The sinking men

What kind of (sustainable) policy implementations are there available which seek to improve the quality of the living environment in areas affected by land subsidence.

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Bachelor thesis Geography, Planning and Environment

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Foreword

In my second year of the bachelor student of Geography, Planning and Environment I had a course, globalising worlds, were talked about the topic of land subsidence in Indonesia. I found it very fascinating. It was fascinating to hear how local inhabitants deal with effects of land subsidence. That is almost the only thing they can do, is to lift up their house. Another thing that intrigues me is that the sunken constructions form so to say a whole underground village. That seems to me not to be good for the environment, it is not sustainable. Therefore is this the origin of my interest for this thesis.

My thesis represents the knowledge I gathered in my years as a bachelor Geography, Planning and Environment student. This research compels to my interest about land subsidence, therefore I did research about the phenomenon of land subsidence in Semarang, Indonesia. Semarang was the place to be because the land subsidence rate is there very high. The city encounters the effects of land subsidence now for many years. I focused on sustainable policy implementations that could increase the quality of the living environment of the coastal urban area of Tambalorok. Nowadays one of the only ways for the local people to deal with the effects of land subsidence is to high up their homes. They will keep doing it until their home has sank to much that they have to rebuild it altogether. This is not good for the environment and the problem of land subsidence is with this measurement not solved.

To write this thesis was an adventure of its own, going to Indonesia was terrific. Therefore I want to thank Madeloes de Win and Hidde Hessling for accompanying me one this amazing trip. They helped me with my research giving me new insights, and helping me when I got stuck on something. Beside that I want them to thank them for the unforgettable experience we had together. Foremost I want to thank my buddy Alvin, he was very helpful in understanding the Indonesian culture. Especially for helping me doing research in a foreign country, because it was a bit different than doing research in the Netherlands. Thank you, for the translations otherwise my research would not have been possible. A special thanks to the UNIKA university for helping me in general, giving me the opportunity to do my research at the university. It helped me gather respondents and thank you Oely SidaBalok for getting the research starting. Foremost I want to thank Dr. Djoko Suwarno for the talks we had about my research. They were very helpful, guiding me to the right place. A special thanks to my brothers whom helped correcting my thesis on grammar errors. At last I would like to thank my supervisor Dr. Lothar Smith for the helpful remarks and feedback.

Anne Beune

Nijmegen, June 2019

Summary

The sinking men are the inhabitants of the city district of Tambalorok. This district is located in the coastal area of Semarang. Semarang encounters for a long time the effects of land subsidence.

"Land subsidence is the downward displacement of the land surface relative to certain surface, such as mean sea level (MSL) or reference ellipsoid, or relative to a certain assumed stable point" (Abidin et al., 2013a).

Tambalorok encounters the effects of land subsidence on a daily basis. The state of the infrastructure shows the direct impact of land subsidence. Land subsidence has influence on more than just the infrastructure, the indirect impact. The impact of land subsidence can be categorized in four categories. The four types of impact are: environmental, infrastructural, social and economic. All these impact have influence on the quality of the living environment of an area affected by land subsidence. The quality of the living environment is the way in which the physical environment has influence on the people living in the selected area . Policy implementation that could decrease the effects of land subsidence could increase the quality of the living environment. Nowadays, the way to deal with the effects of land subsidence is with short-term measurements. This is not sustainable because it are not measurements that tackle the causes of land subsidence. Those are measurements that only deal with the effects, but it will not provide structural changes.

Therefore the main research question is: *What are (sustainable) policy implementations that seek to increase the quality of the living environment in urban area of Tambalorok?*

To answer this question, there are three sub-questions formulated that will make it possible to answer the main question.

- What are the physical effects of land subsidence?
- What kind of sustainable policy implementations are there available for the effects of land subsidence?
- In what extent does land subsidence influence the urban coastal area of Tambalorok?
- How do the local inhabitants of Tambalorok perceive the quality of their living environment?

This research has been done with qualitative methods. The methods of doing interviews and observation were used to answer the research questions. Furthermore literature studies were done to form a theoretical base for this research. This triangulation will increase the validity of the research. The dynamics of policy arrangements was used to understand the governance behind the planning for the effects of land subsidence. The diagram shows the factors that influence the governance process.

The most of the people in Tambalorok work as fishermen. Their life is intertwined with the sea. That is the foremost reason why people stay in the Tambalorok district. They accept the effects of land subsidence. It is their way of life. The effects of land subsidence are quite noticeable in the area. It can be seen in the state of the infrastructure but also the cracks in house. But foremost the sinking constructions.

To increase the quality of the living environment there are a couple of approaches with policy implementations available. The 'waterproof' urban planning consist of implementations that embrace water in the urban planning. Building housing units for the population of Tambalorok with a deep foundation of at least 30 metres could help. One of the causes of land subsidence is the heavy weight of constructions on the fragile soil of Semarang. The soil

of Semarang is fragile because it is so young. Another cause of land subsidence is water withdrawal. There are already restrictions on water withdrawal, but a prohibition on taking deep water will be very helpful. A strict regulation on water withdrawal is an example of a policy implementation of the sustainable water management approach. At last planting mangroves will be beneficial. Mangroves form a natural water dam and can decrease the frequency of floods. This is beneficial for land subsidence because floods and land subsidence are linked.

To conclude the problems of the sinking men are very complex. It is much more than just the effects of land subsidence. They also encounter the effects of floods. That is not all, they live in insecurity. This has influence on their mindset, which is individualistic. The only thing they can think about is their house and that influences their way of life. So, to increase the quality of the living environment in Tambalorok the insecurity were the local population live in should be decreased. That could be done by dealing with the effects of land subsidence and floods.

Content

Chapter 1. Introduction

"Owning a home her is like renting a house .. so in few years they have to rebuild it. The have to build a new house, it is like renting a house"; middle aged female inhabitant of the subdistrict 16 (street interview 3).

The quote above describes the consequences of land subsidence in a honest way. People are subconscious and actively always thinking about their home. Lifting up their homes costs a lot of money and time but also gives insecurities. The picture on the front page represents the local inhabitants of Tambalorok. The statute is a personification of the people in the districts of Tambalorok. The statute of a local inhabitants was ones positioned above the ground. The local inhabitants are figurative sinking, because of worry and the consequences of land subsidence. Therefore the statute of the sinking man will represent the whole population. So it is not about the sinking man but about the sinking men. A way of pulling the population out of the ground is implementing sustainable policy implementation. The policy implementation in mind are focused on increasing the quality of the living environment. The research side is in Semarang, Indonesia. The research has taken place in a residential district in the coastal area of Semarang. The key concepts in this research will be land subsidence, sustainable policy implementations for land subsidence and the quality of the living environment.

This chapter is an introduction to the research. In the first part, the topic of this research will be introduced. The key concept of land subsidence is explained. Furthermore the research area is described. The specific residential coastal area that has been chosen for this research is furthermore elaborated in paragraph 3.5. Thereafter the research questions are mentioned and the sub questions. The arguments for the relevance of this research are also mentioned in this chapter. At last the structure of this research is described.

1.1 Framework

Environment and society are two factors that are always connected. Humans cannot live without the produce from the environment. The environment gives people a lot of opportunities. But the effects of the environment can also be of restrictive nature. This is the case for the city of Semarang, Indonesia. Semarang is a coastal city on Java. It is the capital of central Java province. Semarang is located on the northern coast of the Java Island. In 2004 the coastal city housed over 1,5 million people. It has been estimated that in 2025 there will be about 2 million inhabitants (Marfai, M.A. & King, L., 2007). The city is characterised by the hilly and coastal areas. This makes the city vulnerable for disasters including flood, storm surge and landslide. Beside that the area is also vulnerable to periodic drought.

Climate change is a problem the whole world encounters, that is effecting the problems that Semarang is already facing. Climate change can increase the intensity of these problems. Furthermore the sea level will be rising on the long term, this will also effect the city. This will be most problematic for the coastal area. Nowadays the coastal area is already often terrorized by floods. So even more rainfall will be problematic, an ACCRN-sponsored vulnerability assessment predicted more intense rainfall in shorter periods than experienced historically, causing perceptible and significant impact by 2020 (Sutarto, R. & Jarvie, J., n.d.). The city is not capable to manage that amount of water. Therefore the streets will be filled with water even more than nowadays. So the foremost problem that the city of Semarang has to deal with are the effects of flooding and land subsidence (Sutarto & Jarvie, n.d.).

"Land subsidence is the downward displacement of the land surface relative to certain surface, such as mean sea level (MSL) or reference ellipsoid, or relative to a certain assumed stable point" (Abidin et al., 2013a). Land subsidence can be caused by natural and/or human activities. Examples of natural causes are tectonic activity, volcanic activity

and landslide. There are also human activities that cause the land subsidence, like underground mining activities, excessive extraction of groundwater or oil/gas extraction, natural consolidation of alluvium soil and weight of construction. (Abidin, et al., 2015b). The extraction of water and oil or gas has the effect that the pressure in pore increases, therefore the sediments consolidates. This process causes the land subsidence. Land subsidence is most common in areas where the soil consist of clay, the soil of Semarang consist of that type of soil (Marfai & King, 2007). The land subsidence leads often to specific pattern of ground deformation. Therefore the buildings and underground infrastructures are under higher risks. Land subsidence is seen as a human-induced hazard (Feng et al., 2008). Because of population growth and urban development there are more buildings and construction on the soil. Furthermore there is more water withdrawal. In the case of Semarang there is a linkage between the increasing in water withdrawal and the growth of the population. This process has taken place since 1900 (Marfai & King, 2007).

Land subsidence is not a new phenomenon in Semarang. It has been happening for more than 100 years (Abidin et al., 2010). This natural phenomenon has influenced the city and the inhabitants of the area. The impact of land subsidence in Semarang can been seen in many forms. For example the wider expansion of (coastal) flooding areas, cracking of buildings and infrastructure, and increased inland sea water intrusion (Abidin et al., 2010). All these forms of impact influence the living quality of the area. The land subsidence has accelerated through the growth of the population and urban development. One of the reason is that the land use pattern and physical environment in Semarang has changed rapidly. These changes in land use were not always planned. There has been uncontrollable changes in the upland and lowland areas. It mostly problematic for the lowland area because the soil consist of clay and the most inhabitants live in that part of the city. The residential growth, industrial expansion and agriculture in the lowland area are main factors for land subsidence and the affected areas increase every year (Marfai & King, 2007). That is not the only problem, because of the land subsidence there have been a higher frequencies off floods. A part of Semarang is already located below sea level, through land subsidence that will only increase (Kuehn et al., 2010).

Land subsidence has influence on urban areas. A common way to deal with the losses caused by land subsidence is to high up residences and infrastructure. Inhabitants in areas affected by land subsidence have accepted their faith and high up their homes when it is needed (Sunarti et al., 2018). In Semarang home owners have to high up their homes at least ones every five years. Besides that it costs a lot of money, home owners have to live with and keep in mind that in the near future they have to high up their homes again. They have to keep that in mind, because they need to set money aside for when the times comes that they have to rebuild their home. That home owners have to do construction at least once each five years is not very sustainable. Not in the way of an investment, because the investment latterly disappears in the ground. The investment is not profitable. Besides that construction work disappears into the ground. Therefore the ground is stuffed with parts of houses and infrastructure. This is not a sustainable way, in sense of investment for home owners and in the way of making use of the environment. Therefore in this research there will be looked if there are sustainable ways to deal with the urban losses caused by land subsidence.

1.2 Research questions

Land subsidence has an impact on many aspects in society. The impacts of land subsidence have a huge impact on the life of people living in areas affected by land subsidence. People in those areas do everything they can to maintain their living environment. Besides inhabitants that are affected by the impacts by land subsidence, the government has a part in how to deal with the impact of land subsidence. A way for both parties is to deal with the impact of land subsidence to high up the home and the infrastructure. Those solutions are

temporary, because after a couple of years the houses and infrastructure have sunk down so much that the process of high up the constructions can be done again. This is not a sustainable way to deal with the impacts of land subsidence. Therefore the main focus of this research is, are there sustainable policy implementations for the impacts of land subsidence on urban areas. And can those policy implementations be implemented in the coastal area of Tambalorok, Semarang Indonesia. To answer these questions it is important to understand how land subsidence influences the urban area of Tambalorok. Besides that it is important to understand the process of land subsidence, and foremost the process of land subsidence in Tambalorok. In the urban area the focus will be on how the quality of life of the residents is affected. Furthermore, it will be explored if the sustainable policy implementations can increase the quality of life. Besides that it is important to now the policy that is made for the coastal area of Tambalorok. So the urban planning for that area will be investigated, when that is possible. The reason for that is to find out if the policy makers incorporated in their policy, measurements that will compensate for the losses of the quality of the living space caused by the land subsidence.

Therefore the main research question for this research will be: *What are (sustainable) policy implementations that seek to increase the quality of the living environment in urban area of Tambalorok?*

To answer this question, there are three sub-questions formulated that will make it possible to answer the main question.

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1.3 Scientific relevance

The reason why this research is scientific relevant is given by Athanasiadou and Sposito (2015).

"There is growing international acceptance on the inadequacy of conventional urban water systems to provide services and tackle climate change, yet there is limited understanding on the realization of a reform in mainstream policy and practice. The transition, from a socio-economically and engineered approach city, to a water-sensitive landscape approach requires changes in the way urban water systems are planned, built and managed. According to Dominguez et al., (2011), Ferguson et al., (2013) and Monstadt, (2009) [50] [51] [52], there is limited academic and practical understanding for this large scale endeavour" **.**

This research can contribute to increase the knowledge about sustainable policy implementations for the effects of land subsidence. When those sustainable policy implementations are qualified as water-sensitive landscape approach than this research will contribute to the limited academic and practical understanding of the switch to a water-sensitive landscape approach from a socio-economically and engineered approach city.

Monstadt (2009) states the following:

"It is thus argued that we need adequate conceptual approaches which reflect the complex interdependencies between cities, networked infrastructures, and urban ecologies and which broaden our understanding of the ways we can develop, govern, and renew our infrastructures in cities in a sustainable way."

In the paper from Ferguson, Frantzeskaki and Brown (2013) called 'Landscape and Urban planning', they stated the following. "There is now growing international acceptance

that strategic planning of urban systems needs to increase the resilience of infrastructure, ecosystems, community and the economy by adopting an adaptive paradigm that embraces uncertainty and complexity and provides adaptive capacity through flexibility, diversity and redundancy in its solutions (Ahern, 2011; Brown, 2012; Dominiguez et al, 2009; Lessard,1998; Wollenberg, Edmunds & Buck, 2000)".

A big problem besides the sinking of constructions is the sinking of the infrastructure in areas affected by land subsidence. Therefore is planning and development of infrastructure in a sustainable way beneficial for this research. Because of that this research can contribute in increasing the knowledge about sustainability and the planning of urban infrastructure. There is enough theoretical background about water-sensitive landscape approach and sustainable urban planning but there are not many papers talking about the implementation of those approaches. Especially papers about implementing sustainable policy implementations for the effects of land subsidence. Because of that reason this research will have a scientific relevance.

1.4 Societal relevance

A couple of scholars have called land subsidence a silent hazard. Aldin, Andreas, Gumilar, Sidiq and Fukuda mentioned it in their paper: "a large number of population are exposed to this silent disaster" (2013). In a paper about 'Environmental impacts of land subsidence in urban areas of Indonesia', the authors called this hazard also a silent hazard (Abidin et al., 2015a). There are already many publications about land subsidence in Semarang, but still people call it a silent hazard. Therefore the relevance for the civil society is that with this research, will give attention to this silent hazard.

Various scholars have mentioned that the impact of land subsidence has economic consequences. "The impacts of land subsidence in urban areas are quite numerous and the resulting losses cannot be underestimated"(Abidin et al., 2014).The urban infrastructure, including buildings, roads and train rails, are affected. The damage that is cost by the hazard has to be repaired. Otherwise the living conditions of the people in the area will decrease. But water is an aspect humans cannot live without. Water is often called friend but also an enemy. A city has to deal with water issues, but water also has to be incorporated in the city. The city should not only fight with water and its consequences but embrace the possibilities that the access to water gives humans. In planning water and its consequences like land subsidence or floods are not always incorporated on the right way. "Land subsidence is usually forgotten in assessment and modelling of flooding and inundation in urban areas"(Abidin et al., 2015b).

"Nowadays, the challenge of urban research is raising concern to the prevalent demand for landscape and for a safe and better future of cities, the one strictly related to the other and, both, to the matter of ecology" (Athanasiadou & Sposito, 2015). This research will contribute to raising awareness of the scarcity of land and keeping the city same. The scarcity of land leads to more people living in the coastal area and that causes other problems that has influence on the safety of the inhabitants. In this case safety in the form of urban safety, the quality of the living environment.

Besides that the literature that has been read for this research is mostly very technical. This research will not be technical, this research will have a social approach. It will have a social approach because of the theories that it is based on. None the less it will take into account the technical part, because that is necessary to understand the problem at hand. But it will use the social approach to investigate what the consequences of land subsidence are for the people living in areas affected by land subsidence.

1.5 Structure

In chapter two the main theoretical concepts are elaborated. The key concepts will be explained, consisting of land subsidence, the quality of the living environment and

sustainable policy implementation for land subsidence. The conceptual model will also be presented in this chapter. After that in the chapter about the methodology the choices wich were made about the research strategy and material are explained. Also the way the data was analysed will be explained. The research area will be elaborated, why that part of Semarang has been chosen. The results of this research are presented in three chapters. In the fourth chapter the focus will be Tambalorok and how the local inhabitants encounter the effects of land subsidence. Following is a chapter about the four impacts of land subsidence in Tambalorok. After that in chapter six the sustainable policy implementations that could be beneficial for the research area are mentioned. The result will contain the observations that have been done and the interviews that have taken place. Besides that in these chapters the sub-questions will be answered. At last there will be a chapter that consists of the answer of the main research question. Also the recommendations and reflection will be presented. Finally, the references and reflections are presented.

Chapter 2. Conceptualising land subsidence

As Abidin et al. (2014) stated the impact of land subsidence are quite enormous. These impacts can be categorized in four types of impacts. All of those four types of impact will be explained. What they entail and how the impact can be seen in an urban area. In the quote of Athanasiadou and Sposito (2015) used in the previous chapter they mentioned that there is a need for reform in the mainstream policy and practice for urban water systems. The investigation about possible policy implementations for land subsidence can satisfy a part of that need. In the second paragraph of this chapter the policy implementations for land subsidence are investigated. This has been done on the basis of three approaches. Following the dynamics of policy arrangements is explained. This approach makes it possible conceptualise the aspects that have influence on the policy process. This knowledge is beneficial for further recommendation for policy implementations. At last the conceptual model that is the base for this research is presented. It shows the key concepts and their relationship with each other. The underlying processes in the conceptual will also be explained.

2.1 The four impacts of land subsidence

Land subsidence does not only impact the inhabitants of the area but it has an effect on a couple of other factors. It impacts the urban area, the impact can be categorized into infrastructural, environmental, economic and social impact. The effects of land subsidence can already be seen in the urban environment. A couple of examples are: cracking and damage of housing, buildings and infrastructure, wider expansion of (river and coastal) flooding areas, malefaction of drainage system, change in rivers, canals and drain flow systems and increased sea water intrusion. There can be concluded that land subsidence will increase the maintenance and rehabilitation costs for the affected environment, buildings and infrastructure (Abidin et al., 2015a). The effect of land subsidence on the infrastructure, environment, economy and social life can been seen directly and indirectly.

The *environmental impact* is an indirect effect of land subsidence. The impacts are mostly caused by lowering down of land surface and malfunction of river, canal and drain flow systems due to subsidence phenomena. An environmental impact of the subsiding land are floods. Because of land subsidence the flooded areas can increase. A consequence of that is that the inland sea water intrusion will increase. Other examples of the visible environmental impact are inundated areas and infrastructures followed by changes in river canal and drain flow system. Besides this there is a general deterioration in quality of environmental condition in land subsidence affected areas. The environmental impact of land subsidence is usually underestimated. That is because of that the impact has mostly an indirect effect. But the environmental impact has influence on the other three impacts. It has influence on the infrastructural, economic and social impact of land subsidence. That shows the importance of the environmental impact. The environmental impact is not directly visible and therefore it takes longer to have a response or solution for those problems. By the infrastructural impact is that not the case, there the impact is directly visible in the urban environment. The consequence is that the effects of the environmental impact already influence the daily life of the local inhabitants in a bad way. The measures to deal with the problems caused by the environmental impact are long-term measurements. The focus in coastal areas that are badly affected by the subsiding land is on short-term solutions. This shows a gap, it could explain why the environmental impact is underestimated. The effects of *infrastructural impact* are the ones that can be solved with short-term solutions. The foremost reason for that is because the infrastructural impact is the most noticeable in the urban areas (Abidin et al., 2015a). Infrastructural impact can be seen in ways as cracks on infrastructure. In combination with floods it will worsen and will result in that it could be a real disaster. These infrastructural cracks will eventually become a real danger. Because

damages on roads or bridges can be dangerous for transport (Andreas et al., 2018). The mobility of people is also impacted by the infrastructure that is damaged by the subsiding land. The accessibility of the road can decrease, therefore the mobility of local inhabitants decreases. This has effects on many things like running errands. This has an effect on the social life of people. Also the infrastructural impact has influence on the economic impact (Abidin et al., 2015a). When the mobility of people decreases they can in the worse case not go to work. Access to the local market can decrease, that will influence the local economy. Besides that the *economic impact* is huge, the costs that have to be made to compensate for the losses caused by land subsidence are enormous. It costs a lot of money to fix the problems of land subsidence (Andreas et al., 2018). It is not only the economic consequence to rebuild the urban area, but the local inhabitants have to save for the possibility to high up or rebuild their houses. Therefore they have to make financial choices that can have big consequences. Besides that the maintenance costs are higher in areas affected by land subsidence than in a normal situation (Abidin et al., 2015a). The environmental impact besides the economic and infrastructural impact also influences the social impact. The *social impact* has only influence on the economic impact. The state of a home says a lot socially. It is quite visible which households have more money to spend on the renovation of their homes. Those homes are of better quality and are higher. The environmental impact can have consequences for the health of the inhabitants of the area affected by land subsidence and so influences the social life of local inhabitants. The influence on the mobility of people also has influence on the social life of people. Inhabitants could get isolated, socially when they could not pay to lift up their homes. When they have bad access to the road they cannot leave their homes and that has consequences aswell.

All these impacts together have influence on the quality of the living environment in the urban area. The quality of the living environment is influenced by health and sanitation in an urban area. When those factors are not good the quality of the living environment will be lower than in areas where those factors are of good quality. Therefore the social and economic life of the inhabitants is influenced. The living conditions of the affected population are deteriorating. Besides that the quality of their social and economic activity is consequently decreasing as well (Abidin et al., 2012). The impact of land subsidence can be so bad that inhabitants of affected areas have to evacuated. The permanent land subsidence is so bad that the urban area is sinking in the sea and therefore the area is not liveable anymore (Andreas et al., 2018).

All the factors are closely linked, that makes it a problematic matter. In figure 1 the inter-relationship between the environmental, infrastructural, economic and social impact of land subsidence is shown. To fully understand the matter, people should know about this inter-relationships between the four impacts of land subsidence and the quality of the living environment. (Abidin et al., 2015a).

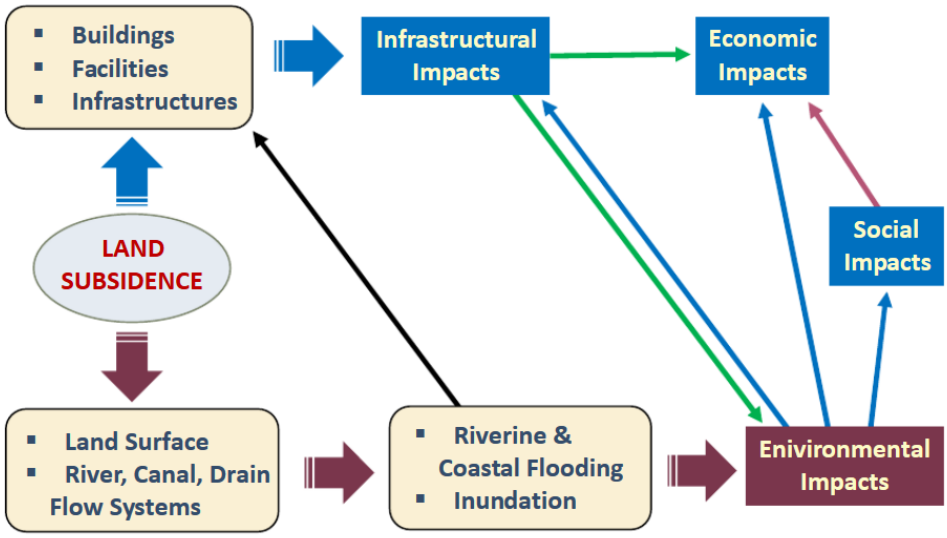

Figure 1: Land subsidence impacts and its connection system (Abidin et al., 2015a)

2. 2 Sustainable policy implementations

The phenomenon of land subsidence cannot be ignored. The spatial planning should respond and incorporate the effects and the possibilities to increase the quality of life in their policy. For now the focus in Indonesia is on short-term measurements to mitigate the effects of the disasters. Examples of short-term measures that Andreas et al. (2018) have given, are: building temporary dykes, fixing or elevating roads, repairing houses and land and also includes building up mangrove areas in the coastal area. Steenfelt (2019) presented three approaches that are useful for cities who deal with the effects of land subsidence. Those approaches linked with long-term measurements to mitigate the effects of land subsidence present by Andreas et al. (2018) are concrete ways to deal with the effects of land subsidence.

Steenfelt (2019) stated that there are three types of ways to prevent cities form sinking. Those types of prevention mechanisms are for the long term. The first category is *sustainable water management*. Land subsidence is in most causes caused by excessive amount of deep water withdrawn. Because of the water withdrawal there is an empty space created in the ground. Because of that the ground can move downwards. One way to decrease the land subsidence is to reduce the amount of water that is withdrawal. A sustainable water management can be a solution for that. Because of the growing population and the scarcity of drink water, good management for even distribution of drink water is necessary. Good sustainable water management could decrease the amount of water withdrawal. Because of that approach the drinking water will be evenly distributed and therefore people do not have to withdrawal that much water from the ground (Steenfelt, 2019). Therefore a long-term mitigation measurement is stopping groundwater extraction. In Singapore is for that reason the extraction of ground water prohibited (Andreas et al., 2018). The second category consist of *restoring water ecosystems*. Besides reducing water withdrawal maintaining the underground water level is very important. A way to prevent the ground from sinking is to build groundwater tables. This is a challenge for most cities nowadays, because of the amount of brick that is used in urban areas. Because of the brick use the rain water disappears in the city swage system instead of the ground. Therefore less water can infiltrate into the ground, thereby the ground water level cannot increase. A way of increase the rain water infiltration into the ground is by creating more open green spaces. The water can easily infiltrate in open green areas. The result will be that the ground water

level will increase and the city sewage system has less rain water to deal with. Therefore is there less chance on over spillages out of the city sewage system (Steenfelt, 2019). Another way to maintain the ground water levels is by artificial recharge of the water (Andereas et al., 2018). That can be done by refilling the water quell with waste water that has been cleaned (Steenfelt, 2019). The last category is *'waterproof' urban planning*, this category focusses on ways to embrace water in the urban area instead of fighting against water. This type of urban planning focusses on that cities do not sinks. Besides that they find ways to cope with incoming water. One of the crucial things for cities that are affected by land subsidence is protecting the shorelines, to prevent that the sea takes over the city. Cities in coastal areas that encounter the effects of land subsidence most of the times also have problems with the incoming sea water (Abidin et al., 2015a). The theoretically spatial relation between land subsidence in an urban area and flooding in a certain location can create a real disaster (Abidin et al., 2015a) (Andreas et al., 2018). The flooding problem may increase if there is a significant linear rate of land subsidence in coastal areas also affected by floods. So the flooding problem can be reduced when land subsidence is stopped. Because the infrastructure and constructions would not be at the same height as sea level or even lower than the sea level (Andreas et al., 2018). But it is also the other way around, flood prevention will help for land subsiding. It is very important with policy implementation to take into consideration that floods and land subsidence are linked. Therefore a long term solution can be building a giant sea wall. Because of that the water can be kept out of the city. Also compensated foundations could reduce stress on the cities soil (Andreas et al., 2018). Mangroves could also be helpful. More greenery in a urban area is always good. But mangroves have special features that are very helpful for the flooding and land subsidence problems. Mangroves can prevent erosion, because the keep the soil together with their roots. Besides that mangroves can prevent flooding, because they can feature as a natural sea wall.

2.3 The dynamics of policy arrangements

Land subsidence is a phenomenon that influences a lot in societies that are affected by this hazard. To deal with the consequences of the subsiding land the municipality of the area that is affected has policies. Policies can be influenced by a couple of aspects. Those aspects are resources, actors, rules and discourses. These aspects form the dynamics of policy arrangements. The diagram shows the aspects that have influence on policies and vice versa. The name of the approach says it all, it is dynamic process. (Arts & Leroy, 2006). Examples of resources are knowledge but also money. Resources are one of ways that actors can have influence on the policy domain. Actors are all the people that are evolved in the policy domain on a specific matter at hand. Discourses form the content of the policy. It is also the way in which the actors give meaning to the policy. Rules are the formal and informal agreements and interaction rules between actors. The dynamics of the policy arrangements is an institutional approach that is developed to describe the changes in the content and organisational characteristics of policy domains (Wiering & Immink, n.d).

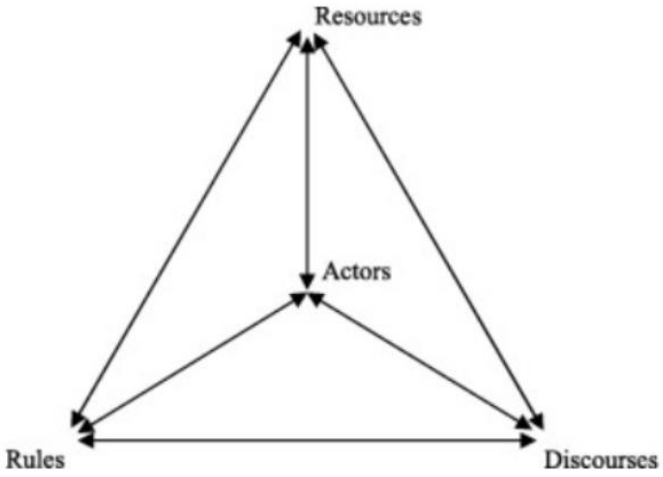

Figure 2: Dynamics of policy arrangements (Arts & Leroy, 2006)

Policies are influenced by societal phenomena, examples are globalisation and individualisation. All those phenomena influence the relationship between state, civil society and the market. This is a dynamic process, because state, civil society and the market are always changing. The change on one party has influence direct or indirect on the other parties. There are closely linked. To investigate a dynamic of a policy arrangement, the definition of this approach has to been know. The definition is, the temporary stabilization of the content and organization of a (...) policy area or a part of to be defined (Arts & Leroy, 2006). The dynamics of policy arrangements approaches is there to make a link between daily policy processes on one side and social and political development on the long-term other sides (Personal communication, Mark Wiering, 2018). Besides that it shows the interaction between the actor and the structure. The actor acts in the structure, but is also influenced by the structure.

To fully understand the dynamics of policy arrangements the concept of institutionalism has to be understood. Each policy domain has his own origin and own institution. They want to protect them. The institution could be turning points. Intuitionalism is the process were the behavior of people becomes a pattern. In case of policy it means that problem definitions and solutions are gradually stabilized. There meaning will show consistency, which makes working with them easier. The definitions are known, that leads to a particular divisions of tasks and interaction between actors. The policy processes development through particular rules (Leroy et al., 2003). The effect of institutionalism on policy content and organisation is that it will gradually structuration and stabilisation are achieved. This is one side, because policy content and organisation subjected to continuity of change. Institutions are also subjected to change besides there stable character. The change leads to the need for adaptation that comes from the change.

The main purpose of the dynamics of policy arrangement approach is to understand the constant stability and change. Also to grasp the institutionalisation of the policy arrangements and the understand the underlying mechanisms. Necessary is to search for an explanatory mechanism between the strategic actions of the partaking actors. One side it is important to understand the comprising and structural processes of society and the political changes. Because this all will have influence on the policy.

A policy domain can be analysed with the dynamics of the policy arrangements. This makes it possible to better grasp the underlining factors that have influence on a policy. That knowledge could help with making policies (Wiering and Immink, n.d.). When the diagram of the dynamics of policy arrangements is filled in for Semarang a complex process is conceptualised. This makes it easier to grasp the process. The gathered knowledge makes it possible to look into the four factors of the dynamics of policy arrangements that have

influence on policies in Semarang. This could help with recommendation for sustainable policy implementations. It will be known in which parts changes are needed or what parts withhold change. A right responds could be given in the form a policy.

2.4 Conceptual model

The conceptual model (figure 3) displays the key concepts and their relationship with each other. Land subsidence is the key concept in this diagram. Besides that sustainable or/and long-term policy implementations and the concept of the quality of the living environment are of importance. The other concepts that take part in the diagram have influence on the concepts that are just mentioned.

Land subsidence has a couple of causes. The causes for land subsidence in Semarang are the weight of constructions, the deep water withdrawal and the type of soil. The soil in Semarang is very young, especially in the coastal area, that makes it very fragile. Land subsidence has impact in different forms. In the literature there has been made a distinction between environmental, infrastructural, economic and social impact. Those four impacts influence the quality of the living environment. The living environment consist of the living space of inhabitants in an urban setting. Among the living space in an urban setting is the public space, often managed by the government. But the residences of the inhabitants are also included in the living space in an urban setting. The concept also consists of the ability of people to act in the urban area. That is why the social impact is of matter. The mobility of inhabitants in an urban area is of importance for the quality of the living environment. To sum up, the quality of the living environment is how the life of the local inhabitants is influenced by the physical environment they live in. Land subsidence influences, through the four impacts, the quality of the living environment. The quality of the living environment could increase with implementing sustainable or/and long-term policy measurements. Available policy implementations for the effects of land subsidence could be categorized in three approaches. Those approaches are sustainable water management, restoring water ecosystems in cities and 'waterproof' urban planning. These approaches provide measurements for the effects of land subsidence. Furthermore they form a framework in which new measurements could arise.

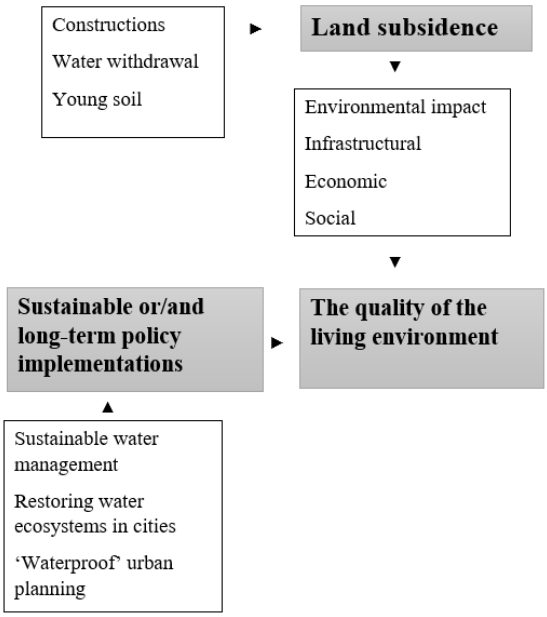

Figure 3: Conceptual model

Chapter 3. Methodology

In chapter two the key concepts and theory are explained. The focus for this chapter are the choices that are made about the way of doing the research. The research questions will be answered with qualitative methods. The methods that will be used to answer the research question are to generate primary and secondary data. The primary data will be conducted through interviews with experts. Furthermore the fieldwork that has be done, will contribute to the primary data. The interviews with the local inhabitants will also contribute to the primary data. The secondary data is conducted through literature studies. These methods are useful for doing research in the coastal area of Semarang. These methods make it possible to fully understand the situation.

First off, the research strategy is elaborated. In this paragraph the choices that are made about the research strategy are explained. This will be done by the method provided by Verschuren & Doorewaard (2007). After making the three crucial choices, provided by Verschuren & Doorewaard, the research strategy will be explained. In the second paragraph the focus will be on the research material. What is the research material and how is it conducted. Also for each sub-question the methods are mentioned which are used to answer the question. At last is there a paragraph about the data analysation, how will the data be analysed and the choices that are made about the way to transcribe. In this chapter there will also be a short note about the research site.

3.1 Research strategy: Case study

Verschuren and Doorewaard (2007) described in their book 'Designing a research project' that it is very important for a researcher to make a good technical design of the research. Therefore the research strategy is very important and the choices that are made should be elaborated. To choose a research strategy three important choices have to be made. The first one is, will the research be in-depth or a broad research. After that, choices have to be made about which type of research methods there will be used. Lastly, it must be decided in which way the data will be collected.

This research is an in-depth research. One of the reasons for this decision, is that it was not possible to do a broad research because of the time that was given. Besides that, an in-depth research gives the opportunity to investigate the problem in a precise way. Therefore it was possible to speak with many people, not only inhabitants of the research area but also government officials. Because of that the problem at hand could be looked at different angels. This gave a more precise view of the problem in the research area.

The second question at hand is, which research method will be used. For this research the method of qualitative research has been chosen. The tools provided by the qualitative research method are tools that serve the research interest. These tools are the best for answering the research questions. With the methods that are available it is possible to investigate the research area precisely (Creswell, 2007). A characteristic for qualitative methods is that the researcher does the research in natural setting of the respondents or the area (Creswell, 2007). That makes it is possible to have face-to-face interaction over time. That is the case for this research, the fieldwork and the expert interviews have taken place in the research area. Another characteristic is that the research question will be answered through different kinds of data (Creswell, 2007). The data that is gathered are primary and secondary data. The primary data will consist of expert interviews and observations of the research area. The secondary data is gathered through literature studies. The relevant literature is collected through the snowball method, thus looking for relevant literature in the references of other literature. The literature study is the theoretical base for this research. The triangulation is important because it increases the validity of the research. Because of the different forms of data collection the research findings can be compared. By using different ways for data collection it is possible to investigate the problem at hand from

different point of views. Therefore the conclusion in the end is more reliable because the problem is looked at from different angles. Therefore the research is not heavily influenced by one perspective. The conclusion will be made based on all the different types of data and therefore the conclusion have a higher validity (Vennix, 2016).

The final question that has to be answered is in which way the data will be gathered. This is an important question to be answered because it influences the choice of research strategy. For this research the data that is used to answer the research questions is gathered through fieldwork. The fieldwork consist of interviews with local inhabitants and government officials. Besides that the data also consist of multiple observations. Additional data is gathered through literature studies. This is necessary for the theoretical base of the research.

After making all these choices the research strategy that has been chosen for this research is a case study. This type of research method fits the best by the research question. This is because of the bounded system and the in-depth data collection through multiple sources of information (Creswell, 2007). The research is a single instrumental case study, because the focus is on one particular issue and area. Besides that the bounded case that is selected is used to illustrate the issue at hand (Creswell, 2007). The bounded case is, the district of Tambaklorok in the coastal area of Semarang Indonesia. The issue that is investigated, is how does land subsidence influence the quality of living environment in the urban area of Tambaklorok. After doing observations in a large part of the coastal area of Semarang, the district of Tambaklorok seemed the most suitable for the research. More precisely the districts 12, 13, 14, 15 and 16. That are the sub-districts that were the main focus for this research. Later on in this chapter, the reasoning for choosing those subdistricts will be explained (in paragraph 3.5). An even more precise description of the research area can be found in paragraph 4.1. Besides doing observations in the research area, also data gathering has been done through street interviews with local inhabitants and interviews with government officials. For sampling of the expert respondents the method of snowball sampling has been used. This method has been used because of the lack of knowledge of that area. Using the network of the experts gives the opportunity to speak with relevant other experts. The sampling method for the interviews with local inhabitants was to speak with people who were on the street. Therefore the group of respondents is homogeneous. Not many people form the working class were included in this research because of that reason.

3.2 Research material

One of the important things to have completed before gathering research material is to define and operationalise the research question (Verschuren & Doorewaard, 2007). This necessary for finding the right methods to answer the research questions. In which way will the data be gathered and whom will contribute to this process? That are questions that are crucial for this process in the research. First of all it is important to know the research area, Tambaklorok, because the research area is the base of the research. After that it is possible to decide the research objectives, the people whom will be interviewed.

The base for the observation was a framework provided by Abidin et al. (2015a). The framework is an operationalisation of the four impacts of land subsidence. The four impacts, infrastructural, economic, social and environmental, have influence on the quality of living environment in urban areas. This framework is used because Abidin et al. (2015a) described in a precise way in which way each of the four impacts have influence on urban areas.

No.	Category	Representation of impact	Level of impact
1.	Infrastructural	cracking of permanent constructions and roads	direct
		tilting of houses and buildings	direct
		'sinking' of houses and buildings	direct
		breaking of underground pipelines and utilities	direct
		malfunction of sewerage and drainage system	indirect
		deterioration in function of building and infrastructures	indirect
2.	Environmental	changes in river canal and drain flow systems	indirect
		frequent coastal flooding	indirect
		wider expansion of flooding areas	indirect
		inundated areas and infrastructures	indirect
		increased inland sea water intrusion	indirect
		deterioration in quality of environmental condition	indirect
3.	Economic	increase in maintenance cost of infrastructure	indirect
		decrease in land and property values	indirect
		abandoned buildings and facilities	indirect
		disruption to economic activities	indirect
4.	Social	deterioration in quality of living environment and life (e.g. health and sanitation condition)	indirect
		disruprion to daily activities of people	indirect

Figure 4: Characteristics of land subsidence impacts (Abidin et al., 2015a)

Besides using this framework provided by Abidin et al (2015a) for theoretical base, it also made it possible to look with an objective mindsets to the research area. By looking at the research area with the framework in mind it was possible to look with a particular mindset at the research area. Two observations have been done in Tambaklorok. One observation has been done in a larger part of the coastal area of Semarang. After that observation, the research side has been chosen. The reason for multiple observation was to get a complete view of the area. Besides that, doing an observation in mulitple parts increases the validity because the view of the area is not based one observation (Vennix, 2016).

Alongside observation deciding the research objectives is crucial. Which respondents will be part of the research. The method of interviewing was the form of semi-structured interviews. An interview guide will form the base for the interview. The interview guide is so formulated that there is room for probing. That is the main reason why the form of semi-structured interviews has been chosen. For each interview there has been made an unique interview guide. This gives the possibility to make full use of the expertise of the respondent. The respondents for this research are fifteen street interviews, five interviews with government officials and two experts. The street interviews consists multiple times of more than one person. The interview guide for the street interviews was very short, because there was space left open for probing. Figure 5 will display all the interviews that have contributed to the research.

Date	Type of interview	Function	District
04/04/2019	Government official	Employee planning department Semarang	
09/04/2019	Government official	Secretary of Tambaklorok	
09/04/2019	Government official	Head of sub-district 16 Tambaklorok	16
09/04/2019	Street	Inhabitant, home owner (2)	16
09/04/2019	Street	Inhabitant, home owner (1)	16
09/04/2019	Street	Inhabitant, home owner (3)	16
09/04/2019	Street	Inhabitant, home owner (1)	16
09/04/2019	Street	Inhabitant, home owner (1)	16
09/04/2019	Street	Inhabitant, home owner, Local business owner (1)	16
10/04/2019	Street	Inhabitant, home owner (4)	12
10/04/2019	Street	Inhabitant, home owner (1)	12
10/04/2019	Street	Inhabitant, home owner (2)	13
10/04/2019	Street	Inhabitant, home owner (8)	13
10/04/2019	Street	Inhabitant, home owner (4)	15
10/04/2019	Street	Inhabitant, home owner (1)	15
10/04/2019	Street	Inhabitant, home owner (2)	15
10/04/2019	Street	Inhabitant, home owner (1)	15
10/04/2019	Street	Inhabitant, home owner (1)	15
11/04/2019	Government official	Employees planning department Semarang (3)	
13/04/2019	Camar	Employees Camar (4)	16
15/04/2019	Unika employee	Civil engineering	

Figure 5: Respondents

3.3 Research methods

In this part the research methods for each research question are elaborated. Which data will be used to answer the question and which respondents are spoken with.

The main research question - *What are (sustainable) policy implementations that seek to increase the quality of the living environment in the urban area of Tambalorok?* – will be answered with the answers on the sub-questions. Also with gathered primary and secondary data. The sub-questions are an operationalisation of the main research question. That is why the sub-question ranged in this way.

First off all the key concept of the research has to be understood. That is the reason why, "What are the physical effects of land subsidence?" is the first question. To answer this question primary and second data will be used. The primary data consists of the interview with Djoko Suwarno. He explained what the process of land subsidence entails. Besides that he talked about land subsidence in Tambalorok. Furthermore the literature is used to grasp the concept of land subsidence.

Secondly the question about the policy implementations that are available for the effects of land subsidence has to be answered. Besides land subsidence, the sustainable policy implementations for the effects of land subsidence are of importance for this research. The secondary data that has been used is about three approaches. Furthermore the conversations with the BAPPEDA (Reginal Development and Planning Board) contributed to the primary data. Djoko Suwarno gave some insights on possible policy implementations. The CAMAR, a organisation that plant mangroves in the area, also contributed to the primary data. The heads of subdistricts 15 and 16 were also asked about sustainable policy implementations that could be helpful for Tambalorok. The locals were asked what they would wish for in a policy matter.

The following the sub-question is about the influence of land subsidence on the urban area of Tambalorok. This question is foremost answered with the primary data gathered from the street interviews. The locals were asked about the way land subsidence influences

there life. The focus with those questions was on the four impacts of land subsidence. The heads of subdistricts 15 and 16 also contributed were there insights on this matter.

At last the question about the what the quality of the living environment of the urban area of Tambalorok is has to be answered. For this question the same primary data is used as by the previous question. The BAPPEDA was asked about this, so they gave some insights. But the way the local inhabitants perceive their quality of the living environment is more important. The way the local inhabitants perceive it is important for the government to take that into account for policies in the future.

3.4 Data analyse

For the qualitative content analysis, the data gathered through the interviews, will be transcribed. This is essential for the analyse. The transcribed text will make it possible to code the data. The coding process makes it possible to mark the (core) subjects in the data. It is an interactive approach. The subjects at hand will be interpreted and related to each other. That makes this approach very useful, because interrelations between parts of the data will be noticeable. The program that will be used for coding aspect of the data analysation is atlas.it. This program makes it possible to categorized codes, therefore it is possible to connect codes together when that is beneficial for the analysation. The codebook can be found in appendix 1. The core subjects are land subsidence, factors that describe the quality of the living environment, sustainable policy implementations and the four impacts that land subsidence has (economical, environmental, infrastructure and social.). These subjects will be of importance in the coding process but also for the analyse

The data from the street interviews will be compared with the data from the expert interviews. To match the opinion of the local inhabitants about how land subsidence influence their quality of the living environment with policy implementations that could increase that. All the policy implementations that have a positive influence on the effects of land subsidence will be presented in chapter six. Also in that chapter a recommendation for one particular or couple policies will be included.

3.5 Research site

After doing observations in the coastal area of Semarang to look for the perfect research area, the city district of Tambaklorok has been chosen as research site. To be more specific the subdistricts 12,13,14,15 and 16 of Tambaklorok. The effects of land subsidence are the most notable in these districts. The closeness of the sea makes this area very interesting for the research because of the link between land subsidence and flooding. Besides this all, the government has a grand redevelopment project for this area. Therefore it is possible to look into the project and to see if the government used sustainable policy implementations for the redevelopment for this area. In figure 6 the boundary map for the research area is presented.

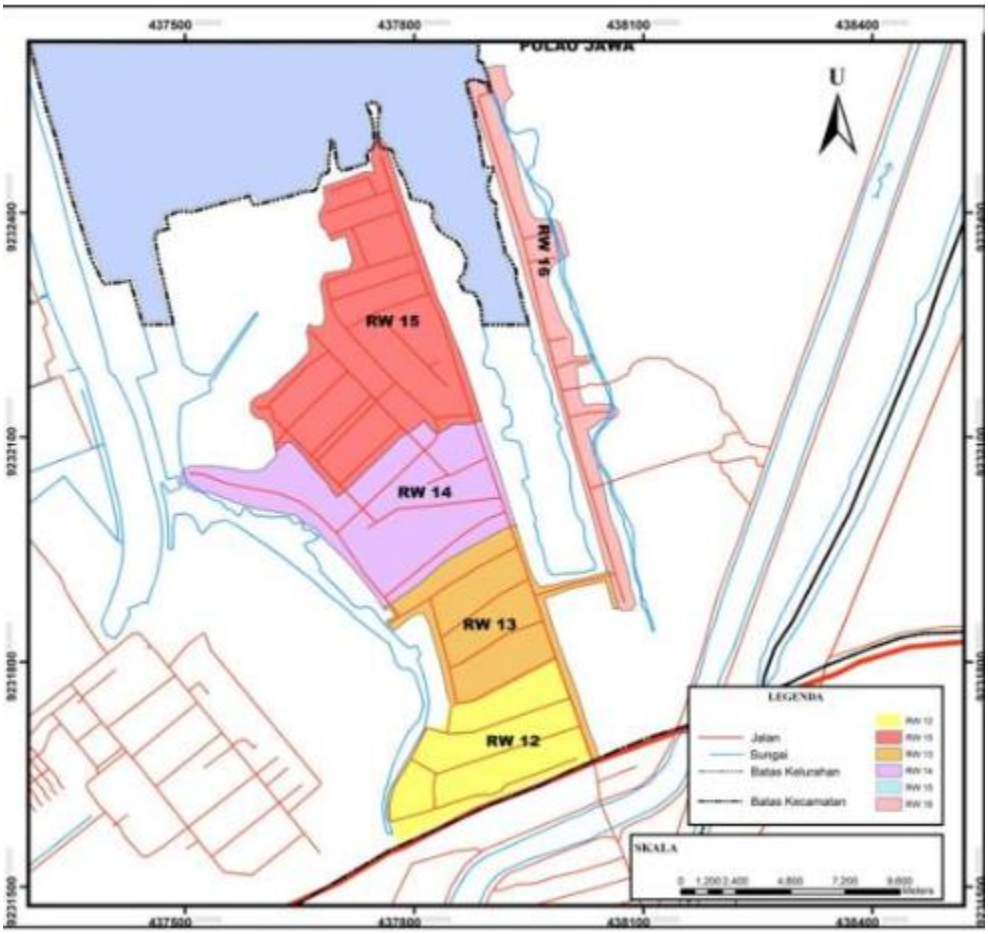

Figure 6: Administrative boundary map of Tambalorok area (Sunarti et al., 2018)

3.5 Reflection on the research

The observations have been done with the help of my buddy Alvin. For the first observation we drove with his scooter through the coastal area of Semarang. When we saw direct effects of land subsidence we stopped and looked around. We took picture of the effects of land subsidence. After doing a day of observation we found are research area. The research area has been observed two times. We spent one day in the subdistrict, talking with locals and observing the area. The second observation in Tambalorok was foremost in the subdistricts 12 and 15. The area was observed and questions were asked to the local inhabitants. This was because there were not many people available in the subdistrict 14. That is the reason we did not speak with locals in that area. The heads of subdistricts 12,13 and 14 did not have time to do an interview, therefore only the heads of subdistricts 15 and 16 are concluded in this research.

Something that has to be kept in mind is that with gathering and analysing data, that the responds of the respondent is translated. Most of the times this went well. Sometimes the question was not really answered. The question is, was that because of the translation or the fact that the respondent did not understand the question. This is learning point for further research. Besides that the interviews went well.

Chapter 4. Tambalorok: the living environment of the sinking men

An idyllic area near the sea, with the elements of the fisherman culture visible. The mangroves add greenery to the area. That makes it the perfect place for relaxation and adventure. This could have been a description of Tambalorok, but that is not the chase. This coastal area has a lot of potential because of the access to the sea. The focus of this chapter is to describe the district Tambalorok of Semarang, Indonesia.. The urban structure is described. Also intensity of the land subsidence in this area is will be mentioned. That is different from the south parts of Semarang. At last the diagram of the dynamics of the policy arrangements approach is presented. It showcases the current situation. That can be helpful with the final recommendation for sustainable policy implementations for the effects of land subsidence, in chapter six. Understanding the dynamics of the policy arrangements of the water and urban planning domain is necessary to make changes in the future. To transform Tambalorok into the idyllic it can be.

4.1 Research area

The district Tambalorok is located in the northern part of Semarang. Tambalorok is part of the city part of Tanjung Mas, the North Semarang District. Tambalorok is divided into sixteen subdistricts (see figure 7). The population of Tambalorok is around nine thousand people. The foremost economic activities are trading of marine products, aquaculture and fish processing. The daily activity in Tambalorok consist of fisherman's activities. Those activities consists of drying fish, repairing fish nets, repairing boats and selling various types of sea food. The drying of the fish is done in the streets, on special blankets. That is the reason why it smells like fish in the urban area of Tambalorok.

Parts of the residential area of Tambalorok can be qualified as a slum area. People living there in bad circumstances. Their houses are of bad quality, that in combination with the hazards encoring in the area there living environment is bad (Sutanta et al. 2010). The land use in coastal cities is very high to accommodate the need for housing, industrial, and business uses. It could have consequences like disappearance of protected space and conflict about the use of the available space in the area. Besides that the scarcity of affordable space causes that people with low income have to work or live in marginal land. This is also a reason why some parts of Tambalorok can qualify as a slum. Marginal land can be found around the river bank, that is near to swamp area in the research area. Marginal land could also be located near a steep hill slope, for the researched districts of Tambalorok that is not the case. Marginal land does not contribute to the quality of the living environment for the people living there, it only decreases it because those areas are more vulnerable to disaster in comparison than prime locations (Sutanta et al., 2010).

There is a project, the name of the project is unknown to me, from BAPPEDA (Regional Development and Planning board) that is in process with the main focus to improve unhabitable houses in the slum area. That is not all, the project also includes improvement of the road and drainage system. They also build public toilets. The project came about after a visit from the president of Indonesia, he saw the living conditions and saw the urge to improve them. After that the BAPPEDA had to develop a project and implement it. Beside the rejuvenation program there is also a project to make the area excisable and worthwhile for tourism. The project is called Marine Tourism Kampong Plan. The area of Tambalorok has potential to be an excellent place for tourism. The area has potential because of the access to the sea. The character of the village, a fishing village, gives its potential. The ponds, the scenery off the sea and the fishermen's culture with the fishermen's life gives this area the chance to flourish. That is the reason why this part has been chosen for redevelopment (Sunarti et al., 2018).

Figure 7: Map of the Tambalorok district (Secretary of Tambalorok district)

The district 12, 13, 14, 15, 16 have been observed. All these districts have approximately the same structure. There is a main road with houses on them. The main road is maintained by the BAPPEDA. The most activity is on the main road, people gather around by the main road. The houses around the main road are mostly of good quality. Entering neighbourhoods not located at the main road the first thing that is noticeable is that the quality of the infrastructure is significant different from the main road (observation). The main road is the infrastructure that the BAPPEDA maintenance. The maintenance of the other infrastructure has to be done by the community. That is not very easy because people have an individualistic way of life (street interview 14). The houses not on the main street are from a different type of quality. There is a differentiation between the quality of houses in those parts of the subdistricts. Good maintained houses and degraded houses are both visible in the urban area, the discrepancy can be very big.

A difference between the subdistricts is that the subdistrict 16 has a lower population density than the other subdistricts. For example the population of subdistrict 15 is just as

much as the population of subdistrict 16. But the population density of 16 is much lower then the of subdistrict 15 (interview with head of subdistrict 15).

4.2 Land subsidence in Tambalorok

Tambalorok is located in the coastal area of Semarang, Indonesia. That is in the north part of the city. The north part has a higher population density than the southern part. Because of that the north part has more industrial and business areas in comparison with the southern part. The soil of the northern part consists of very young alluvium with a high compressibility (Abidin et al., 2012). That is because of sedimentation that started in the X century. The coast line has expanded 2000 metres to the north. The soil is therefore very young and vulnerable (Setioko, 2010). Therefore the soil is very sensitive to water concentration (Sutanta et al., 2005). Land subsidence can be seen as a natural and a human hazard. The human hazard side of land subsidence is mostly caused by the growing population and the effects of the growing population. The growing population needs water, and therefore more water is withdrawal from the ground (Marfia et al., 2007). Big amounts of water withdrawal is bad for the ground water level. Because the extensive groundwater extraction and reduction of water infiltration in the recharge areas in the water basin may lead to compaction of the clay layer. That process causes the land subsidence (Sutanta et al., 2005). The Industry also has the tendency to use a lot of water. That could have quite big consequences. For example the rate of land subsidence will increase. But what can occur through big amount of water withdrawal is that a subsidence bowl will arise. The down going ground creates a puddle. When there is heavy rain and the river cannot hold the water, then the surrounding area, including the subsidence bowl is flooded (Andreas et al., 2018). In Tambalorok there are industries located. How much water they withdrawal is not known. But it has effect on land subding. There are regulation for the water withdrawal for households (street interview 15).

Because of the growing population there are a lot of constructions in the area of Tambalorok. That is a lot of weight for the young soil to deal with, because of the high compressibility of the soil. That is the reason why the subsiding rate in the coastal area is higher than in other parts of Semarang (interview Djoko Suwarno). That is why it is problematic that so many people live in that part of the city. Even knowing about the environmental hazards in the area of Tambalorok the local residents are not likely to move. The accept their faith and deal with the consequences of the natural hazards of land subsidence and the flooding (Marfia et al., 2007). Floods are not beneficial for the land subsidence in Tambalorok. There is a relationship between floods and land subsidence. They both have influence on each other. When floods could be prevented, the already fragile soil does not have to deal with the salty water. That will make the soil less vulnerable. The relation between land subsidence and floods is also the other way around, when land subsidence is decreased the frequency of the floods will be less. That is possible because with less land subsidence the soil will be higher than it is now in comparison with the sea level. Therefore the chance of floods will decrease.

To sum it up the main reasons for land subsidence in Semarang are, deep water withdrawal, heavy load of constructions and the young soil Semarang is built on (Djoko). This also is the case for Tambalorok. Because of the closeness to the sea and the high frequency of floods the amount of subsiding land is very high in Tambalorok. The amount of land subsidence is in Tambalorok around twelve centimetres each year, and in other parts of the city it is around eight centimetres.

4.3 The dynamics of policy arrangement, Semarang

Urban planning and water management are key parts in dealing with the consequences of land subsidence. To investigate the choices that are made for dealing with the consequences of land subsidence can been done by to fill in the diagram of the dynamics of the policy

arrangement. Then it is visible which actors are involved. Or the discourses that influences the process. It gives an overview of it all.

The importance of the urban planning can be seen in that they have power over the usage of space. Spatial planning requires input form different sectors and stakeholders because they all participate in the urban area. In the area of Tambalorok the spatial planners are confronted with increasing number of disasters in the highly populated and economically important area of district. The urban planning for the area of Tambalorok should take that into account. Because coastal urban environments are particular vulnerable areas for disasters. Tambalorok has threats from the climate change, which causes rising of the sea level and that will have influences on the frequencies of the floods. Besides that they have to deal with land subsidence (Sutanta et al., 2010). Spatial planning can help with the achievement of sustainable development objectives through multifunctional use of space. Sutanta et al. explained it in a good way, "Spatial planning consists of activities to allocate space for a number of uses based on envisioned future requirements within its carrying capacity. This process incorporates multiple factors such as population growth, economic forecast, estimated transportation development and available space".

There are three *actors* when it comes to water management. The first one is the government as regulator. The second one is the management of urban safe water as the policy maker. Lastly is the behaviour of the community (Hadipuro, 2004). This combined with the actors of urban planning, all actors for the dynamics of the policy arrangement diagram are known. The *actors* for the spatial planning are also the government and the local inhabitants. But also third parties who are involved in helping realising the plans, like companies who are hired to build the roads. The role of the municipality in this case the BAPPEDA is very important. Because of the slow reaction time of the BAPPEDA, the local inhabitants will spend their own money to stem the impacts of land subsidence. But the government is also spending money because they are elevating the roads and bridges. They also repair the roads and other consequences of land subsidence. Actually the parties that influence the land subsidence for example by water withdrawal should help with dealing with the consequences. They should be responsible for compensating for any damage. In the case of Tambalorok and the water withdrawal should the community and the industries help with dealing with the consequences of land subsidence. Nevertheless, the government should have overall responsibility regarding this disaster (Andreas et al., 2018). This makes the BAPPEDA one very important actor besides the local inhabitants. The local inhabitants are also important because they live in the area affected by the floods and land subsidence. They have to live in a safe and healthy environment, the BAPPED should provide that but the locals should vocalize their wishes.

The *resources* available is the knowledge on the matter from the BAPPEDA. Also the division of the municipality, that does research about climate change, also gathers information about the land subsidence. The BAPPEDA is also the party that provides the money for the projects. There is not a project in that area what is funded by a third party. There is no evidence found that there is private and public collaboration for a project to deal with consequences of land subsidence. After the observation and the interviews with inhabitants in the research area it can be derived that the local people mostly act on short-term solutions. The high up their homes and do not make structural changes like making their foundation very deep. The foremost reason for that is that the population in the research area do not own a lot of money. Also the projects of the BAPPEDA contain mostly short-term measurements, they high up the roads mostly or rebuild a local market (Interview BAPPEDA; Subdistrict head 16). So to say the *discourse* in the research area are short-term solutions for the consequences of land subsidence. The rules are the formal and informal agreements and the interaction of rules between the actors. The formal rules are the regulation made by the BAPPEDA. An example of an informal *rule is* that the local inhabitants have to lift up the roads were when the BAPPEDA is not responsible.

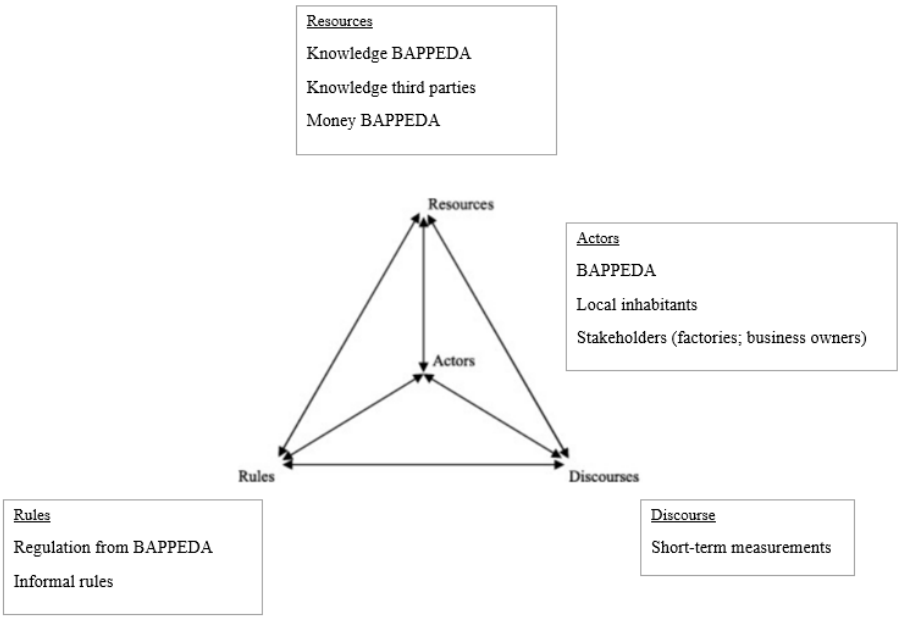

Figure 8: Diagram of the dynamic policy arrangement of Tambalorok

Chapter 5. Land subsidence through the eyes of the sinking man

Middle aged woman said in subdistrict 16, owning a home in Tambalorok feels like renting a house. This describes the feeling of the local inhabitants spot on. They have to lift up their home at least once each five years. Owning a home is not a real investment, it cost a lot of money. Also it gives the locals a feeling of insecurity. This chapter will look into the impacts of land subsidence in the Tambalorok. Speaking with the locals inhabitants makes it possible to know how they perceive their living environment and the quality of it. This knowledge is necessary to link policy measurements to the wants and needs of the local community. The recommendation for policy implementations will be given in the following chapter.

5.1 The four impacts of land subsidence in Tambalorok

The four impacts of land subsidence show how land subsidence has a big effect on society. Therefore the respondents in the research area all have been asked which of the impacts they consider the worst. Most of them stated that the infrastructural impact was the worst.

> "It is a race between the road and the house" (Street interview 13).

It could occur that the road just has been renovated but the houses again or still are sinking in to the ground. Therefore the infrastructure is never as it should be, there will always be something to be desired in forms of infrastructure. It could also be the other way around, a house could just be renovated but the infrastructure is sinking down.

Figure 9: House in district 15 (observation)

Figure 10: House in district 16 (observation)

That is also the case for the districts of Tambalorok. It can be seen in figures 9 and 10. In a street in district 15 the infrastructure had already began to sink, therefore there is a height difference between the houses and the road. The infrastructure to access the road had to be accommodated to the fact that the infrastructure is sinking. In figure 10 the infrastructure is quite new. The construction on the picture is already very much in decay, it has sank already quite a lot. This is a quite typical image for the whole research area.

It is important to keep in mind that the current discourse for policy implementations is the one of short-term measurements. This can be seen by the fact that the first thing the BAPPEDA does, is mostly increasing the quality of the infrastructure (interview BAPPEDA). In the first conversation with Safrinal Sofaniadi (employee of the planning department of Semarang), he mentioned that the BAPPEDA acts on the wishes of the inhabitants. They can let the government know what they want or need by a survey. That is one of the reason why there is difference in the implementations for dealing with land subsidence. Because not all districts in Semarang want the same thing. In Tambalorok the infrastructure is very important because it closely connected with their economic activity. Therefore the main focus is on the infrastructure. It satisfies the wants and needs of the locals. Besides that all, the mindset of many people is individualistic, the inhabitants are mostly focused on their own problems.

"People become more individually because they always think about their house" (street interview 14).

The individualistic mindset can be seen in the fact people do not want to work together to fix problems that are not the responsibility of the government. The main roads in the districts are maintained by the government, but local roads in residential areas have to be maintained in by the local population. That can explain the decay of the infrastructure in the residential areas. Because the population is foremost focussed on their own problems, and have to save money for them.

"People are very individualistic. People do not want to work together or pay together to make it better" (Street interview 8).

Land subsidence could have big economical consequences what could lead to social consequences. Sometimes it is not the individualistic mindset that is the cause that the infrastructure in the residential area is not maintained. It could also be the lack of resources in the form of financial resources but also knowledge resources.

Figure 11: Alley in district 15

There is an alley in the residential area of district 15 (figure 11), that is a corridor between two streets. The alley is used quite often, but it encounters the effects land subsidence a lot. The street is often flooded. It is quite near to the sea, so with incoming water it will be flooded. Then it is not possible for the local community to use this alley, therefore they have to walk a longer distance to get to the other street. Locals do not have the resources to clear the water form that street, so they just have to accept it. Also the sedimentation from the flood can be seen on the pavement and cause problems.

The first problem they encounter after the fact their home is sinking, is the bad quality of the infrastructure. The reason for that is that the bad infrastructure has influence on many aspects of their lives. It decreases their mobility and that can be bad for their social life. For example if they are not able to run errands. Or even from an economical perspective they cannot go to the local market to sell their produce. This could have financial consequences. The economic impacts is the worst impact after the infrastructural. The individualistic mindset also can been seen by how people deal with the economic impacts. The focus is foremost on their home, because that needs a lot attention.

"He didn't mentioned about the environment impact, he wanted to make sure the economic impact was known. Because they have to think about their homes. Sometimes they don't think about other things, the only thing they think about is their home" (Head of district 16).

Furthermore the foremost economic impact is that the local inhabitants have to lift up their homes, and that costs a lot of money. This is the reason for their individualistic mindset, their home is the first thing they have to think about, their home has the highest priority.

"Let say she saved one million for every truck some house needs five trucks and then it is five million just for the land not for finishing" (street interview 15).

The inhabitants of the research area have to remodel at least each five years. So they have to save a lot of money, so when they need to remodel they have the money for it. After three times remodelling their house most of them will rebuild their whole house. One home owner in district 12 had already rebuild her home three times.

"She said this house you visited, it is her third house. So she lived here 27 years" (street interview 7)

In her house you could see the remodelling really good, some parts of the house were very low. She mentioned that she had to use a ladder to climb from her old home to the new one. The woman said she had build three houses, but it can been seen as remodelling because she did not take all of the construction down. She expanded and remodelled her home.

"You can see the difference between the old and new house. .. That was the first one... That lasted for less than ten years, it was flooded. ... So... she said her house was so deep that she used the ladder to climb up from the old house to the new house. She once fell down and hit her head. She even needed surgery " (street interview 7).

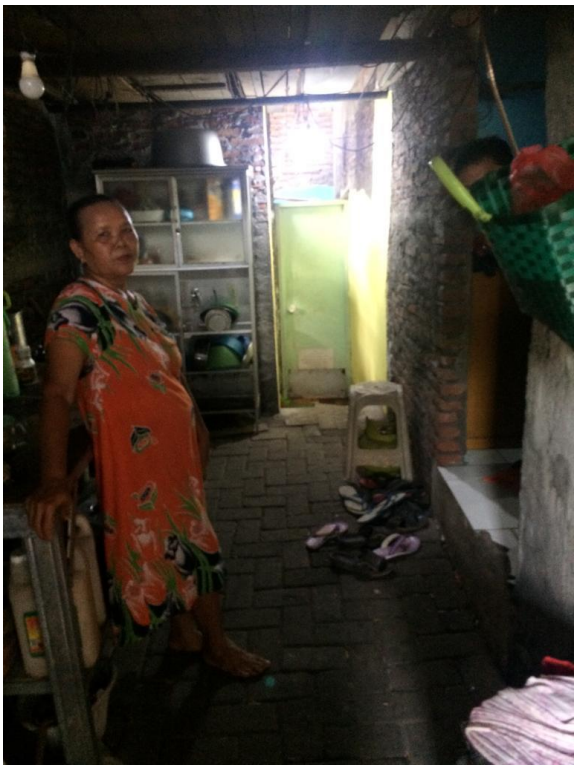

Figure 12: House of the respondent in district 12 (street interview 7)

Figure 13: Kitchen of respondent in district 12 (street interview 7)

The house of the respondent featured in figure 12 had many height differences. To get to the kitchen you had go down at least two times. In the quote above figures 12 and 13, the respondent mentioned that she fell and needed surgery. That shows that the living environment can be dangerous. Her husband earn enough money with his profession as a fisherman, so they do not have to save for remodelling. They have enough money. The house of the respondent is one of the few in the area that has a second floor. The second floor if for more living space. It is also a measurement for flooding and land subsidence. When it gets flooded they can flee to the top floor. When the land is subsiding so much that they lose the first floor, they still have the top floor.

One of the consequences for saving money for remodelling a home, is that the local inhabitants have a lower spending power. The inhabitants with children have to make choices between the tuition for school for their children or remodelling their homes.

"They problem and the have to pay tuition fee for their children for school but they also have to save for their house" (street interview 9).

"She cannot save some money because she has to lift up the floor, but her childeren have to go to higher school and that is more expensive than before" (street interview 15).

"So she mentioned that, most people here their kids are studied until senior high there are not studied university because economic problem and she also mentioned that the price to lift up their house is getting expensive every year" (street interview 15).

"So they have social impact here because they work earn money and every year they have to lift up their floor it takes a lot of money it can be saved for education or other important things but they have to keep it for the house because they have to think about the sinking house" (head of subdistrict 16).

The fact they have less money for school tuition can have social impact for the pupils of home owners who have to make those financial choices. The pupils that are affected by the lower spending power of their parents do not fully use their potential. It is possible that the children will not study after high school because there is no money. In this case the economic impact has social consequences.

The social impact is not often mentioned in the street interviews, because people accept their way of live. Land subsidence is for them an everyday phenomenon. It is a phenomenon that has taken place for years. Also they accept it because it is part of their living environment. Most of the inhabitants do not want to move, because of their profession as a fisherman. They need the access to the sea for their profession, so they accept their living environment.

"So most of them here they have a profession as fisherman so if they move to another better place let's say in the south or other area they got a problem with the distance from the sea to their house. And also if they move they have to find another job, because they can't be a fisherman any more" (head of subdistrict 16).

That is the social reason why they stay in Tambalorok, there is also the economical reason.. Finding another profession is not the only economical reason to stay in Tambalorok. When they would like to move, they also have to sell there house. That is a particular hard because of the bad quality of living environment in that area. There homes are worthless.

The environmental impact is about pollution, like trash on the street (street interview 9). Also a lady in district 15 said that the environment was not clean, and she also suffered from the amount of mosquitoes (street interview 14). The puddles of water that can appear in abandoned residents could attract mosquitoes (figure 14).

Figure 14: Resident in district 15 (Observation)

"Someone leaves left their house like that one" (street interview 15).

The respondent of interview 15 speaks about a house like the one featured in figure 14.

There are more environmental consequences because of abandoned constructions. The constructions are presumable abandoned because of the effects of land subsidence and floods. The real state owner of the abandoned residents did presumably not have enough money to maintain the construction. In figure 14 is a construction featured that is abandoned because of land subsidence and floods. Abandoned residents are not good for the quality of the urban area. It does not look good in the street. It shows the decline of the urban area, and therefore the other dwellings in the village would not look good either. Abandoned residents can lower the image of the urban area. A consequence can be that it is hard to attract new villagers.

Floods and land subsidence are closely linked, which can been seen in figure 14. That house has sunk down and it is flooded. Tambalorok is located near the sea, when it is high tide the sea can get into the residential area. That as consequences like sedimentation on the infrastructure, that can been seen in figure 11. Also the frequency of floods is connect with the sea level rising. Besides the fact that land is subsiding, there is less height difference between the sea level and the soil which increases the chance on floods. Figure 15 shows that the a canal in Semarang is higher than the street, this showcase the land subsidence and the rising of the water level.

"The problem is that the land is below sea level and you can maintain the water so it is not flooded and our land is still above the sea level but we get problems with floods" (head of subdistrict 16).

Figure 15: Ship on a canal in Semarang (observation)

The harbour of Semarang is located near Tambalorok. The harbour of Semarang has effect on the living environment according to the local inhabitants.

"It affects people's health. Because of the closeness of the harbour. The oil, they feel it in here and the plastic bag. And the get the flu, because of the bad environment" (street interview 11).

"The environment problems, the smell form the factory. Also... from my opinion. It is not a really good environment for their children the smell and the factory etc." (street interview 7).

"It is not a really good environment for their children the smell and the factory etc. " (street interview 3).

"His children are getting sick because of the smell" (street interview 3).

The villagers think that the children are getting sick because of the fact that the harbour is so nearby. That the activity of the harbour influences their health. On respondent mentioned that children get a rash on their skin, caused by the bad quality of the water (street interview 9). The quality of the water is bad because of the activity in the harbour.

Some of the villagers think that the economic activity in the harbour causes the land subsidence. One factory in particular, that factory uses a machine that will make the ground shake. It feels like a small earthquake (observation).

"She blames the harbour because they do activities in there, and it is affected the land subsidence. And the guy besides me said that it is about people here like to keep deep water. But she said it is because of the harbour" (street interview 14).

To conclude, a ranking could be made from worst to lesser impact of land subsidence on the urban area after analysing the theory discussed in chapter two. The environmental impact could be stated as the worst, because it has the most influence on the other impacts. After the environmental impact, the infrastructural impact could be seen as the worst. Because it has influence on not only the economical impact but also the social impact of land subsidence. The social impact will come after that because it has influence on the economical impact and the economical impact has influence on no other impact according to Abidin et al. (2015). So it can be stated that the amount of impact can be ordered in the range from worst to lesser impact as following: environmental, infrastructural, social and economic impact (Abidin et al., 2015a). After analysing the data there can be concluded that this order does not match the order of the worst to lesser impact of land subsidence in Tambalorok. The infrastructural impact is the worst followed by the economic impact. After that the environmental impact is stated as the worst and at last the social impact (interview BAPPEDA).

5.2 The complexity of the impact of land subsidence

In the diagram of Abidin et al. (2015a) interrelationships are visible, these interrelationships are also noticeable in Tambalorok. This shows again the complexity of the problem. All the impact have influence on each other. The combination of the infrastructural impact and the economic impact is mentioned a lot. Because those two impacts influence each other.

"It is affected in the way to go to the market, to buy some stuff. Or there family, and is affected when they want to sell something ... or like to make something.. like a fisherman or handicraft" (street interview 8).

The local inhabitants need good infrastructure for their access to the market, the economical and the physical market. The infrastructure is needed to transport the fish from the ships to

the local fish market. Also the infrastructure has to be good for the consumers to buy the fish.

The infrastructural impact has influence on the mobility of the local inhabitants. The infrastructural impact has influence on the quality of the road. But when the area is flooded, that happens on a high frequency, there will be sedimentation on the road. That decreases the quality of the road.

"So she said because the land subsidence it gets flooded and not only with water.. water and some land or sand... and when the water gets dry there is sedimentation and that is dangerous" (street interview 8).

"And also the sedimentation in the street. It gets dirtier" (street interview 13).

This all has influence on the mobility of inhabitants of Tambalorok. That indirectly has effect on the social life of the local inhabitants. The decreases of mobility they could for example not run errands, and this has influence on the economy. Less income is the consequences, the inability to run errands has effect on the financial situation of a fisherman what could lead to social consequences. All the impacts are closely linked.

To conclude land subsidence is a complex problem. All the impacts that are analysed have influence on each other. Therefore a policy on one particular part will only help a little bit. Because all the impacts are so closely linked. To make it even more complex, land subsidence is not the number one problem for Tambalorok. The floods that happen frequently should be the first thing to be solved or decreased. The floods have influence on the land subsidence and when the land is subsiding the chance on floods are even higher. Policy implementations for land subsidence will help, and would increase the quality of the living environment. But he quality of the living environment could be even higher when there would be flood management. The inhabitants also encounter the effects of that hazard. Those two hazard are linked, this has to be kept in mind to deal with land subsidence. The floods have to be prevented otherwise the land will still be degrading because of the flood. In the following chapter there will be looked into sustainable policy implementations for land subsidence. There will also be policy implementations for floods.

Chapter 6. Increasing the living environment of the sinking men

"And they thought when the government makes a sea belt or a dock here it going to help them" (street interview 6).

Locals were asked about things they want from the government, they did not have grand ideas but they wanted simple things to improve their living environment. Like the women in street interview 6. The want a sea belt for example to decrease the frequency of the floods. So to help the local inhabitants there has been data gathered about available policy implementations that could help the local inhabitants. The wishes from the local inhabitants are also kept in mind. Many inhabitants had ideas to improve their situation. To conclude at the end of this chapter which the policy implementations would help the local inhabitants the most, the diagram for dynamic policy arrangement has been used. That shows what changes there could be done in the factors that have influence on policy implementation, that will benefit the local population. An example is a change in discourse.

6.1 Possible sustainable policy implementations for Tambalorok

In chapter two the three approaches for sinking cities by Steenfelt (2019) were presented. The three approaches: sustainable water management, restoring water ecosystems in cities and 'waterproof' of urban planning will be used to look into possible policy implementations that could increase the quality of life in the urban coastal area of Tambalorok. The policy implementations that could be helpful will be linked with an approach. Therefore it is possible to present the available policy implementations in a systematic way. The policy implementations that are already done or on the planning of the BAPPEDA will be shortly mentioned. The big project of the BAPPEDA to make Tambalorok a touristic attraction and therefore increase the quality of life is an example of a plan on the planning. In short the Marine Tourism Kampong Plan is a project of BAPPEDA that was insinuated by the president after a visit in Tambalorok. The project is there to transform Tambalorok into a tourist attraction. The area has potential because of the access to the sea. With this project the quality of the living environment will also increase.

"The president said that, the local people want to build a sea belt they want to protect the sea wave and sea level but the president said if we just build that it is just for a few years so why don't turn this area to become more better with the flooding and something and also make it a tourist attraction so it is like asking for ice cream it" (head of subdistrict 16).

So the urban area will be transformed for touristic purposes but it will be done in such way that the local inhabitants also encounter benefits form it. Those benefits will increase their quality of the living environment. A sea dyke will be built with a high way on it, this will increase the mobility of the local inhabitants. There will a harbour build for fishermen boats. Also will the BAPPEDA plant more mangroves.

One of the causes of land subsidence in Semarang is water withdrawal, this is also the case for Tambalorok (Kuehn, F et al., 2010). One way to deal with the land subsidence is to do something about the water withdrawal. One of the types to deal with land subsidence according to Steenfelt (2019) is *sustainable water management*. This could be very helpful for Tambalorok. The head of subdistrict 15 said that there are in his subdistrict only five households with access to deep water. There is a restriction on new deep water wells. But there is no monitoring on how much deep water those five households extract. A woman from district 16 said that she taught that land subsidence is caused by the activity in the harbour but that the water withdrawal is not the cause. But another men in the same

interview said he does think it comes from the water withdrawal, but the woman is sure that is was not from the water withdrawal (street interview 5). Nevertheless the men in street interview 4 stated that people in his district like to 'keep deep water'. In the conversation with the BAPPEDA they mentioned there is already a project for drinking water. To increase the use of deep water and provide the local inhabitants with clean drinking water. An expansion of the project could be beneficial. That in combination with a regulation that prohibits to take deep water all together. In Singapore is taking ground water prohibited. A prohibition could help the land subsidence in Tambalorok. But the access to good drinking water should be of good quality. So that the inhabitants do not think it is necessary to take deep water. The government needs the monitor the regulation and fine people who take deep water.

Restoring water ecosystems in cities can be done by adding more open green spaces in an urban area (interview with BAPPEDA). In the project to make Tambalorok a touristic attraction there is a space reserved to change into a open green space. The green public space will be a space were the population could meet each other, but it will be good for the filtration of ground water. When rain water can better infiltrate into the ground the ground water level could increase, this could have a positive impact on land subsidence. When water from underground water puddle is withdrawn, the ground can sink because there is a hollow space under ground and soil can sank into that. So restoring the ground water level could help. This is slow process, nevertheless it is important.

Cooperating open green space in the urban area for better rain water infiltration is also an example of *'waterproof' urban planning*. The 'waterproof' urban planning approach consist of policies that include water in the urban area. Their approach is to embrace water instead of fighting against it. Djoko Suwarno presented an idea which is very interesting. The idea is a housing project. The idea Djoko Suwarno presented was to build high housing units, like a flat. This housing unit would have a very deep foundation. The foundation needs to be at least 30 metres or even 40 metres. This foundation will prevent the flat from sinking into the ground. When a couple of those housing units are build and the local inhabitants will move in, the old constructions can be demolished and then there will be less weight on the soil. This is very beneficial for the young soil, because the soil is affected by the weight of constructions. The housing units could increase the quality of the urban area because the slum area will be cleared. That will also increase the quality of the living environment but also the quality of life for the people living in this area. Because they will live in proper housing and not in a slum. Besides that the local inhabitants would not have to think about lifting their house, this will take a lot insecurities away. There are also limitations to this plan, which have to be mentioned. First thing, it will cost a lot of money and the government is most likely the party that has to build the flat. So it can most likely only be realised when the government has the budget for it. Besides that the government has to monitor the space to prevent people to build new constructions without the notice of the government, otherwise the project would not have an effect. Otherwise there still be constructions on the soil who should not be there. The main parts of this idea is the combination of a deep foundation and less weight of constructions. That could also be implemented in other ways. The flat is not the only way, but is was the idea what was presented by Djoko Suwarno. Maybe the use of other building materials could be beneficial. But the housing project is recommended because the inhabitants do not have a lot of money, they remodel their homes with materials at hand. They do not have money for other material or for a deep foundation. They do not think about the effect these materials can have, the reason for this is the individualistic mindset. They have to remodel their house and that is the most important, that has to be fixed. They do not think of something ahead. Therefore it is necessary that the government builds these flats.

Another thing the area would benefit from would be to plant more mangroves. There are to types of mangroves, one of the types decreases the effects of sedimentation and the

other has an effect on erosion. The mangrove type that decreases the erosion figurate like a natural dam for the incoming sea waves (interview CAMAR). The other type keeps the soil together so it would not sink. Form the observation of the head of the CAMAR organisation mangroves help against the effects of land subsidence. Another benefit of the CAMAR project is that the mangroves create oxygen. Besides that, fish gather around mangroves. This is beneficial for the fisherman in the area. So the CAMAR project helps the community of Tambalorok. The CAMAR organisation plants mangroves and give presentations about planting mangroves to show the importance of nature. The benefits that have been mentioned, are more than just environmental. More oxygen is good for the health of the people in the area. The fish ponds that can develop around the mangroves have economical effects. The planting of mangroves can be categorized in the approach of 'waterproof' urban planning, because mangroves will be planted in the coastal area. In the coastal area live a lot of people. The mangroves also create a nice environment.

6.2 Recommendation for policy implementation

The Marine Tourism Kampong Plan for Tambalorok has implementation for floods and therefore indirect for land subsidence. In this paragraph there will be given recommendation about implementation only for the effects land subsidence. The BAPPEDA has already plans for flood management. Therefore the implementations for floods management, besides planting mangroves, are not taking into account. They want to build a sea dyke with a road on it, that would also increase the mobility and accessibility of the area. For the governance aspect the diagram for the dynamics of policy arrangement will be used. There will be given a recommendation about factors in the diagram who could change. Changing those factors is quite difficult but it could be beneficial to have that knowledge. The diagram in chapter 4 (figure 16) will be shown with the new diagram to make the difference noticeable. After that the recommendation for policy implementation will be presented. It will consist of three implementations or regulations what could have a positive effect on land subsidence and therefore increase the quality of the living environment. The first recommendation that will be mentioned is the housing unit project, after that planting more mangroves will be discussed. At last there will be given a recommendation for a possible regulation for water withdrawal.

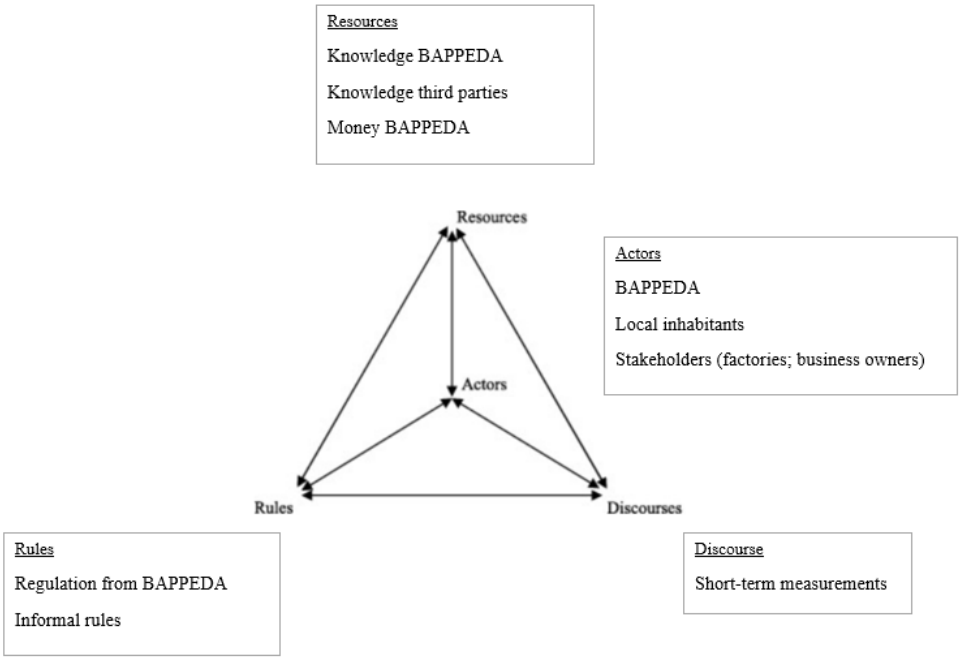

Figure 16: Diagram of dynamic policy arrangement presented in chapter 4

Foreigner companies should be added to the resources. The knowledge of foreign companies who dealt with these kinds of problem could be very beneficial. Their expertise could be used in Tambalorok. For example the regulation in the Netherland about living near the sea can be used as example for Tambalorok. When foreign companies are added as resources they should also be added as an actor, because they will take part in the process. There should be a change in discourse, this is most important. The discourse of the BAPPEDA and locals should change. They should think about long-term measurements and not short-term. There is already a change visible by the BAPPEDA with the Marine Tourism Kampong Plan because of the sea dyke. But most measurements nowadays of the BAPPEDA are short-term, the renovation of the road and the financial help for remodelling of houses. The renovation of the infrastructure is necessary but when there are more long-term measurements used the infrastructure does not have to renovated that often. Also the local inhabitants should think more in long-term solutions. To accomplish that they need to have the security that there home does not need any remodelling. Because then the local inhabitants will get the chance to look further then their individualistic mindset. That will hopefully lead to that they will see the importance of the environment. Therefore will think about long-term measurements that can help them. A discourse that can be added is more public private collaboration: to use the knowledge of private organisations with planning projects. In the Marine Tourism Kampong Plan the BAPPEDA will plant mangroves. The CAMAR could easily provide those mangroves and maintain them. This will lead to caring compacity in the community. The local inhabitants will feel responsible. Therefore they will see the importance of the mangroves. It is not necessary to change something in the rules. There are just formal and informal rules. The content of them could be changed. For example that the government will also renovated the streets in the residential area, not just the main road.

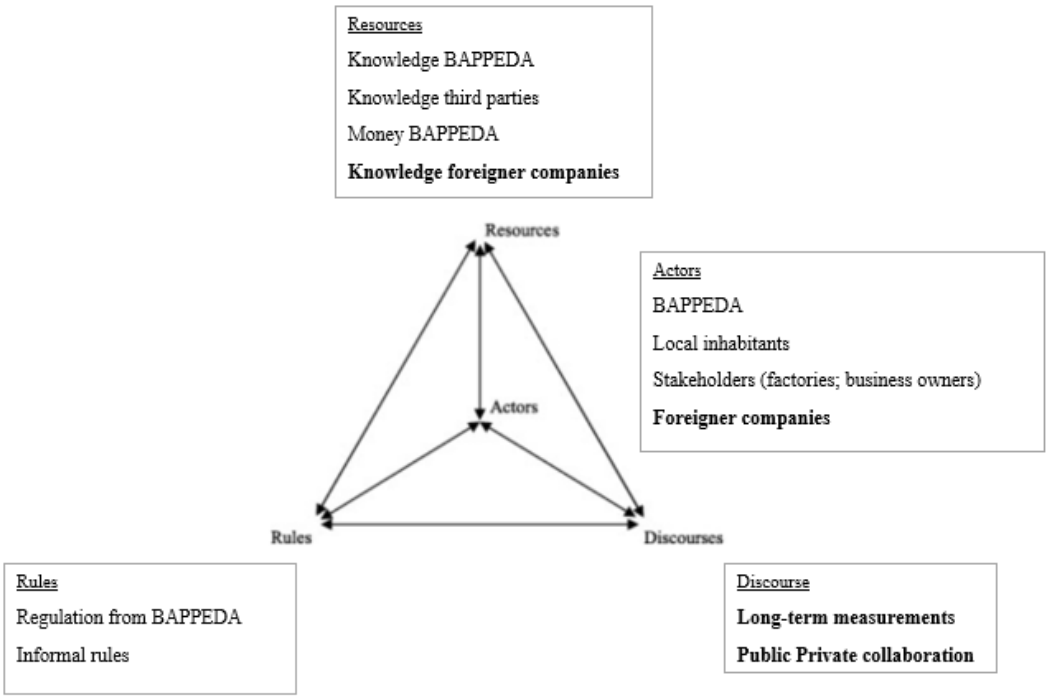

Figure 17: New diagram of the dynamic policy implementations

To sum this all up, the recommendation for sustainable policy implementations will be given. First off all a prohibition of deep water withdrawal would be beneficial. Deep water withdrawal is one of the reasons of land subsidence. In Singapore there is a prohibition on

taking deep water. They also have problems with land subsidence and the prohibition is helpful for them. The regulation for the prohibition of taking deep water will be most successful when there is good sustainable water management for drinking water. Than inhabitants of the area will not use the deep water. Besides that BAPPEDA needs to monitor that there will be no illegal water withdrawal. Furthermore the planting of mangroves needs to be expanded. The planting of mangroves has environmental benefits like decreasing the effects of erosion and sedimentation. It also increases the amount of oxygen in the area. That is good for the health of the local inhabitants, so mangroves also have a social impact. Nevertheless mangroves also have a positive economic impact. Fish ponds arise by mangroves, this is very beneficial for fishermen. The regulation for the prohibition of deep water withdrawal and planting mangroves are measurements that are attainable.

The next recommendation will take more time to implement and develop. For this implementation recommendation should be more research done. The last sustainable policy implementation is, to build a housing unit like a flat with a deep foundation of at least 30 metres. The population of Tambalorok would move to those housing units. Their old homes will be demolished, that will decrease the weight of constructions on the fragile soil. Besides water withdrawal the weight of constructions contribute to the land subsidence problems. The slum problem will be also tackled with this idea and that will also add to the quality of the living environment of the local inhabitants. The housing unit project is just an idea, what by further research should be investigated to its attainability.

Chapter 7. Conclusion: to pull the sinking men out of the ground

The problems of the sinking men are very complex. The floods and land subsidence influence each other. Therefore the sinking men has to encounter these effects and that gives them uncertainties. Furthermore their living environment is degraded because of the effects of the hazards they encounter on a regular base.

"It should be noted that in the coastal areas of Semarang, the combined effects of land subsidence and sea level rise will worsen the tidal flooding phenomena already experienced by Semarang during the high tide periods. Adaptation measures to reduce the impacts of this hazard therefore should be developed as soon as possible" (Abidin et al., 2012).

So this last chapter will sum up the research. The main research will be answered. To sum up the recommendations that could pull the sinking men out of the ground. The problems of the sinking men is complex and has to research further. Therefore there will be given a couple of recommendation for further research. So that the living environment of the sinking can keep increasing.

7.1 Conclusion

The policy implementations that could increase the quality of the living environment in the coastal urban area of Tambalorok can be categorized into two of the three approaches provided by Steenfelt (2019). The approaches that are most suitable for answering the main research question are sustainable water management and 'waterproof' urban planning. Restoring water ecosystems in cities approach is also important, but will be most definitely combined with policy implementations for the 'waterproof' urban planning and sustainable water management approach. Because the main causes for land subsidence in Tambalorok need implementations from those two approaches.

The high housing unit with a deep foundation that could be a perfect solution, could be categorized within the 'waterproof' urban planning approach. The housing unit will increase the quality of the living environment of the people living there. Because many people would live in this vertical housing unit, the already existing housing could be demolished. Than there will be less construction on the soil, this will be very beneficial for the young soil Tambalorok because it tends to be very fragile. The foundation of the housing unit has to be very deep, otherwise the unit will be sinking. When the population is housed in those verticals homes, the BAPPEDA has to have strict regulation on new settlements in the area. This is necessary because otherwise new settlements will be build there and the land will continue subsiding. Than the utility of the housing project will be none. The housing unit will be beneficial for land subsidence but it will also help to javanite the slum area. People will have good housing, this will also contribute to quality of their living environment. Because of the demolishment of the constructions the slum area will be cleared up.

Besides the housing project, protecting the inhabitants from the floods is very important. That will increase the quality of the living environment, because the urban area would not be flooded al the time. This will be beneficial for the social life of the inhabitants, less chances on diseases and their mobility would not be decreased because the road will be excisable and not polluted with sedimentation. A way of flood prevention is to build a sea dyke, to protect the shoreline form erosion and the people for the incoming water. Also planting more mangroves could be very beneficial for the area. It is a sustainable way for flood prevention and it has a positive influence on land subsidence. To plant both types of mangroves, could really help the matters had hand. The mangroves could also figure as a tourist attraction. In other parts of Semarang that is already the case. The mangroves will

also increase the amount of greenery in the area, this will also be good for ground water level and oxygen.

Implementing more greenery in the public spaces is a policy implementation that can be qualitied as both 'water proof' urban planning and restoring water ecosystems in cities. With more green in the urban space, the rain water can better infiltrate in the ground. That will be beneficial for the ground water level, it also includes water into the urban area. Because there will be thought about ways to incorporate the water in the urban area, the water in this particular example is rain water.

The policy implementation that is a must for the coastal urban area of Tambalorok is a strict regulation of water withdrawal. Deep water withdrawal is one of the foremost reasons for land subsidence in Semarang, therefore it is also a main problem for Tambalorok. The BAPPEDA should make very strict regulation for the withdrawal of water, and they should enforce the regulation. People whom violate the regulation should encounter consequences. The BAPPEDA of Semarang could just like Singapore prohibit to withdrawal water all together.

To conclude the problems of the sinking men are very complex. It is much more than just the effects of land subsidence. They also encounter the effects of floods. That is not all, they live insecurity. This has influence on their mindset, which is individualistic. The only thing they can think about is their house and that influences their way of life. So, to increase the quality of the living environment in Tambalorok the insecurity were the local population live in could be decreased. That could be done by dealing with the effects of land subsidence and floods.

To conclude, the main research question: *What are (sustainable) policy implementations that seek to increase the quality of the living environment in urban area of Tambalorok?,* is answered.

7.2 Reflection and recommendation

For further research I would recommend to investigate more policy implementations for land subsidence. Maybe policies implementations that are not connected with the approaches. Because now only policy implementations are used from the three approaches provided by Steenfelt (2019). Further more I would recommend to investigate the already existing policy document of the BAPPEDA of the city of Semarang. That was not possible now because of the language barrier. With the knowledge about the already existing the policies, the recommendation for other policy implementations could have been more precisely. Because than I had the precise knowledge about policies and I would have known what already had been done. Furthermore it could be interesting to speak with the actors in the research area about the recommended policies and ask them what they think of it. The questions asked for the local inhabitants could be if they would be satisfied with these policies or that they miss something in the policy. Speaking with the BAPPEDA would also be necessary, they should be asked about the feasibility of the recommended policies.

Furthermore a research about the insecurities they local inhabitants have is very beneficial. The insecurities of the local inhabitants can explain why they do thing they do. Their insecurities is a underlying problem, that could be considered and investigated. This will help with finding ways to increase their quality of the living environment.

Thus the recommendation for further research are to look into more policy implementations for land subsidence that are not within the used approaches, sustainable water management, restoring water ecosystems in cities and 'water proof' urban planning. Besides that doing a more specific policy investigation would be beneficial. Also doing research about the insecurities of the local inhabitants. At last to present the recommendation for sustainable policy implementations for the consequences of land subsidence to the local actors in the research area of Tambalorok.

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Figures

Note, all pictures are from own observation when that is not the case it will be mentioned. This is also the case for some figures featured in this thesis.

Appendix

Appendix I Codebook

Name	Grounded
CAMAR	9
Causes of landsubsidence	5
Dam	1
Deep water	5
dock	1
Economic impact	10
Environmental impact	9
Erosion	2
Financial consequences	3
fisherman	6
Floods	10
Four stages plan	3
Goverance	1
green open space	2
Harbor	3
Health	2
HOUSE	1
individualistic mindset	1
Industry	4
Infrastructural impact	6
It affects people's healt...	0
Lifting up residents	13
Link economic and infr...	4
Mangroves	7
Marine Tourism Kampo...	11
Mindset	1
Nice quote	2
Reasoning to stay	2
Responsibility governm...	4
Responsibility local inha...	3
Saving money	3
Sedimentation	4
Sinking constructions	6
Social impact	6
Survey	3
Sustainable policy impl...	8
Wish for policy implem...	7
Worst impact	7

Appendix II Interview guide Safrinal Sofaniadi

Thank you sir for meeting me. I am Anne Beune, I am a student from the Netherlands who follows a course at the UNICA university. For an assignment I am interested in possible sustainable policy implementations that can increase the quality of life in urban areas that are affected by land subsidence. I was wondering: do you approve if I record this interview. I will only uses the recording to transcribe the interview. Do you mind it when I take notes during the interview? I formulated a couple of questions. I will asks the questions by theme. The interview will not take longer than 60 minutes. Thank you in advance for meeting me.

Job
First I would like to know what is your job description?

Land subsidence
Land subsidence has influence on the urban scenery of the places that are affected by land subsidence.

- Is that also the case for areas in Semarang
- ...And in which way is the urban scenery affected by land subsidence.
- How can the quality of life increase in areas affected by land subsidence?

In which way takes the planning department of Semarang into account the effects on urban areas?

- Do you have a different planning approach for areas affected by land subsidence than areas that are not affected.
- What is the planning approach?
- .. And what is the difference?

Are there sustainable policies for the effects of land subsidence?

- Are these sustainable policies used for the urban planning for areas effect by land subsidence?
- ... If there are sustainable policies implementation and they are not used in nowadays planning, why are they not used?

Do you know if people move from areas affected that are affected land subsidence if the move because of the land subsidence or that their move has other motives?

- If that is not the case... do you maybe know why stay at places that are affected by land subsidence.

Thank you very much for answering our questions. It was very helpful and interesting. Do you have any questions for us? Again a lot of thanks for meeting me. If you are interested, we can email you the conclusion of our research.

Thank you very much and have a nice day.

Appendix III Interview guide Djoko Suwarno

Thank you for meeting me, after doing my research I wanted to know about the process of land subsidence. Because in my interviews I mostly talked about social aspects of land subsidence.

Land subsidence

- Could you explain to me the process of land subsidence?
    - How does it work?
- What are the causes of land subsidence?
- Do you know the main reasons for land subsidence in Tambalorok, especially districts 12 till 16?

Infrastructure

- Can you tell me something about how land subsidence has effect on the infrastructure?
- Do you know long-term measurements for infrastructure that are affected by land subsidence?

Environment

- Can you tell me something about how land subsidence effects the environment?

Thank you very much for answering our questions. It was very helpful and interesting. Do you have any questions for us? Again a lot of thanks for meeting me. If you are interested, we can email you the conclusion of our research.

Thank you very much and have a nice day.

Appendix IV Interview guide CAMAR

Thank you for meeting me today. I am a Dutch student does research about land subsidence in Tambalorok for an internship with the UNIKA University. My main focus for the research is on sustainable policy implementations that can increase the quality of the living environment.

Organisation
- What does this organisation?
- How is it related to Tambalorok?

Government
- How does the project of the government intervene with their work?
- Is this project funded by the government?

Land subsidence
- How does their work influences land subsidence?
- What do you think causes the land subsidence in Tambalorok: water withdrawal, constructions like buildings and factories or the type of soil?
- The project; does it compensate for the losses caused by land subsidence?
- How do you think your project can increase the quality of life in Tambalorok?

The impact factors
- On which factor has it more impact in your opinion: environmental, economic, social or infrastructural?

Mangroves
- Do you think mangroves are a sustainable way to prevent land subsidence?
- Can mangroves prevent floods?

Thank you very much for answering our questions. It was very helpful and interesting. Do you have any questions for us? Again a lot of thanks for meeting me. If you are interested, we can email you the conclusion of our research.

Thank you very much and have a nice day.

Appendix V Interview guide BAPPEDA

Thank you for meeting me today. I am Anne, a Dutch bachelor student who has an inthership with the UNIKA University, post-grade Environmental & Urban studies. I do a research about land subsidence in Semarang. My research area is Tambalorok. I already did research in this area. I did research in districts 12,13,14,15 and 16. After talking to a couple of districts heads and locals, I have some questions about the plan the government is implementing in the area of the districts 12, 13, 14, 15 and 16.

Project

- What entails the project in the area of districts 12, 13, 14, 15 and 16?
    - The heads of the subdistricts and locals mentioned about four stages.
    - What entails each stage? The locals mentioned a sea belt or dock.
- Why did the national government, I heard that the president visited the area, choose this area?
- What is the main focus of this project: social, infrastructure, environment or economic?
- In which can this project increase the quality of life for the people in the research area?
    - Which grade would you give the quality of life in this area?

Land subsidence

- What do you think causes the land subsidence in the area of districts 12, 13, 14, 15 and 16: water withdrawal or the industry in the harbour?
- Do you have policy to decrease land subsidence, like a maximum of litres of water that may too with drawled or a maximum of harbour activities?
- As a policy maker what do you think land subsidence has most impact on; environment, social life, economic and infrastructure?
    - Why?
    - Which impact does not get that much attention?
- What do you think is a bigger problem land subsidence or flooding in the research area?
    - How does that show in the urban planning?

Thank you very much for answering our questions. It was very helpful and interesting. Do you have any questions for us? Again a lot of thanks for meeting me. If you are interested, we can email you the conclusion of our research.

Thank you very much and have a nice day.

Appendix VI Observations

First observations

The first observation on the fourth of April was used to find the proper research site. Therefore a part of the coastal area was observed. With the help of my buddy Alvin and his scooter it was possible to observe a large part of the coastal area of Semarang. After this observation the research area was chosen. Land subsidence has four impacts, three of them only have indirect effect. The infrastructural impact is visible in the urban area, therefore is this impact has been investigated with a observation. The observation framework is based on the table of Abidin et al. (2015). The characteristics in that table will also be used for the observation scheme. Only the direct impact on the infrastructure has been used.

Infrastructural impact	
Representation of impact	
Cracking of permanent constructions and roads	The quality of the infrastructure is different in each place. In one part the infrastructure had just been renovated and in other parts there were holes in the road. The holes in the ground are very inconvenient because when it has rained the water will great a puddle in the hole and this limits the accessibility of the road. To get to Tambalorok we needed to pass a road with a lot of holes, we had to take a detour to get to the place we wanted to go.
Tilting of houses and buildings	 This door has been sinking but it is also tilting. The tilting of houses and buildings was not very visible. The sinking of houses was much more visible.
'Sinking' of houses and buildings	The man problem for the inhabitants of Tambalorok is the sinking of houses. In some places the land subsidence is more visible. In some cases the home owners have remodelled their home in such a good way that the sinking is not noticeable in the first look.

The left part of this house sank further down then the right side. The right side is most likely added.

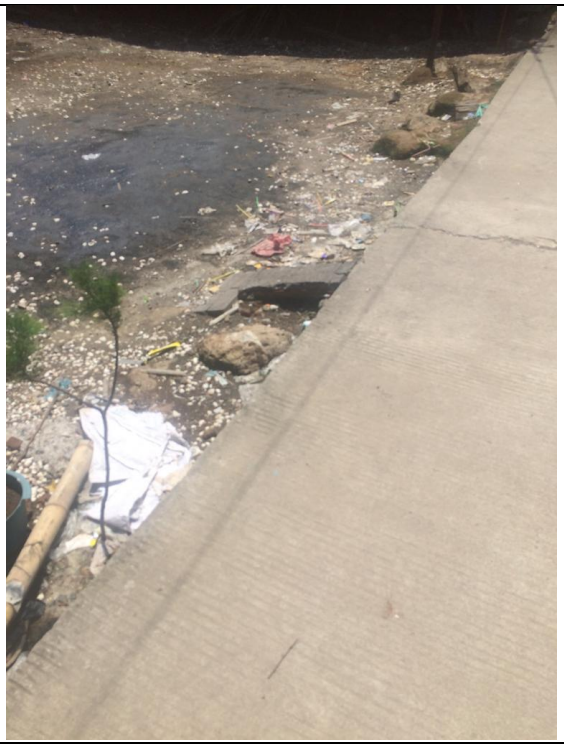
	A house that is almost completely sank down, the height difference with the infrastructure is very noticeable.  Company building sinking down, the old door is almost completely sank down. The door is not almost not noticeable.

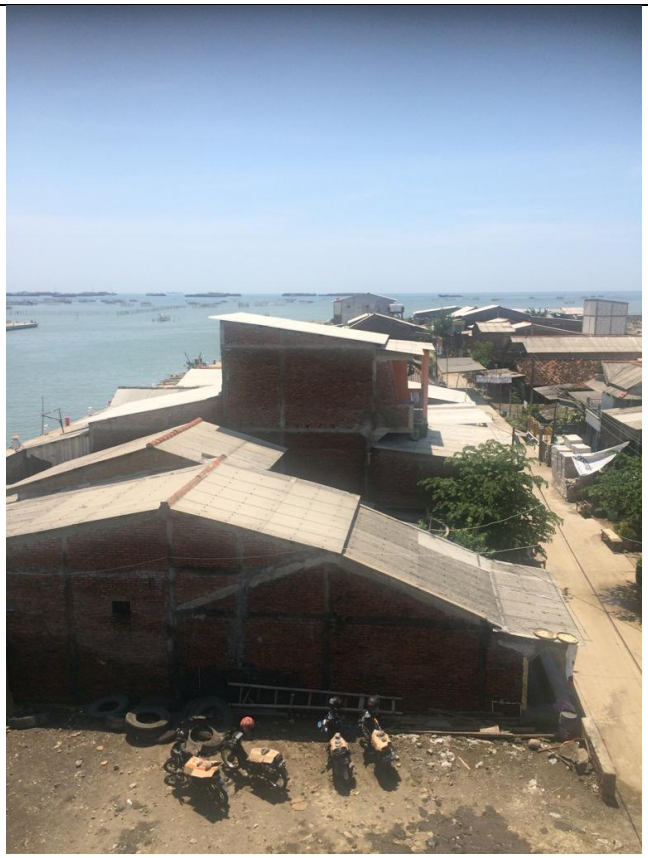
	 We passed a puddle of water with gate around it, the gate is almost not visible anymore
Breaking of underground pipelines and utilities	This was not noticeable.

Second observations

The second observation has been done in sub district 16 besides speaking with the local inhabitants and the head of subdistrict 16 have look at my surroundings with the observation scheme in mind. The second observation has taken place on the ninth of April.

Infrastructural impact	
Representation of impact	
Cracking of permanent constructions and roads	The road in subdistrict 16 was just renovated. This is very visible in the picture below. The infrastructure is higher than the surrounding soil.

	
Tilting of houses and buildings	The tilting of houses and buildings was not very visible. The sinking of houses was much more visible.
‘Sinking’ of houses and buildings	 A sinking house in subdistrict 16, it almost completely vanished into the ground.

	 In this picture the outlines of the old house are noticeable. The old structure of the house is visible. It is visible what is remodelled. In district 16 the sinking houses are the main problems. There is a difference noticeable between constructions. Some houses are further sank down than others.
Breaking of underground pipelines and utilities	This was not noticeable.

Third observations

The third observation has been done in sub districts 12, 13, 14 and 15 besides speaking with the local inhabitants and the head of subdistrict 15 have look at my surroundings with the observation scheme in mind. The third observation has taken place on the tenth of April.

Infrastructural impact	
Representation of impact	
Cracking of permanent constructions and roads	The main road in this area was just renovated, so the quality of the road was good. The roads in the residential areas were of other quality.
Tilting of houses and buildings	The tilting of houses and buildings was not very visible. The sinking of houses was much more visible.

	 In this picture tilting is visible. But that is not the main problem, that is the sinking part and the fact that the house is flooded.
‘Sinking’ of houses and buildings	 An example of a sinking house in district 15.

	 The picture shows a picture of a garage that is sinking down.
Breaking of underground pipelines and utilities	This was not noticeable.