold. This inspired the search for a concept which would use this valuable feature of the population as the foundation for building upon a framework for design. This led me to the definition of adaptive resilience, which over arches the pursued aims and more importantly creates a logical path for achieving them.

Both the theoretical and empirical research made an impact on the decisions I took for proposing the strategic framework, phasing and design interventions. These were cau-

tiously reasoned by linking the obtained contextual knowledge with research concepts from the literature review. For instance, reflecting upon the context of rapid population growth and rising vulnerability creates the need for safe, liveable space, which inspires the design of an urban dike, while the theoretical research draws upon the additional societal benefits that could be created from increasing the adaptive capacity in socio-spatial terms.

**The relationship between the theme of the studio and the chosen subject / case study / object**

The dynamics of the natural systems are changing more rapidly than ever before under the immense pressure of global trends like climate change and population growth. The urgency of configuring new types of spatial conditions that can accommodate this change is recognised in the work of the urbanist. Today's "normal" is a term in transition, bordering with the "extremes". It requires flexibility and adaptability of all natural or urban systems in order to correspond to the uncertainty.

Looking at trends in the current processes of spatial development in Bandung region made me question the integration and efficiency of the measures taken for overcoming the rising vulnerabilities. The solutions seemed unbalanced and many times contra productive to the social and physical flood resiliency of the region. Often the coordination between different fields of expertise is missing links and functional relations, thus not being able to withstand the changing conditions of the context.

Trying to comprehend all the elements and their relationships, I constructed my conceptual framework which could clarify the needed equilibrium between the agencies driving future (re)developments. Re-tuning the roles of the conventional domains of spatial planning, urban design and engineering enhances the performance of both social and physical systems at risk. This multidisciplinary approach has been integrated in the practice of the master track of urbanism, but also pursued by the studio of Transitional Territories. Dealing with such uncertainty levels as the one in the case study of Bandung region calls for the integration of different fields of knowledge, which was my motivation to choose this studio.

By choosing these concepts complementing socio-spatial integration and safety, it was important to go beyond the static fields of the conceptual framework, but look into the functional relationships that could be constructed in the context. My work on the matrix of adaptive resilience was a showcase for combining spatial measures dealing with flood vulnerability and looking at them across scales and different time frames. With this, my project also contributes to the studio. By working with the different fields of knowledge and illustrating the spatial perspective of the theoretical concepts I revealed potentials and limitations of the design. My work proposes a narrative for dealing with flood risk extremes and creates a platform for long term and short term practices in reality.

**Elaboration on the chosen methodology and research approach. Scientific relevance of the work.**

The motivation of the project's methodology and approach came from the site visit conducted in the beginning of the year. The significance of the site and particularly the local communities there, acted as an inspiration for the search of theoretical foundation that can grasp the spirit of the locals and the identity of the place. Their high adaptive threshold was the basis that I needed to ground my research in. This emerged to the creation of a research approach, which combined several concepts into an assessment tool (Conceptual Framework) and their spatial interpretation (Matrix of Adaptive Resilience).

It is important to note that the inspiration and motivation that I found in my meetings with the local communities was always taken upon with respect and understanding to the difficult, life threatening situation that they are living in. My consideration to their strength and efforts for coping with the natural disasters was never taken for granted or interpreted in a sentimental or poetic manner.

Undertaking this framework defined my further exploration into the relevant stakeholders and their role in the projects. The stakeholder analysis supported an in-depth understanding of the restrictions and opportunities for utilizing the local knowledge and experience in the process of decision making. It created guidelines for establishing efficient cooperation by balancing responsibilities, but also without avoiding overpowering some stakeholders on account of others.

The graduation thesis explores existing projects and uses the example of their implementation outcomes, advantages and constrains to set a starting point for the design. The particular case of the flood management project of JICA for the Upper Citarum Basin has been an object of study for its proposal and current implementation on site. It gives many insights of the relevant practices and the constrains that they meet. For instance, the realization of some proposed measures has met resistance from key stakeholders and therefore has been unable to proceed with their construction. This acts as confirmation for the relevance of exploring the stakeholder analysis and making an attempt for building engagement strategies.

**The relationship between the project and the social, professional and scientific framework. Transferability.**

As a result of the sensitivity of the graduation topic and the global issue that it is dealing with, it has a significant social purpose. The societal concern and its potentiality has been the motivation for this project. It is dealing with questions like socio-spatial segregation, vulnerability to flood risk, exclusion through infrastructural availability. The aim is answering those questions through design proposals, which will not only improve the safety conditions in the region, but also will create additional benefits for healthy and just urban environments.

The context is facing adversity from two sides – one, is the fact that many spaces in the valley of Bandung are threatened by the constant risk of flooding, and second, the need of re-adjusting the built environment for meeting the expected growth in population. These two issues create a controversy in which the vulnerable population cannot be evacuated from their land because of the growing demand and higher costs, but it can no longer stay due to the life threatening conditions. Therefore, the design tries to balance those two extremes, by improving the vulnerability capacities of both physical and social systems, but recognising the importance of preserving the identity and value of the local spaces. Acknowledging the importance of the societal issues, the project is built upon the base of stakeholder involvement and decision making through all governance and social levels.

**Ethical dilemmas**

Comprehending the context as a foreigner always gives a bias and possibility of misreading behaviour patterns or processes. This is reinforced by the language barrier which creates limitations not only in the communication, but also for reaching to different sources of literature. Many of the publications that I found and use in the thesis are from the research from the western world – Japan, Netherlands, etc. This sets a certain tone to the inquiry, which I recognise as a weakness, but also something that cannot be overcome completely as the author of the project I am coming from a western country.

Going to the site visit, the purpose of all the meetings, interviews and informal talks was under the umbrella of the academic nature of the stay. This was only in favour of the project and responded well to the expectations that I had in the beginning. However, all communication was through a translator, hence, paraphrased and interpreted differently. I acknowledge this in my project and that is why the verification through additional theoretical perspective was vital, also in reversed manner – from theory to local experience.

The constrains connected to providing the cost-efficiency of the design proposal are present, despite providing with the intermediate step of the design, which uses the circular approach by creating a closed material loop using materials available on site. However, the bold proposal could be used as a starting point of a discussion, where the importance of safety is not overlooking the relevance of societal values and benefits. This is fundamentally important for bringing awareness and pushing forward new possibilities for accommodating to the change in today's world.

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# Appendix

# Ecosystem-Based Approach in a Densifying World

## Western Flood Risk Adaptation Model Transferred to the Context of Rapid Population Growth - Modifications and Controversy

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### Abstract

Climate change has put immense pressure on both social and physical systems all around the world. While there is growing amount of researches commenting on building capacity to overcome vulnerability to risk in the western world, there is a significant gap in connecting those practices to the specifics of the developing countries, although many of them are directly transferred into the context of densification and overpopulation. In this paper we explore the possibilities of conducting similar to the western ecosystem-based approach, but in a different socio-economic and nature setting, while overcoming its limitations. We investigate the causes and effects of risk vulnerabilities and how they define the adaptive strategies, based on the contextual factors that allow or constrain particular measures to be taken.

Key Words: climate change, vulnerability, flood risk, western model, developing countries, densification

## 1. Introduction

The traditional systems in today's cities are facing immense challenges driven by the global processes of climate change. In this context, integration and flexibility of the strategies coping with hazard exposure are critical for creating sustainable and safe urban environments. There is a need for better understanding of the driving forces of vulnerability in both social and physical systems. In the recent years, there have been many studies on these topics in the western countries, hence many practices emerging, which follow the goals of sustainable urban development and cohesion between nature and humans. The trends from the western adaptive approaches are directly transferred to poorer and less

developed societies. But in the context of rapid population growth and thus immense pressure to the territory, many of those practices fail to achieve their sustainability and safety goals. This paper tries to align the western ecosystem-based approach to the context of urban densification by adding additional variables and measures. However, this research is limited mostly to the risks and effects of flood exposure, thus there is a need of future research on the other extreme events that arise from climate change.

The paper is structured in six main paragraphs, coming from the introduction of the topic and specifics of the climate change and vulnerability components, going through the analyse of the western ecosystem-based model and stating the limitations that it meets in the context of developing countries. All this is followed by the paragraph exploring the possible transformations of the adaptation model and its enhancement for the framework of densification. The final paragraph states the conclusions and future explorations of the topic.

## 2. Climate change, Vulnerability and Risk

### 2.1. Climate change and Vulnerability

The impacts of climate change are already evident in many parts in the world. Countries from all around the world are in direct exposure to the global warming and rising sea level. However some of the countries are more likely to cope with the risks due to their advances in defence infrastructure, technology and stability of governance. Emerging vulnerabilities are associated with multiple factors like extreme drought or rainfalls, change in the precipitation, frequencies and intensity of storms, etc. The key, for overcoming those extreme vulnerabilities to climate change in any context, is the understanding of their causes and effects on the urban systems.

The literature review guided the alignment of the **definition** of "vulnerability" and helped establishing a position towards the components and measures that it is determined by. The term provides the "*entry point*" for the research on the significance of climate change (Adger & Kelly, 1999), but it also supports the understanding of the necessary tools for overcoming it. We find that vulnerability to climate change is the extent to which both social and physical systems at risk are able to sustain damage and to recover to their initial state. Many authors discuss the measures which define the vulnerability of a system. We perceive these factors as the link between socio-economic specifics of an area and the ecosystem context that they are based on. The authors Adger and Kelly argue that the ecosystem, and in particular the climatic and topographical factors, has more weight to the level of vulnerability of a society, due to the fact that they define the dimension of risk exposure. Even though, the socio-economics factors, like poverty, inequality or institutional context, have no direct implications, they can be the reason for the inability of a nation to respond to the extremes (Adger, Huq, Brown, Conway, & Hulme, 2003). Thus, we come to the idea that the vulnerability is assigned to a specific society and the conditions of the change of the environment can be taken as exogenous (Adger & Kelly, 1999).

Similarly, the components of the vulnerability to climate change also have many different views on their definition and understanding. For the purpose of this paper we take the framework from Rutger De Graaf as central and then associate the related topics of the findings of other authors. In his work De Graaf explains the components of vulnerability by the sequence of four building capacities – threshold, coping, recovery and adaptive, by which the term is defined. To illustrate his framework, the author uses a damage return period graph (Figure 1) and argues that for creating a thorough strategy for risk reduction and adaptation, attention should be paid on all levels of vulnerability.

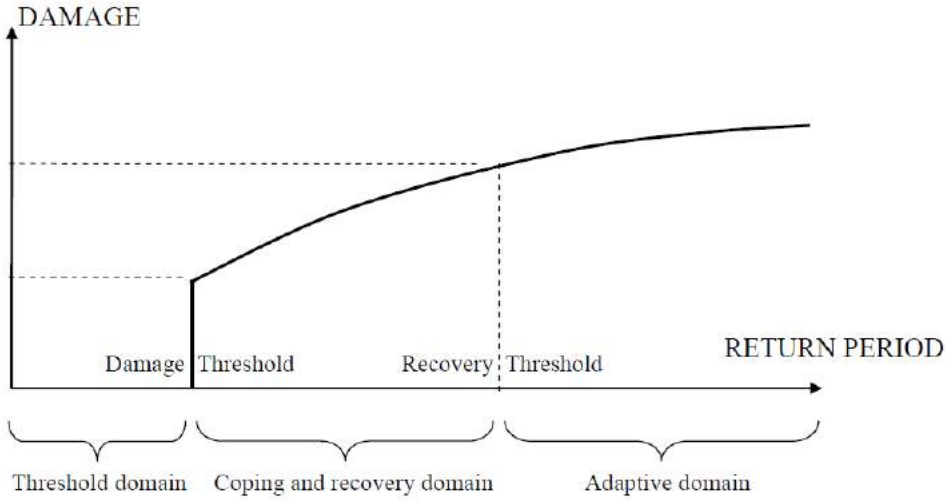


*Figure 1 Vulnerability Framework by Rutger De Graaf*

## 2.2. Vulnerability components

The ***threshold capacity*** of a system can be found in other researches as *exposure* or *sensitivity* of the system to risk (Adger et al., 2003). This is the physical setting and/or the existing defence infrastructure, which can be characterised with the location of the built system (floodplain, hill slopes, low costal zones, etc.) (Adger et al., 2003). The objective of the threshold capacity is to prevent risk and increase safety, therefore to enhance the ability of the society to avoid possibilities of damage (Juarez Lucas & Kibler, 2016). If we related it to the practice, this would be building of defence line, dikes, dredging of rivers to increase the flow capacity, floodgates, etc. These solutions are mostly engineered hard infrastructure, which needs special attention towards its construction and maintenance. Thus, the threshold capacity is highly dependent on the efficiency of the socio-economic and institutional structures, their abilities and resources (De Graaf, 2009).

The ***coping capacity***, referred to also as building *community capacity* or *decision making reinforcement (Huntjens et al., 2012),* reduces the damage during the extreme event, when the threshold capacity is surpassed. In practice it relates to the evacuation plans, emergency signals, organizational structure among inhabitants and institutions. The organization can be based on planned measures, considered and taken by the government in favour of the society, but also it can be self-sustained and managed by the people themselves (Adger et al., 2003) (Huntjens et al., 2012). The objective of the coping capacity is to develop the ability of reduction of the impacts from the risk event, which needs multiple actors to be involved in cooperation from the civic society, through the technical and emergency support teams, to government institutions (De Graaf, 2009). This aim has been elaborated by other authors as the need of social capital involvement, introduction of flexibility and innovation in the governance system and engagement of the private sector initiatives (Adger et al., 2003) (Otto-Zimmermann, 2011).

The ***recovery capacity*** is rarely discussed in climate resilient or adaptation studies, but still it can be found as the *potentiality* of a system to meet severe consequences of exposure and recover from the

stress (Adger & Kelly, 1999). The reality suggests that it is the capacity to rebuild and reconstruct damaged critical infrastructure, connections, housing, defence infrastructure, etc. The objective is to create a capacity to recover from the disaster event as quickly and effectively as possible (De Graaf, 2009). However, the potentiality to restore the previous order strongly depends on the abilities and financial stability of the institutions and socio-economic cohesion of the population (Adger et al., 2011). Rutger De Graaf also explains that the recovery time is not easily defined, as it may vary from weeks to decades, but once overcome, it makes the population more resilient towards similar extreme events in the future.

The ***adaptive capacity*** is the ability of a system to cope with uncertainties in the future. *Adaptation* is the adjustment of the systems to the extreme unpredictable disturbances, which occurrence is rare but effects are immense. In the framework of Rutger De Graaf, he argues that even though a system functions nowadays, there could be exogenous or endogenous factors that could put it under great risk, where examples could be climate change, rapid population growth and uncontrollable urbanisation sprawl. In those cases, the act of adaptation needs to be taken into consideration by society in general, based on the availability of resources like physical and technological capital, knowledge, institution flexibility etc. (Adger et al., 2011). Unfortunately, it is very difficult to address and define the actors for building the adaptive capacity, since the risk and impacts are in deep uncertainty. The objective of the adaptive capacity is building understanding and ability to foresee developments for the future in which the main goal is establishing robust and healthy living environment (De Graaf, 2009). Without such adaptation systems and planning, the society will come to a capacity *threshold* (Figure 1) to which recovery can no longer be possible (De Graaf, 2009).

| Component: | Related Terms: | Objective: | Duration: | Responsibility: |
|---|---|---|---|---|
| Threshold Capacity | Exposure Sensitivity | Prevention | Continues Practice | Socio-economic & Institutional Structures |
| Coping Capacity | Community Capacity Decision Making | Reduction | During Emergency | Local Society & Institutions |
| Recovery Capacity | Potentiality | Reaction | After Emergency | Economic & Institutional Structures |
| Adaptive Capacity | Adaptation | Anticipation | Future Envisioning | Undefined |

*Table 1 Description of the components of the vulnerability framework. Adapted from De Graaf, 2009*

Each of the above explained components of vulnerability has particular implementation in reality and most of the times identified responsible actors (Table 1). Some of them refer to a specific infrastructure based model (threshold capacity), others to more soft measures with policies and social reinforcement model (coping capacity), to the economic model for rebuilding (recover capacity) or to

flexible and robust urbanization model (adaptive capacity). For the creation of a resilient to climate change strategy we need to consider each of those components, and design respectively to their implementation models, but also identify how to connect them for obtaining the most advantages of the framework.

## 3. The Western Model

In the world, millions of people are affected by the consequences of climate change and the increasing natural disaster risk. One of the most frequent disasters, affecting the greatest amount of people is flooding. The western practice, a world known leader in flood protection, evolves through the structural vision of the water management. The objective is to reduce vulnerability through minimising the exposure, thus increase the threshold capacity of the system at risk (Juarez Lucas & Kibler, 2016).

### 3.1. Three water management approaches and a paradigm shift

We find that for the better understanding of the western model against flood risk, we need to follow the change in the water management system through time. In their book "Governance and complexity in water management", the authors Bressers and Lulofs are describing three phases of the evolution of water management for the past forty years. They guide us step by step to a paradigm shift in the understanding of the water management, but also understanding of the maintenance of ecological resilience for increasing possibilities for reaction to inevitable stress events. The first one, the *integrated water management* emerged in the early 1980s, when the water engineers found the need and possible infrastructure solutions to link the sub-sectors of the water system into a coordinated structure. This internal integration joined the groundwater, surface water, storm water, waste water and drinking water systems into one. The innovations in sewage and waste water treatment were substantial for the change in the water management (Bressers & Lulofs, 2010). The second, the *integrated water resource management* is the upgrade of the previous stage, and in it the integration is not only with internal, but also with external sectors of the society. This combined water management with agriculture, tourism, nature, economy, housing, transport, etc. This link gave the opportunity of the water management system to acquire knowledge on the change in the behaviour of different actors towards water (Bressers & Lulofs, 2010). And the third one, the *adaptive water management*, is the most recent innovation, which is seen as the opposing strategy to the context of knowledge and information gaps, and also uncertain actor-related dynamics. It recognises these imperfections and works towards overcoming the risks by developing management capacity – flexibility in institutions, resilience in the ecological systems, managing scenarios for avoiding disasters and their negative outcomes for the society (Bressers & Lulofs, 2010). This is also referred as the *ecosystem management* which builds upon the adaptiveness of the previous two stages and presents the paradigm shift of the western risk adaptation model *– the ecosystem-based approach.*

### 3.2. Ecosystem-Based Approach

The objective of the ecosystem-based approach is the reduction of risk by using the natural or constructed ecosystems as barriers and buffers to the hazard exposure (Kamble, Abhinav, & Thakare, 2013). In this approach there is a redefinition of the terms "nature" and "built infrastructure", combining them into "nature as infrastructure", a complex system of practices between urban planning, design, landscape ecology and engineering (Kuzniecow Bacchin, Ashley, Sijmons, Zevenbergen, & Van Timmeren, 2014). This approach comes as a counterpoint to the hard, fixed infrastructure solutions, dealing with short-term and long-term resource management, which provides multiple benefits for

both the ecosystem and the society (Bélanger, 2013). It constructs wetlands, grows forests, and protects costal systems to reduce the physical and socio-economic exposure to risk, but also has the complementary benefits of sustaining the natural balance in the system.

When we discuss the flood risk adaptation model of the western world, we come across different concepts that are grounded in this approach, but coming from various schools of thoughts, they often have diverse objectives. Concepts like "Design with Nature", "Nature as Infrastructure", "Infrastructural Ecologies", etc., all have the common feature of protecting and limiting land uses in the flood prone areas, in favour of the natural flows. One example of these concepts brought into practice is the "Room for the River" project in the Netherlands. This is a nature-based solution, which makes space for rivers to flood adjacent areas (their floodplains), which increases their retention capacity and therefore prevents critical infrastructure or society to be affected. All the actions that are taken are inspired or supported by the natural systems in the area (Kothuis, Brand, Sebastian, Nillesen, & Jonkman, 2015). To reflect on the vulnerability, we can conclude that solutions as the given example, are aiming at building the threshold capacity of a system, keeping the society safe from risk.

## 4. Context of Densification

While there is growing amount of researches commenting on concepts related to the ecosystem-based approach and soft measures towards resilience in the western world, there is a significant gap in connecting those practices to the developing countries, although many of those concepts and practices are blindly transferred into the context of densification and overpopulation. Issues like rapid population growth, urban sprawl and escalation of informal settlements, are only few of the problems that the developing world needs to face. On the other hand, these countries hold the most vulnerable places due to climate change and the hydro-meteorological hazards brought upon them (Djalante, Garschagen, Thomalla, & Shaw, 2017). In his research Adger argues that society's vulnerability is determined not only by the response capacity in the area, but mostly by the equal availability of resources for the individuals in the society. Inequality brings population to the most dangerous and dilapidated areas as their last resort for seeking opportunities in cities. Many times these are floodplains or landslides, and they can be the food and shelter resources for a large number of the population in the developing countries. Often the soft engineering measures based on the ecosystem approach, require more space for their implementation, however these risky areas sustain the livelihoods of the local societies and the exclusion of their direct uses is not always possible.

> *"Trends in altered and degraded river systems and potential impacts of climate change (…) may drive implementation of joint flood risk-ecosystem approaches in developing countries. The exclusion of direct human use of floodplains, however, may be a poor fit in the developing world. Rapid population growth and corresponding land pressure (…) may challenge practices based on 'keeping people away from floods' as people expand into marginal land such as floodplains." (Juarez Lucas & Kibler, 2016)*

Therefore the question remains, how to effectively transfer practices for flood risk adaptation into territories, where space, finances and infrastructure is limited, and governance and institutional flexibility is merely possible?

## 5. Practices Transfer – Advantages, Limitations and Transformations

In order to understand better the ways of flood risk adaptation methods, we use the Equation 1, which is based on a combination between several researches (Juarez Lucas & Kibler, 2016), (Merz, Hall, Disse, & Schumann, 2010) and (De Graaf, 2009). Risk can be measured through its function of the probability of flood hazard, combined with the vulnerabilities in the area; when vulnerability is determined by its four components of capacity building in the area – threshold, coping, recovery and adaptive capacity as explained above (De Graaf, 2009).

Equation 1:

$$Risk = f\,(Hazard + Vulnerability)$$

$$Vulnerability = f\,(Threshold\ Capacity + Coping\ Capacity + Recovery\ Capacity + Adaptive\ Capacity)$$

Reducing the risk means that there is a change in the vulnerability variables as the hazard exposure is unpredictable. Often in the western world, practices aim at enhancing only the *threshold capacity* for minimising the negative effects on the system. This is mostly done with practices such as "*building with nature*" (Kothuis et al., 2015) or projects like "*Room for the river*" (Sijmons, Feddes, Luiten, Feddes, & Bosch, 2017), in the example of the Netherlands, where the logic of structural solutions are combined with the forces of the natural system for safer environment. These examples rarely consider change in *any of the other* variables of vulnerability, as in this context, the urban development is limited to the assumption that it "*can only be achieved if the environment is fully adapted and modified to fulfil societal needs" (Juarez Lucas & Kibler, 2016)*. The assumption that is barely achievable in the developed world, meets a lot more challenges in the developing countries. This act of transferring policies and practices from one place in the world to another has great difficulties related to the rapid population growth, socio-economic inequalities and multiple vulnerabilities, which makes them inadequate and inefficient for most of their part.

However, we see a possibility for overcoming the limitations of the western model by considering change in the other variables of the vulnerability. A next step will be to enhance the *coping capacity* in the area (societal, economic, and governmental), not only will there be reduction of flood risk, but this could also lead to co-benefits for the area. This idea has been put forward first by the authors Juarez Lucas and Kibler, who argue that in a developing world a "*direct transfer of practices from developed countries that limit uses of flood-prone lands or constrict access to flood-adapted livelihoods may be unlikely to succeed*". Therefore, the authors propose a framework in which there are measures for supporting the natural ecosystem, but also securing the livelihoods within the floodplains by enhancing the performance of the society. The framework gives a central role to the assessment of the risk, but with that also to the co-benefits that the projects can provide without limiting the human activities within the flood areas (Juarez Lucas & Kibler, 2016). This idea can be used as a stepping stone towards the reduction of flood risk, but should not be taken as absolute.

In order to cope with the vulnerabilities of the urban realm – built and social, we need to take into consideration all the variables due to the fact that they are in a complex relation between each other. This means that "*increasing one vulnerability component could decrease one or more of the other components resulting in higher, rather than reduced vulnerability" (*De Graaf, 2009). In the conditions of the densifying world, building recovery capacity is strongly related to the economic conditions of the country (De Graaf, 2009), hence the execution is merely possible. On the other hand, the threshold

tolerance towards floods and hazards of the population in most cases is much higher than the one in the western world. The social conditions enables them to cope better physiologically in a moderate events of flooding. Therefore, if we use this advance, we can enhance easier the adaptive capacity of the population and further build upon a physical adaptiveness.

A strategy towards decreasing the risk of flooding needs a complete range of interventions, policies and infrastructure solutions for coping with the vulnerabilities. In the western world there are many social, economic, political preconditions that allow the focus to be just the threshold capacity, based on engineering solutions. The ability to build and maintain an efficient hard defence infrastructure is a main priority. However, in a densifying world, where the space and finances are limited, but the exposure to hazard is higher, these strategies should work in a direction of scope of coping practices. The climate change is evident and the uncertainties for the developing countries are growing faster, therefore special attention should be paid to all of the vulnerability components for an extensive risk management strategy building.

## 6. Conclusion

Overcoming the effects of climate change on the social and physical systems of the urbanised world requires deep understanding to the vulnerabilities and relevant measures. The definition of the term vulnerability and the classification of its components create an efficient framework for further exploration of the different risk management approaches in the world. This strong base enables us to estimate the advantages and limitations of the western ecosystem-based model for adapting to the climate change. The paper advances on coping with these limitations by understanding the need for holistic strategy building upon all the variables of vulnerability. However, this research does not focus on the standard approach of managing climate change consequences like resilience and sustainability. Though attempting to reduce the limitations on the western adaptation models transferred to the developing countries, it only concentrates on the flood risk exposure. Further researches are needed in the actual transfer of policies and governance that is usually combined with the specific risk adaptation models, which are essential part of the successful implementation afterword in reality.

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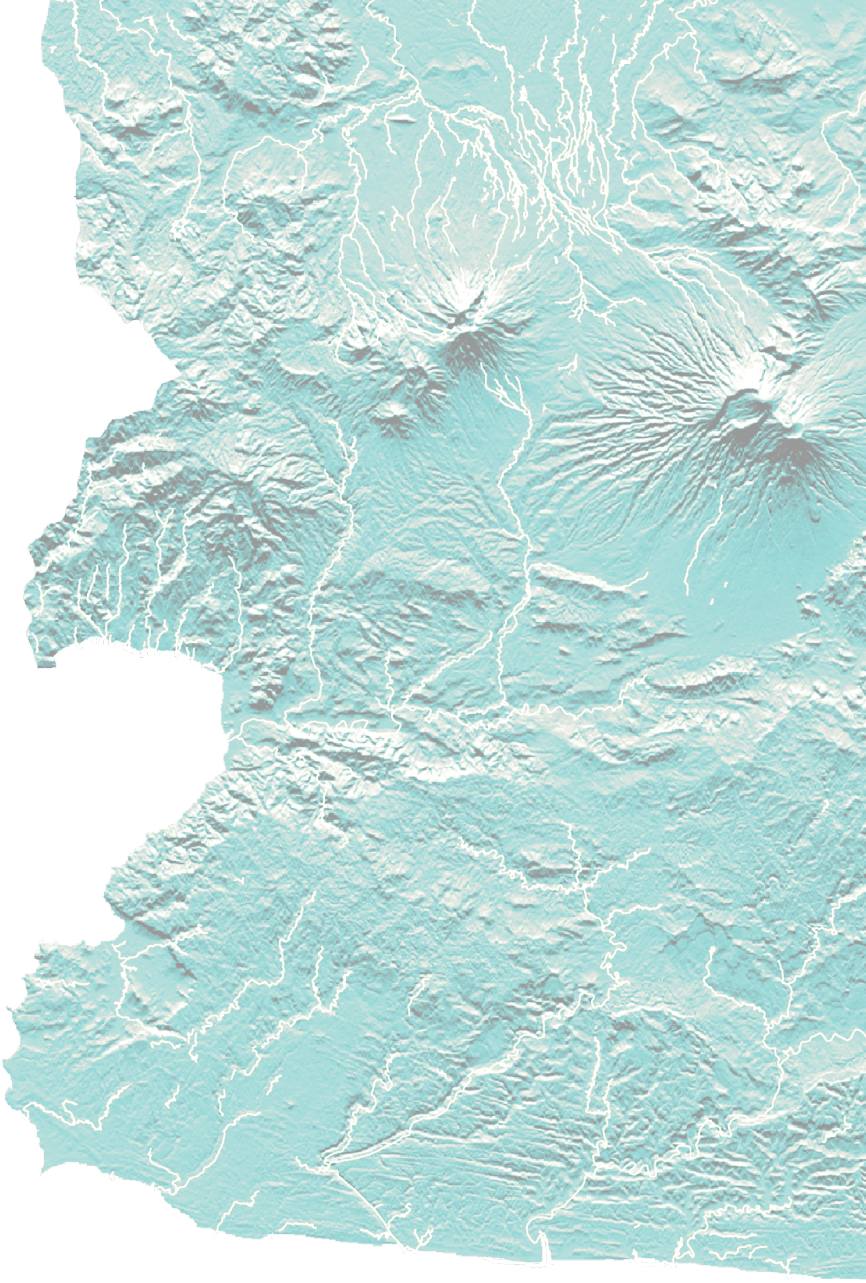

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