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# Community resilience in a Danish coastal context A case study of Løgstør and Thyborøn

Master thesis in Natural Resource Management

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Trondheim, May 2016



**NORDRESS**

Nordic Centre of Excellence  
On Resilience and Societal Security



 **NTNU**

Norwegian University of  
Science and Technology

## Acknowledgments

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This master thesis is the culmination of two years as a student at the Department of Geography at the Norwegian University of Science and Technology (NTNU). The two years have been educational with informative courses and fieldwork. The process of writing this master thesis have at times been challenging but most of all it has been awarding to work with a research topic that I find extremely important and utmost current.

First and foremost, I would like to thank my supervisor, professor at the Department of Geography Haakon Lein, for an educational and very competent supervising this past year. I would also like to thank Jan Ketil Rød (NTNU) for sharing his knowledge of GIS, which have been extremely valuable. I would like to thank NORDRESS for the opportunity to examine an interesting topic and for supporting the fieldtrips to Denmark. Furthermore, I would like to thank the Danish Coastal Directorate and in particular Carlo Sørensen and Martin Jebens for providing me with invaluable material on Thyborøn and for including me in their meetings on the topic. I would especially like to thank Carlo Sørensen for providing a small fieldtrip to Thyborøn where introductions to possible research participants were made. This was instrumental for my thesis. I would like to thank Sheila Smed from Kystcentret Thyborøn for setting up meetings with local research participants in Thyborøn and for being extremely helpful. Also I would like to thank Anders Bloksgaard from Limfjordsmuseet in Løgstør for providing me with material and for getting me in contact with locals from Løgstør. I would like to thank Camilla Neve Lieknins for help with layout.

Last but not least I would like to thank all research participants that have participated in this study for their time and interest. Without them this study would not have been possible.

## Abstract

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Climate change in Denmark is estimated to result in increased precipitation, a rise in sea-level as well as more intense storms. As a result of this, small low-lying coastal communities will be particularly exposed to storm surges. This paper examines how well prepared to handle storm surges two Danish local communities, Løgstør and Thyborøn, are and how they can enhance their community resilience toward storm surges. This was done through field observations, interviews and a conceptual model applied to assess strengths and limitations of the two communities. The focus of this study is on four dimensions of resilience, which are social capital, community capacity, information & communication and institutional capacity. Results from the study indicates that Løgstør is better prepared to handle storm surges than Thyborøn because their strengths are better equipped at preparing for and coping with an impact where as Thyborøn have strengths that are more suitable for a recovery phase. Findings further indicate that Thyborøn should focus on the information & communication dimension of resilience to enhance the community resilience and to improve the flow of information regarding storm surges and the planning process in the municipality to the local community should be the main focus. Løgstør can enhance their community resilience significantly by prioritizing the security over the amenity value and therefore raise the height of the seawall that is protecting the city.

## List of Tables and Boxes

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Table 1: Dimensions of resilience baselines and candidate variables.

Table 2: Research participants

Table 3: Strengths and limitations that can influence the community resilience.

Box 5.1.: Local primary student's perception of climate change.

## List of Figures

---

Figure 1: Number of times the coastlines in Denmark have been hit by storm flood between 1991 and 2008

Figure 2: Number of reported damages in the period 1991-2008

Figure 3: The connection between the concepts vulnerability, extreme weather, exposure and disaster risk.

Figure 4: The connection between vulnerability and resilience.

Figure 5: The connection between resilience and adaptive capacity.

Figure 6: Community resilience as a set of networked adaptive capacities

Figure 7: Modified model of figure 6 and table 1.

Figure 8: The three pillars of community.

Figure 9: Dimensions of community resilience studied in this project and the methods applied to examine them.

Figure 10: Graphic illustration of how the interviews cover the baseline components for resilience.

Figure 11: Map of Denmark

Figure 12: Web of contact with local research participants in Løgstør and Thyborøn

Figure 13: Picture of Thyborøn

Figure 14: Picture of Løgstør

Figure 15: Map showing the location of the case cities

Figure 16: Map of the infrastructure in Løgstør

Figure 17: Map of the Danish height model in Løgstør

Figure 18: Value of buildings in Løgstør

Figure 19: Map of coastal protection in Løgstør

Figure 20: Map of the infrastructure and critical buildings in Thyborøn

Figure 21: Map of the Danish Height Model (DHM) in Thyborøn

Figure 22: Map of impermeable surfaces with 1-meter buffer around the buildings in Thyborøn

Figure 23: Map depicting the value of buildings in Thyborøn

Figure 24: Picture of Thyborøn

Figure 25: Picture of Løgstør

Figure 26: Variables found in the empirical data

## List of Acronyms

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CC	Climate Change
DMI	Danmarks meteorologisk institut
IPCC	Intergovernmental Panel on Climate Change
UNISDR	The United Nations office for Disaster Risk Reduction

# Table of Contents

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Acknowledgments

Abstract

List of Tables and Boxes

List of Figures

List of Acronyms

Table of Contents

**1 Introduction 15**

1.1 Background 15

1.2 Objectives and limitations 18

**2 Key concepts and models of resilience 25**

2.1. Key concepts 25

2.1.1. Flood 25

2.1.2. Disaster 25

2.1.3. Vulnerability 26

2.1.4. Exposure 27

2.1.5. Risk 27

2.1.6. Adaptation 27

2.1.7. Recovery 28

2.1.8. Resilience 29

2.1.9. The connection between the concepts 30

2.2. How to measure resilience 32

2.2.1. Community resilience 34

2.3. The concept of Community 36

**3 Applied methods and Methodology 41**

3.1. Study design and structure 41

3.1.1. Case studies 43

3.2. Applied methods 45

3.2.1. Document analysis 45

3.3. Interview 45

3.3.1. Respondents 46

3.3.2. Types of interviews 48

3.3.3. The design of the interview questions 49

3.3.4. Coding of interviews 50

3.4. Questions for 8<sup>th</sup> grade school students 50

3.5. Application of GIS (Geographical Information System) 51

3.6. Positionality and ability to do research 51

3.7. Ethics 52

3.8. Methodological reflections 53

**4 Presentation of study areas 59**

4.1. Løgstør 60

4.2. Thyborøn 63

4.3. Summary 68

**5 Strengths and limitations in regards to enhancing community resilience 69**

Box 5.1. Local primary school student's perception of climate change 69

Responses from the pupils 69

5.1. Community competence 71

5.1.1. Local initiative towards floods 71

5.1.2. Volunteers 72

5.1.3. Local understanding of risk 74

5.1.4. Building the problems away	78	6.1.3. Recommendations for enhancing community resilience	119
5.1.5. Type of local community	79	6.2. Reflections	120
5.2. Social capacity	82	6.3. Conclusion	121
5.2.1. Attachment to place	82	<b>Bibliography</b>	<b>125</b>
5.2.2. The ability to live with risks of flood and storms	84	Appendix 1	129
5.2.3. Sense of community	86	Appendix 2	130
5.2.4. Local knowledge	87	Appendix 3	132
5.2.5. Perceived and received support	89	Appendix 4	133
5.3. Institutional capacity	91	Appendix 5	134
5.3.1. The effort of the municipality	91		
5.3.2. Emergency services	92		
5.3.3. Emergency response plans and the continuity of the plans	95		
5.3.4. Water supply institutions	96		
5.3.5. Interoperable communications	97		
5.3.6. Cooperation and citizen involvement with locals	99		
5.3.7. Zoning & building standards	100		
5.3.8. Climate mitigation/adaptation and future plans	101		
5.3.9. Amenity	104		
5.4. Information and communication	105		
5.4.1. Information	105		
5.4.2. Communication between locals and the municipality	107		
5.4.3. Trusted sources of information	108		
5.5. Concluding remarks	109		
<b>6 Discussion, reflections and conclusion</b>	<b>113</b>		
6.1. Discussion of main findings	113		
6.1.1. Relevance of the conceptual model for assessing the communities' strengths and limitations	117		
6.1.2. Is it possible to measure and compare resilience?	118		

PART 1

GENERAL INTRODUCTION

# 1 Introduction

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## 1.1 Background

Over many years' climate change (CC) and the possible repercussions of the changes have been a prominent discussion worldwide. The discussions range from whether climate change is truly occurring, what are the main drivers of the changing climate and how we can prevent future ramifications of our current actions. These discussions often focus on a global warming world and not until recent years taken in to account the more local variations occurring. Since the consequences of CC can differ immensely from one region of the world to another, more comprehensive local studies are necessary to get an insight to how climate change are affecting places differently. We may not see the full impact of the rising temperatures and changing climate in our lifetime but the changes that have already transpired are sufficiently alarming. Scientists predicted early on that the world would experience loss of sea ice, an increase in sea level, decrease in biodiversity and more intense droughts or storms (NASA, 2016). Such changes have already been observed more so in some zones of the world. Even the scientists are surprised at the alarming rate of the changes. (NASA, 2016).

Studies show that the weather in Denmark in the future will be more extreme due to climate change (Miljø- og fødevareministeriet, 2015). The northern part of Europe will experience intense precipitation, longer and more severe storms and higher storm surges (Miljø- og Fødevareministeriet, 2016). Also to be expected are drier summers and wetter winters with floods during the winter periods more extreme than earlier experienced (Miljø- og fødevareministeriet, 2015). However, the precipitation will not be equally distributed throughout Denmark as the western Jutland will receive the highest amount yearly. Furthermore, western Jutland is likely to experience increased erosion of the coastal line, which will be worsened by less material present by the coast to break the storms. It is predicted that the largest challenge climate change wise in Denmark will be to protect the west coast of Jutland. An increase in storm surges and floods is expected, which in particular will affect the western coast. (Miljø- og Fødevareministeriet, 2016). This is caused by a rise in sea level approximately at 70 cm in Denmark over the 21. century and by severe storms caused by intense low-pressure activity in the North Atlantic (Centre for Ecology & Hydrology, 2014) (Miljøministeriet, 2014). So far, the sea level increased in the 20th Century with 1,7 mm yearly until 1993 where it escalated to 3,2 mm a year (Miljøministeriet, 2014). As can be seen on figure 1 most of Denmark have already been hit by a relative large number of severe storm floods. These are occurring in the winter months (Stormrådet, 2009). As can be seen on the map, the western part of Jutland has not yet experienced that



many storm surges but the earlier mentioned prognoses are bound to change that.

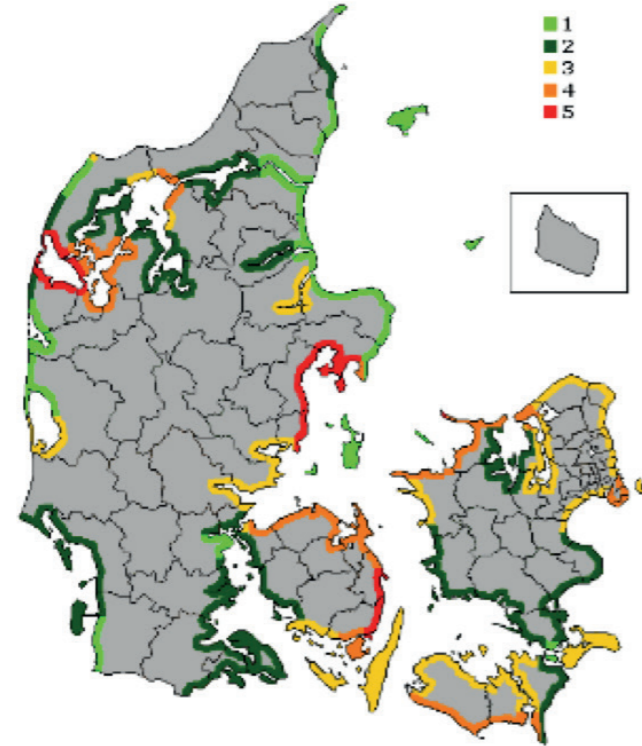


Figure 1: Number of times the coastlines in Denmark have been hit by storm flood between 1991 and 2008. (Stormrådet, 2009)

Even though the number of severe storm surges are not as high as they are predicted to be in the future they are still today causing considerable damage. The number of reported damages from 1991 to 2008 can be seen on figure 2. It is evident that the eastern part of Denmark has experienced a high number of reported damages. It does, however, not necessarily mean that the west coast experience less damage but it is an indicator that can be applied to understand the magnitude of damages and impact of the storm surges in the affected areas.

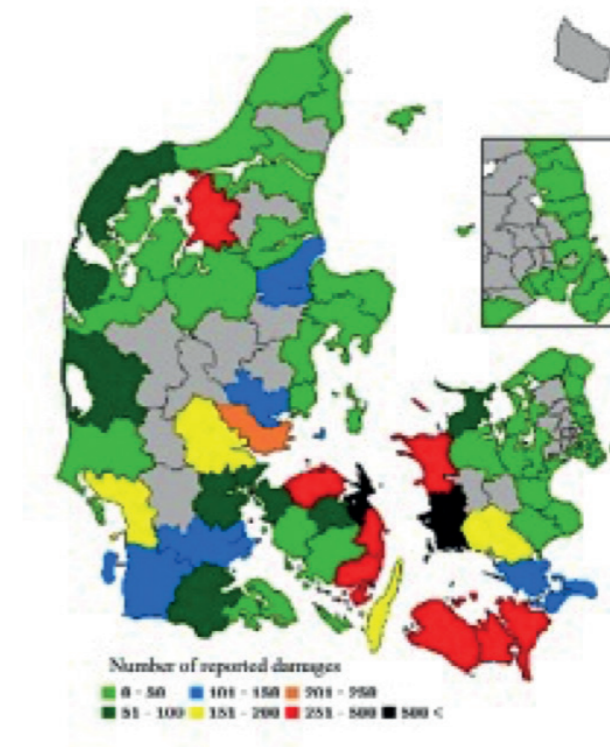


Figure 2: Number of reported damages in the period 1991-2008. (Stormrådet, 2009)

Despite the changing climate the outlook for the Nordic region is considered favourable compared to other regions. The Nordic countries have both robust economies and institutions with a great capacity to adapt (Goodsite, 2013). Even though Denmark is on the list of the top five countries in Europe able to handle CC the country is expected to have the highest damage costs relative to BNP due to sea level rise. (Miljøministeriet, 2014) Denmark will also be one of the most expensive countries to protect against climate change particular due to the very long coastal line given that Denmark have more than 7300 km of shoreline as well as over 70 inhabited islands (Kystdirektoratet, 2009). Denmark is going to face a changing climate that most likely will challenge the status quo and the preparedness of the coastal regions.

Even though we like to believe that disasters are merely one-time **events** disasters are in reality merely a matter of where, when and what (Masterson, Peacock, Van Zandt, Grover, Schwarz, & Cooper, Jr., 2014). So-called “natural hazards” are not new features in the human history but both number and severity of natural disasters are predicted to increase in our near future due to climate change (Masterson, Peacock, Van Zandt, Grover, Schwarz, & Cooper, Jr., 2014). Even with such gloom future estimates the world population continue to develop highly vulnerable areas that are prone to hazards (Cutter, 1993). The growing population is one of the factors that pushes developers and planners to build in high-risk areas and rely on short-term engineering solutions such as levees, seawalls and dikes. However, it would be unrealistic to completely prevent any expansion into hazardous coastal zones as these areas are by many considered ap-



pealing to settle in due to beautiful views and prestige. But how do we prevent disasters from occurring when we settle in highly vulnerable areas? Is there a way of making regions, cities and communities better prepared for such natural hazard impacts that are likely to become more frequent and intense?

Many studies have focused on uncovering vulnerable areas of the world (IPCC, 2012). The studies aim to uncover areas that are most likely going to experience devastating losses both economically and human wise when hit by a natural hazard. Instead of using an approach where the vulnerability is emphasized, a more positive approach when dealing with natural disasters could be by focusing on making communities more disaster-resilient. Communities play an important role in preventing natural hazards in becoming disasters and also in recovering after a crisis. Extreme events can lead to communities experiencing stark physical and social consequences. It is imperative that local communities of all sizes have the ability to prepare for, act throughout, and recover after a significant disaster.

The described challenge of a changing global climate affected by the greenhouse effect, which is foreseen to cause an increase in precipitation and more intense storms in Scandinavia, has led to an interest in examining how the effects and consequences of these changes in the Earth's climate can be mitigated. In particular, the effects of floods and storm surges since those are predicted to become more intense and frequent in the western part of Denmark now and in the future. This study will focus on how local communities can be engaged in the process of building resilience towards storm surges.

## 1.2 Objectives and limitations

The main objective of this study is to examine how two chosen case studies can enhance their community resilience toward storm surges. The focus of this study will be on the local scale because the changes occurring globally will have different impacts on different local communities depending on several factors such as resources, location etc. An interest in examining how it is possible for communities or smaller cities to better prepare themselves for future impacts led to an objective of finding the strengths and limitations, in regards to resilience, of two chosen case communities in Denmark. Furthermore, these strengths and limitations could then be used to appoint aspects of the community that, if focused and improved on, could enhance the community's resilience towards storm surges. This interest has led to the following main objectives presented in the box and the working bullets presented below the box.

How well prepared to handle storm surges are the communities of Løgstør and Thyborøn and how can the communities enhance their resilience toward storm surges?

- Examine and define the strengths and limitations of the local community's that may influence the resilience.
- Examine how the locals prepare themselves and their property before a storm flood.
- Examine how the municipality through initiatives and plans have improved the community's resilience toward storm floods.
- Evaluate variables in the local community where an improvement would significantly enhance the community resilience towards storm floods.

The main objectives are aimed towards an assessment of how local communities can be strengthened to enhance the overall resilience towards storm floods. Also examined are the differences between the two chosen case studies and how the communities vary in their approach to prepare for storm surges. The decision to focus on storm floods is based upon the examination conducted by The Danish Environmental Ministry (Danish: Miljøministeriet) based on the report by IPCC from 2014 concluding that Denmark is expected to experience more intense storms and a rise in sea level. Combined, these are bound to cause a higher quantity or more intense storm surges, which is something coastal and fjord regions of Denmark has already experienced. When in this study flood is mentioned it implies the definition given by the Danish Flood Directorate, which is further described in chapter 2.1.1.

It is chosen that this study will focus on certain aspects of community resilience to give a more in-depth examination of the case community. The interest of this study is partially to uncover limitations that the locals themselves can improve. The focus of this study will be on the social aspect of the dimensions of resilience which in this case are social capital, community capacity, information & communication and institutional capacity. All these dimensions are easier and less economic to improve and develop meaning that the community are more likely to altercate these dimensions to be better prepared for a storm flood.

In this study the focus is only on two case studies in the northern part of Denmark. They have been chosen based on size, location and a number of parallel factors, which will be further explained in chapter 4. It is highly possible that different results would emerge if different case studies in another country had been chosen or even if different case studies in Denmark were chosen. However, the approach could be similar for other studies if the same natural hazard is considered. Most likely a number of similar strengths and limitations would emerge if the study was conducted elsewhere in Denmark where there are many aspects of small communities that

are comparable to the two chosen here.

In this chapter I presented the background for the interest in examining community resilience as well as the main objectives. Relevant concepts for this study and the conceptual model applied to assess strengths and limitations for the two communities will be presented in the next chapter.

PART 2

LITERATURE REVIEW AND METHODS



## 2 Key concepts and models of resilience

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For the study of community resilience towards storm surges occurring in smaller Danish communities a number of different key concepts and models on community resilience have been applied. First are key concepts related to climate change presented followed by a presentation of theories on resilience and community resilience. The analytical approach for this study based on two models is revealed and lastly the concept of community is presented.

### 2.1. Key concepts

Recently research on climate change and natural hazards have gone from being two separate research areas to now being combined in many studies (IPCC, 2012). Within both climate change studies and natural hazard studies a large number of concepts are applied, which sometimes overlap or occasionally have conflicting meaning within the different studies. Furthermore, disaster risk management and adaptation are very dynamic fields where the concepts and definitions evolve and change over time based on a varying context. A presentation of the different concepts related to climate change and natural hazards are given to offer an understanding of how the different concepts are understood and applied in this thesis. In addition, visual descriptions of how the concepts are connected and how they all relate to resilience are presented.

#### 2.1.1. Flood

The concept of flood and flooding can be somewhat comprehensive and are defined differently depending on the context. It can range from flooding of basements to time-based definitions (Miljø - og Fødevarerministeriet, 2016). Given that the study area is in Denmark, the Danish official government definition of floods will be applied in this thesis. The flood directive defines the type of flood they focus on as; *“floods of a time limited character where normally dry land areas are covered by water. This includes floods from streams, mountain streams, ephemeral streams and from the ocean in coastal areas.”* (Miljø - og Fødevarerministeriet, 2016). A temporary flood is caused by a time limited increase of water influx. In this thesis the relevant flood type is in a low-lying coastal area that experience floods in the shape of storm flood. The risk of flood disasters leading to casualties in the coastal region in Denmark is perceived as low due to the possibility of notifying the public one to several days in advance. (Miljø - og Fødevarerministeriet, 2016)

#### 2.1.2. Disaster

For a physical event to be defined as a disaster it must affect communities and human values. Disaster are by IPCC defined as; *“Severe alterations in the normal functioning of a communi-*



ty... due to hazardous physical events interacting with vulnerable social conditions” (IPCC, 2012, s. 7). Furthermore, these events will require instant emergency response. The United Nations Office for Disaster Risk Reduction (UNISDR) have a similar definition;” *Serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.*” (UNISDR, 2007) No minimum value of either deaths or economic losses are mentioned in any of the descriptions for an impact to be classified as a disaster. Such classification is however used in databases worldwide for natural hazards (Bye, Lein, & Rød, 2013). The number of disaster events will increase in an area if the area experiences a decrease in social conditions also understood as increased vulnerability. All disasters are local but their effects will cascade outwards and reach further out.

In this study the disaster will exclusively be floods caused by severe storm. There will be no minimum value of economic losses and losses of human lives to be needed for categorizing the impact as a disaster. In particular loss of human lives will be considered irrelevant since storm floods in Denmark are very unlikely to cause fatalities but only economic and environmental loss.

### 2.1.3. Vulnerability

The concept vulnerability has over the years had several different definitions depending on the theme being examined. (IPCC, 2012) Since the 1970’s vulnerability has been developed as a concept within disaster work and can within that context be seen as a result of a communities’ history, social, economic, political, cultural, institutional, natural resource, and environmental characteristics (IPCC, 2012). Vulnerability have over the years added to studies of risk and risk management by including focus on the social aspects of disaster management. It is important to not only examine the probability of a physical impact occurring but also the condition of a community. (IPCC, 2012)

In 2012 the Intergovernmental Panel on Climate Change (IPCC) defined vulnerability as;” *the propensity or predisposition to be adversely affected. Such predisposition constitutes an internal characteristic of the affected element. In the field of disaster risk, this includes the characteristics of a person or group and their situation that influences their capacity to anticipate, cope with, resist, and recover from the adverse effects of physical events.*” (IPCC, 2012, s. 8). The last part of the description concerning *capacity to anticipate, cope with, resist and recover from* is very alike the definition currently attached to the concept of resilience, which will be discussed later in the chapter. In this thesis vulnerability is seen as populations properties that affect the communities’ capacity to prepare for, react to and recover from a physical event in this study a storm flood.

### 2.1.4. Exposure

The concept exposure explains to which degree an area or community is exposed to a physical event. For exposure to be relevant there has to be a presence of either values or people in hazard zones that are then in jeopardy of obtaining a loss (Bye, Lein, & Rød, 2013). Exposure is by IPCC defined as;” *the presence of people, livelihoods, environmental services and resources, infrastructure or economic, social or cultural assets in places that could be adversely affected by physical events and which, thereby are subject to potential future harm, loss or damages.*” (IPCC, 2012, s. 8). The exposure definition by IPCC will be applied in this study.

### 2.1.5. Risk

Risk can be defined as the measure of *probability* that a hazard will occur. It’s a way to measure the threat of hazards in an area (Cutter, 1993). Risk are however by other seen as a function of probability and expected outcome; *probability x consequences*. When referring to probability one do not necessarily calculate the statistic probability but can rather perform a qualitative assessment of the risk. However quite a few different definitions of risk exist. It can also be applied to define the uncertainty regarding the consequences of for example a storm flood. Therefore, two sides of risk exist; probability with expected outcome and the uncertainty of consequences from an impact. (Bye, Lein, & Rød, 2013). UNISDR have another definition with focus on, “*the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or society over some specified future time period*” (UNISDR, 2009). Their definitions do not take in to account the probability of a hazard occurring. IPCC also take in to account the exposure to a threat and for example a communities’ vulnerability in their definition of risk. IPCC define disaster risk as;” *the likelihood over a specified time period of severe alterations in the normal functioning of a community*” (IPCC, 2012, s. 10).

A risk may always be present but not until people or human values are in the equation will it possibly lead to a disaster (Cutter, 1993). Risk are not shared equally. Some individuals or groups in a community will have a higher risk than others (Cutter, 1993). This could be socially or economically weak groups who does not have the resources and influence to prepare or respond adequately to a risk. In this study risk will be understood as the probability of damage on a community as a result of a physical impact combined with vulnerability and exposure.

### 2.1.6. Adaptation

Adaptation can be understood as a means to anticipate the different effects of a changing climate and implementing appropriate actions to either minimize the damage or fully prevent it from occurring (European Commission, 2016). The European Commission on Climate Change consider early implemented adaptation schemes to be more economical later on and prevent the loss of lives. An example of adaptation measures could be raising the height of dykes or levees due to a rise in sea-level or more intense storms. Adaptation to the ongoing change of climate



ultimately contribute to disaster risk management (European Commission, 2016).

IPCC define adaptation in human systems as: "...the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, it is defined as the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate" (IPCC, 2012, s. 12). Its relevant to note that the definition include beneficial opportunities that might arise due to climate change. The importance is to adapt to a changing climate and plan for both challenges and benefits. The definition applied in this thesis will be the one presented by IPCC.

Related to adaptation is adaptive capacity, which in this study is defined as a systems ability to adjust to change while also moderate the effects and cope with a disturbance. Adaptive capacity and the use of it can increase a communities' resilience (IPCC, 2012). Adaptive capacity will not be a key concept in this study because it has similar properties to resilience.

### 2.1.7. Recovery

Recovery can be seen as a process where a community have to restore, rebuild and reshape not only the physical infrastructure but also the economical and social systems after a disaster. Furthermore, the natural environment must undergo the same process with restoring, rebuilding and reshaping the system. When returning the community to a stable state after the impact there must also be focus on networks. Recovery can be seen as a process with different phases. First comes the immediate emergency period and secondly the restoration of the communities' basic services and functions and thirdly the reconstruction takes place. The reconstruction includes post disaster action such as restoring the community back to its normal state or improve upon the normal state known as the Phoenix effect. By Phoenix effect it is understood as a city or area rising out of the ashes after a devastating impact (Cutter, Emrich, Mitchell, Piegorsch, Smith, & Weber, 2014). It's a multidimensional task where focus is on several aspects such as job security, education opportunities, infrastructure, both physical and mental health conditions and the natural environment. Even though all these have to be rebuilt then post disaster social and economic trends are consistent with tendencies pre disaster. If a community is experiencing outmigration or if the community is in a period of experiencing growth in economy, then the disaster will disrupt the trend occurring at the time prior to the impact. Studies show that the population of a community will decline shortly after a disaster, which will cause an increasing inequality between the population choosing to remain in the community. This can possible affect the recovery (Cutter, Emrich, Mitchell, Piegorsch, Smith, & Weber, 2014).

Recovery will not be a vital key concept in this project given that the focus will be on the preparedness of a local community and the situation in the community prior to an impact.

### 2.1.8. Resilience

A concept that has changed significantly over time is resilience. Initially it has its origin in mathematics and physics where resilience was applied to a materials bending and bouncing back property. The materials ability to return to equilibrium after a dislodgment was termed resilience. Instead of breaking from an impact or when stressed it simply bounces back to the original state. Later on resilience was used to describe individuals' adaptive capacities (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). In psychology resilience is an individuals ability to handle adversity and rebuild themselves after a catastrophe. It is seen as the ability to cope with setbacks and arising problems (About Health, 2015). In the 1970's it appeared for the first time in disaster studies however with a different definition than from the engineering world. Holling was one of the first to define resilience in 1973. His definition was focusing on ecological systems and was; "The persistence of relationships within a system; a measure of the ability of systems to absorb changes of state variables, driving variables, and parameters, and still persist." (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007, s. 3).

Still resilience has varying levels of interpretation and appliance given that some apply it to the entire process of a disaster event – before, during and after impact. Common for most definitions are that they emphasize how important it is for a community to have the capacity to successfully adapt when confronted with disturbance or hardship. Resilience does not prevent distress given that it is commonly accepted that distress to some degree caused by an abnormal impact is standard. The definitions also have in common that the unit of analysis is a system or a community (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). Most definitions and discussion differentiate resilience with resistance. Both concepts have overlapping aspects but in this study only resilience will be applied.

Resilience is by IPCC defined as; "Resilience is defined as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions." (IPCC, 2012, s. 10). This definition focus on anticipation as well as improvement. Instead of only surviving and "bouncing back", as previous definitions of resilience emphasis, this definition stress bouncing forward. To build back better than what was previously there and to learn from prior weaknesses to avoid them in case of a future impact. The definition of resilience has a slightly different wording by UNISDR however the definition is very similar. UNISDR do not include improvement in their definition and the focus is therefore not on bouncing back improved from the state prior to the impact. The wording of the definition is as follows; "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions." (UNISDR, 2007). Susan Cutter defines



resilience in her article from 2008 as;” *Resilience is the ability of a social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat.*” (Cutter, et al., 2008, s. 599). The wording here is very different from UNISDR and IPCC and in Susan Cutters definition vulnerability have a central role as the inherent conditions.

All these definitions have in common that resilience is best described as a process or an ability, of for example a community, rather than an outcome. When choosing to look at resilience as a process the focus are on continual learning as well as deciding to focus on improving the communities’ capacity to handle impacts from hazards (Cutter, et al., 2008). Likewise, it can be argued that resilience is best seen as the ability to adapt to the circumstances rather than the ability to remain stable. If a community is stable prior to an impact but lack the ability to change any aspect of the community, it can be seen as lack of resilience. If one part of a system changes then the connected parts have to be able to adapt accordingly for it to be considered resilient (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007).

Along with resilience growing as a concept and becoming increasingly widespread so has the criticism. Most of the criticism accuses resilience of being inappropriate and inaccurate (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). That the concept is currently popular without a clear sense of how to measure resilience and compare the resilience of different places. The critic focus on how resilience is difficult to apply in real life and that the concept is very broad.

In this study the definition of resilience is the same as the IPCC. Resilience is seen as a process where continual learning is imperative for the community. An important aspect of resilience in this project is that after an impact the community should not strive to build back to prior conditions but to improve weak areas to enhance their overall resilience.

### 2.1.9. The connection between the concepts

The concepts that has been presented throughout this chapter are the cornerstone of working with climate change and extreme weather. These concepts are all related to managing and understanding how climate change will affect a given location. In figure 3 it is possible to see the coherence between some of the central concepts that has been presented. These concepts will be applied further in the study.

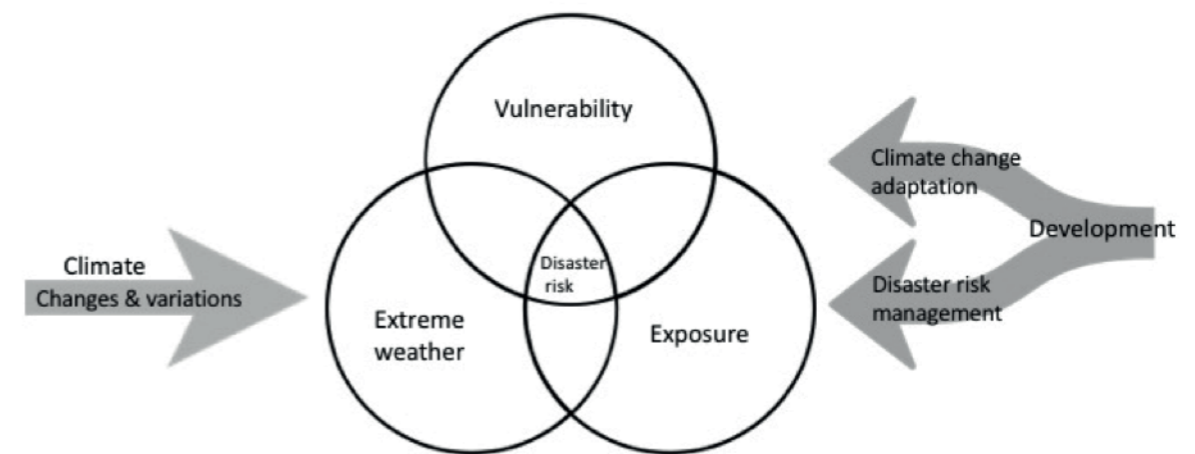


Figure 3: The connection between the concepts vulnerability, extreme weather, exposure and disaster risk. The model is from (IPCC, 2012) but is slightly modified for this study purpose.

As can be seen on the figure resilience is not included. Resilience can be visualized in connection with vulnerability like on figure 4. It is possible to see that vulnerability and resilience as partly overlapping concepts. The concepts are often linked in disaster studies. Vulnerability have lately to some degree been replaced with resilience in climate change studies due to similar overlapping characteristics. Also the shift has gone from focusing on a negative approach with vulnerability to a more positive approach with resilience. With negative approach it is referred to the fact that when working with vulnerability one highlights and points out weaknesses and flaws of a community. Resilience focus instead on how to strengthen a community and how to build on the existing foundation. Further on vulnerability will not be applied severely in this thesis given that resilience is an adequate way of analysing and examining the condition of a community prior to impact.



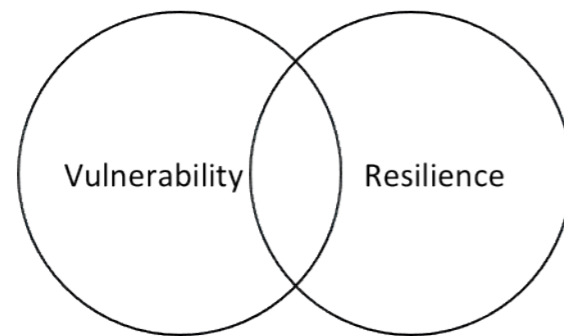


Figure 4: The connection between vulnerability and resilience. The figure is from (Cutter, et al., 2008).

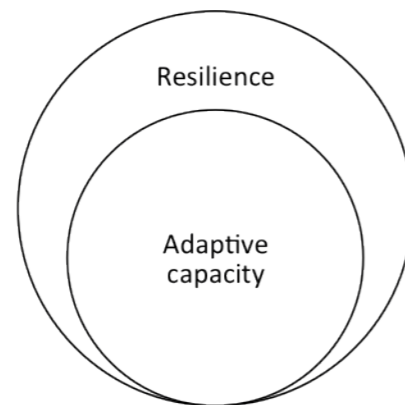


Figure 5: The connection between resilience and adaptive capacity. The figure is from (Cutter, et al., 2008).

Figure 5 shows how the connection between resilience and adaptive capacity is perceived in this study. Adaptive capacity is perceived as an integral component of resilience. Here it is seen as the ability to contain the results of disasters and recuperate without major disruptions of the social aspect. Resilience also include measures that will prevent damages arisen due to hazards and can be seen as preparedness (Cutter, et al., 2008). This is not something adaptive capacity is perceived as containing in this study.

## 2.2. How to measure resilience

How to become more resilient is the question but also the goal (Masterson, Peacock, Van Zandt, Grover, Schwarz, & Cooper, Jr., 2014). Resilience can be described as being a process of which to best prepare individuals or a community for a future physical impact. It's a process that creates adapted outcomes. A way to measure resilience is to look at how fast the return to pre-event functioning are. The faster the return the greater the resilience (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007).

The resilience of a community will always be connected to the treatment of its resources and the environment. A community that perform unsustainable practices regarding the environment

will be more prone to experience environmental hazards (Cutter, et al., 2008). There are currently ongoing discussions on how to efficiently measure resilience. Susan Cutter has proposed a more quantitative approach where six community resilience baselines are examined and then allocated a ranking. A final score is assigned a city or community. It is then possible to realize weaknesses and strengths compared to other places. The dimensions of resilience baselines proposed by her are social, economic, infrastructure, institutional capacity, community capacity and environmental. In table 1 it is possible to see the candidate variables of the community resilience indicators.

Table 1: Dimensions of resilience baselines and candidate variables. From (Cutter, et al., 2008).

Dimension	Candidate variables
Ecological	Wetlands acreage and loss, erosion rates, % impervious surface, biodiversity, # coastal defence structures
Social	Demographics (age, race, class, gender, occupation), social networks and social embeddedness, community values-cohesion, faith-based organizations
Economic	Employment, value of property, wealth generation, municipal finance/revenues
Institutional	Participation in hazard reduction programs (NFIP, Storm Ready), hazard mitigation plans, emergency services, zoning and building standards, emergency response plans, interoperable communications, continuity of operations plans
Infrastructure	Lifelines and critical infrastructure, transportation network, residential housing stock and age, commercial and manufacturing establishments
Community competence	Local understanding of risk, counselling services, absence of psychopathologies (alcohol, drug, spousal abuse), health and wellness (low rates mental illness, stress-related outcomes), quality of life (high satisfaction)

Examining the variables in the table is referred to by Susan Cutter as measuring inherent resilience (Cutter, et al., 2008, s. 604). Susan Cutter argues that resilience has two qualities this being inherent and adaptive. The inherent characteristic is prominent in non-crisis periods also known as prior to an impact. The inherent resilience is all the qualities a local community possesses when they are in a stable state. The adaptive resilience is seen as flexibility during disasters. During and after an impact the adaptive resilience will be the one applied (Cutter, et al., 2008).



### 2.2.1. Community resilience

Even though resilience and community resilience are two sides of the same coin small differences exist. When discussing community resilience, it is seen as the whole is more than the sum of its parts. Resilient individuals do not necessarily make a resilient community. Even though people living in a community is resilient together it may not be in a similar way (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007).

Planning for community resilience can be challenging but studies show that comprehensive proactive planning is the best solution for minimizing losses and avoiding large consequences from a hazard (Masterson, Peacock, Van Zandt, Grover, Schwarz, & Cooper, Jr., 2014, s. 183). Also to have an understanding and knowledge of the characteristics of the community in question is important for decision making and engaging in open communication when planning and making decisions. It is understood that an engaged but also an informed local community are capable at providing better support in regards to climate change adaptation & mitigation plans (Masterson, Peacock, Van Zandt, Grover, Schwarz, & Cooper, Jr., 2014, s. 184).

Community resilience can be argued to emerge from a set of networked adaptive capacities, which can be seen on figure 6.

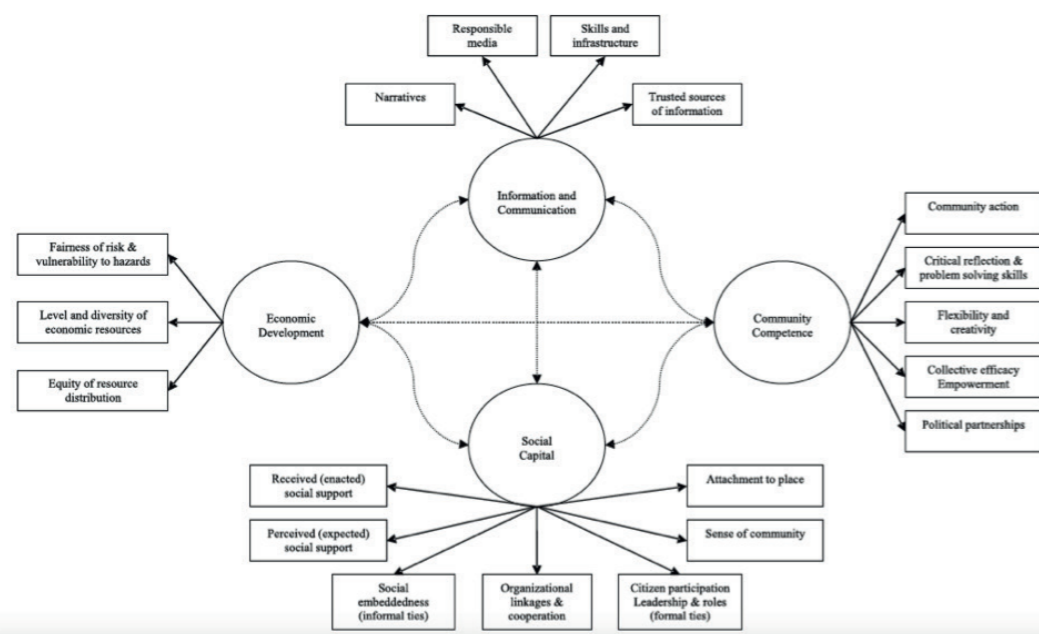


Figure 6: Community resilience as a set of networked adaptive capacities. The model is from (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007)

This understanding of community resilience is very similar to the one of community capacity presented by Goodman in 1998. He defined community capacity in two ways as; "1) the characteristics of communities that affect their ability to identify, mobilize, and address social and public health problems and (2) the cultivation and use of transferable knowledge, skills, sys-

tems, and resources that affect community- and individual-level changes consistent with public health-related goals and objectives." (Robert Goodman, 1998, s. 2). Many of the dimensions of community capacity are included in the set of network adaptive capacities seen on figure 6. Norris et al. have based on existing literature determined four capacities that in their opinion forms key dimensions in community resilience. These are economic development, information & communication, social capital and community competence.

Some studies reflect upon community resilience's role in preparedness. In this study the focus will be on identifying a communities' strength and limitations prior to an impact consequently mainly looking at enhancing the resilience prior to impact.

The resilience will be examined and measured loosely based on Susan Cutters dimension of resilience baseline presented in table 1. However, not all six baselines listed in table 1 will be examined for this study. The main focus will be on the social factors of community resilience such as community capacity, institutional capacity and social. The three remaining baselines will only be examined superficially. This will be further explained in chapter 3. The model by Norris et al. on community resilience as a set of networked adaptive capacities will also be used to examine and measure the community resilience. The two approaches or models have been modified and combined to work as an analytical approach. The modified model will function as an aid to analyse the current situation or inherent resilience in the chosen local communities. The model can be seen on figure 7.

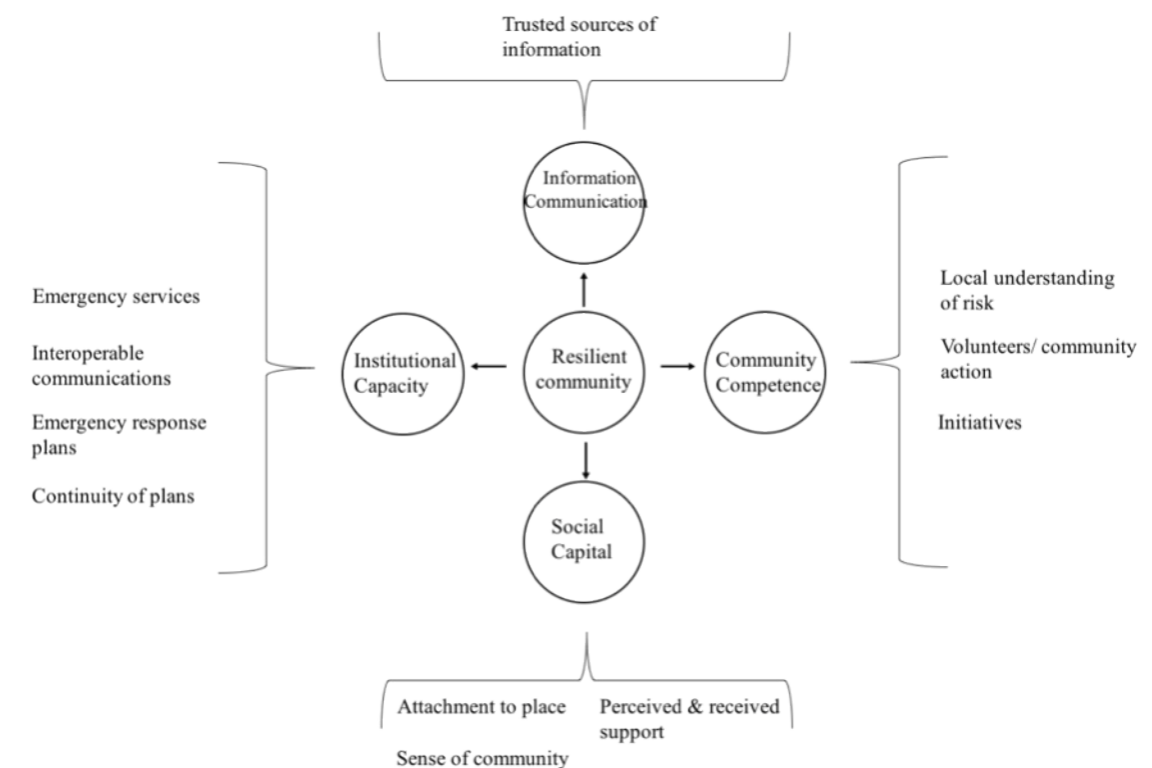


Figure 7: Modified model of figure 6 and table 1. The model shows the dimensions of community resilience and examples of variables that will be examined in this study. (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007) (Cutter, et al., 2008)



The model has four main dimensions of community resilience, which are community competence, social capital, institutional capacity and information & communication. All the portrayed variables from Susan Cutters dimension of baseline resilience and the variables from the model “Community resilience as a set of networked adaptive capacities” are not included in the modified model. Some of the variables have been excluded given that they have been perceived as least relevant or simply irrelevant for the chosen case communities. The exclusion of some variables is based on knowledge obtained concerning the case communities during the initial field trip. Likewise, it was determined that the focus of this study will be on certain aspects of resilience, which has been explained in chapter 1.2. Instead the focus will be on some of the variables portrayed in the model and any new variables that might be uncovered during the analysis.

### 2.3. The concept of Community

A central element in the main objectives for this thesis is the concept ‘community’. Many people have over the years immersed themselves in solving the following questions; “What is a community and how do we define it?”. Some attempts and definitions have emerged from such considerations (Agrawal & Gibson, 1999). Agrawal and Gibson argue that most definitions on community involve concepts of space, size and composition. They argue that a community can be defined as either; “*a small spatial unit, a homogenous social structure or a set of shared norms.*” (Agrawal & Gibson, 1999, s. 5). These separate definitions tend to overlap thereby a community can be both a small spatial unit as well as having a homogenous social structure. For example, if many of the inhabitants in a community work in the same industry i.e. fishing villages then the place and interests coincide. Agrawal argues that focusing solely on only one of the definitions is not adequate and an incomplete study (Agrawal & Gibson, 1999).

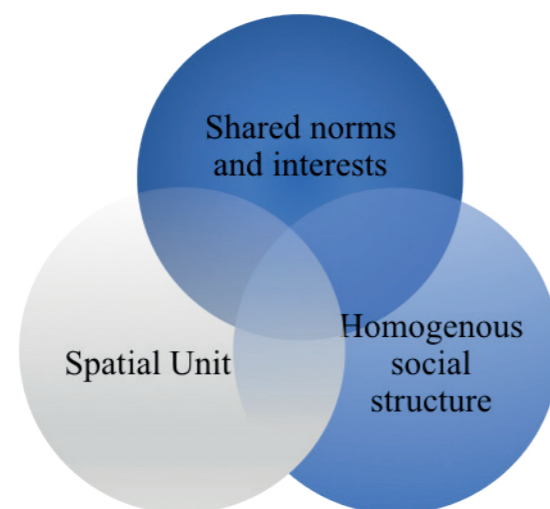


Figure 8: The three pillars of community.

Firstly, with “*a small spatial unit*” Agrawal & Gibson (1999) refer to a smallness of both the physical area as well as population size. A spatial unit refer to a territorial connection to the location of the community. Fewer individuals and a shared small space may provide a sense of community. Also it is likely that members of a small group, which are linked to the same geographical location are bound to interact with each other regularly. It will then lower the overall cost of making decisions in the community. However, as emphasised by Lee and Newby 1983 even though people live close together it does not inevitable mean that they are socially close (Lee & Newby, 1983). Communication and interaction between neighbours are not a must. It is therefore unlikely that a shared small space without any interaction between the residents will have a strong sense of community. Important is also the social networks that the local residents are a part of (Lee & Newby, 1983).

Secondly with “*a homogenous social structure*” Agrawal explain that usually observes believe that the local residents in a community must have somewhat similar resources in terms of income and other possessions. Furthermore, other characteristics such as race, religion, status and language/ dialect should be alike in the community. All these characteristics are believed to lead to a community forming such as for instance ‘Little Italy’ in New York. These similarities result in coherence within the community and strengthens the cooperation ability as well as lessening hierarchy. The assumption that communities have homogenous social structures align with the notion of a small spatial unit given that people living in rural towns often are employed in the same industry and share a similar dialect of the national language. Through a shared workplace interaction will be heightened amongst the local residents.

However, Agrawal points out that it is uncertain when a group may be labelled as “homogenous” despite having a number of things in common such as race or religion. Instead one should focus on the degree of homogeneity and how the things the inhabitants have in common play a role in the chosen study (Agrawal & Gibson, 1999). For example, how a shared religion plays a role in community resilience towards storm surges and climate adaptation.

Thirdly with “*a set of shared norms and common interests*” Agrawal and Gibson reasons that these follow from a shared small location, and the homogenous structure of the municipality. Ascher argues that a community consist of individuals who have both shared interests and identification (Ascher, 1995). Kiss argues that individuals in a community is bound to waive part of their individuality given that the community achieve its goals by working as a single body (Kiss, 1990). The community bounded by shared norms and interests derive from processes and interaction within the community. Often combined with perceiving others as outsiders. Norms in a community may benefit natural resource management due to some norms within the community prohibiting for example deforestation in certain areas (Agrawal & Gibson, 1999). Common norms may facilitate corporative decision making in a community. Therefore, the norms may encourage certain behaviour while also stopping other. Concerning climate change it may be a norm in the community that climate change is not believed to affect us. Norms are



not static and if a community today holds a set of beliefs it is not likely that they in the future will hold the exact same norms as important. Norms are seen to develop based on specific contextual factors. Even if the norms are written down or codified they are still prone to change (Agrawal & Gibson, 1999).

However, there are also disadvantages with such communities or networks given that they at times can be oppressive and not very open minded. They can appear somewhat closed off for outsiders. Therefore, communities interested in opening up to newcomers should consider working towards acceptance and difference even though likeness is one of the parameters that unite the community in the first place. If one is interested in judging the quality of life in a community shared expectations needs to be assessed. These expectations often involve implicit behaviour. Also important is to assess whether or not the individuals take on these expectations (Agrawal & Gibson, 1999).

Interaction is what allow people to form communities and makes it possible to have a social structure and what makes people commit to each other. Research shows that trust within social networks may enable individuals, neighbourhoods, enterprises and nations to thrive economically. Such social capital may help mitigate socioeconomic disadvantages such as peripheral location (Smith M. K., 2001). However, Putnam argues that;” *A society of many virtuous but isolated individuals is not necessarily rich in social capital.*” (Putnam, 2000, s. 19).

In this thesis the community is primarily defined as a geographic entity, a small spatial unit. When choosing the case cities, it was not a criterion that the community should have a homogenous social structure or have shared norms and common interests. This however does not exclude the communities from in fact fulfilling these aspect of the community definition. As Agrawal argues it would be an insufficient study to only understand a community as a spatial unit and not look at the interactions within. Therefore, it will also be examined in this thesis whether or not the two chosen communities have a homogenous social structure and shared norms.

As I will argue later I think that Thyborøn to some degree can be seen as a community with a homogenous social structure but as Agrawal argues, a community is only homogenous to a certain extent. Some parameters such as language with a dialect and ethnicity are prominent and common among the local residents. Others such as religion or caste are not entirely alike for the population in Thyborøn. This will be further examined in chapter 6.

In this chapter the concepts of climate change and the models applied for examining community resilience has been presented. Furthermore, the conceptual model applied to assess the strengths and limitations of the two communities in regards to community resilience has been presented. In the next chapter the applied methods and the methodology for this study will be offered.



## 3 Applied methods and Methodology

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The following is a review of the study design, applied methods and theoretical science reflections for this study. First presented is the structure of the study and the analytical approach of the empirical data. Secondly is a presentation of the applied methods and lastly theoretical science reflections.

### 3.1. Study design and structure

The following is a presentation of the structure of the study as well as a presentation of the methods utilized to identify the strengths and limitations and analyse the different dimensions of community resilience.

It was decided that the focus of this study would be on the social and institutional dimensions of resilience and not on infrastructure or economy. This was decided because a study of all dimensions of resilience would be too comprehensive and a focus on the four chosen dimensions would provide a deeper understanding of aspects the municipalities and the locals themselves considerable easily can alter and improve. The chosen dimensions of community resilience, which are community capacity, information & communication, institutional competence and social capital, can be seen on figure 9. If a community is flexible and understanding of the risk, the community is more likely to themselves enhance their resilience through initiatives. Community competence was therefore the initial dimension of resilience chosen to be examined in this study.

Institutional capacity was chosen based on an interest in exploring the capability of the municipality, Emergency Services, and other related public institutions in regards to preparing for storm floods and collaborating with the local population in affected areas. Examining institutional capacity is crucial to understanding how well the local community is prepared for a natural hazard. If the emergency plans and services are not comprehensive and carried out it may cause damage that otherwise could have been avoided.

Social capital is chosen to uncover the strength and limitations of the social relations within the community and also examine the sense of community the local's experience. Attachment to place explains why so many people live in vulnerable areas despite knowing the possible hazards they expose themselves to and the level of disaster risk. Examining the social capital dimension reveal how well the community collaborate and how tightly knitted the locals in the community are. This will affect the resilience if the locals are not helping each other before, during and after an impact or if they do not feel an attachment to the place.

Information & communication is included in this study based on the interest in examining

the exchange of information between the community and the municipality or other official institutions in regards to storm surges and the planning process. This is perceived as important for community resilience because lack of information or communication before, during and after a natural hazard could reduce the communities' resilience. Also important for the resilience is the trustworthiness of the sources of information and if the locals or the community take the information serious and perceive it as valuable.

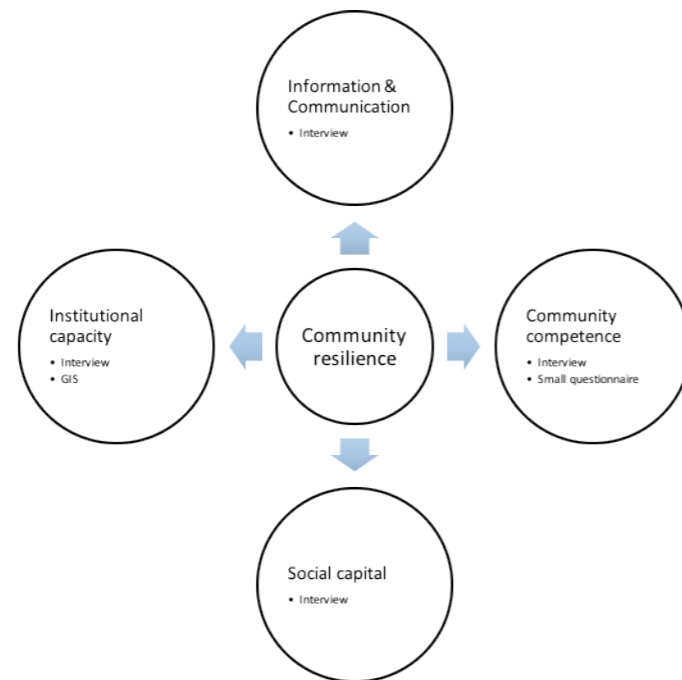


Figure 9: Dimensions of community resilience studied in this project and the methods applied to examine them.

For the different dimensions of community resilience being examined in this study, a number of mainly qualitative methods have been selected. Some of the main characteristics of qualitative research can be argued to be concerned with social structures and people's experiences of place. This aligns well with the interest in exploring how a community's social structures influence resilience (Smith, 2001). The fact that qualitative methods perceive the social world as ever changing and dynamic and as something that is always being constructed through the intersection of cultural, economic, social and political processes align well with the interest in examining the relationship between those processes (Smith, 2001).

The methods applied to uncover how the social structures influence the resilience in this study is presented on figure 10. Different qualitative methods have been applied for the different dimensions of resilience even though interview has been a common method applied for all four dimensions of resilience baselines. The sections have been examined through a number of interviews with the local municipality, the coastal directorate, the locals, emergency services, the water supply institution and an expert on floods occurring in Denmark. On figure 10 it is presented how the four dimensions of community resilience is examined through interviews.

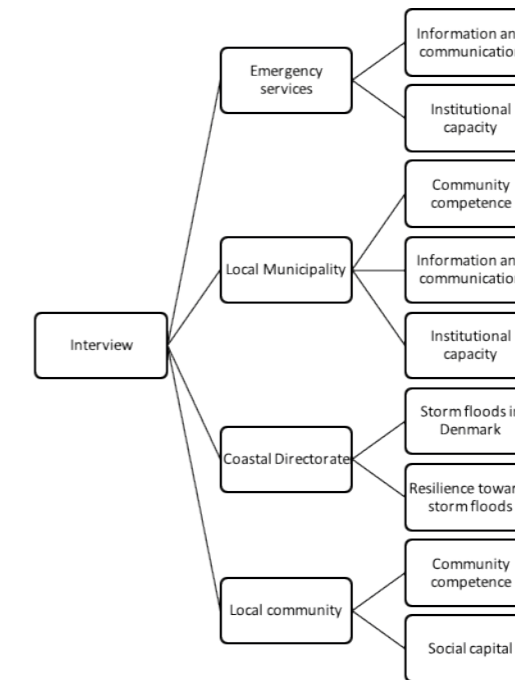


Figure 10: Graphic illustration of how the interviews cover the baseline components for resilience.

Furthermore, GIS have been applied to contribute with a visual presentation of the chosen case studies and to illustrate some of the initiatives the municipalities have implemented to enhance the resilience towards floods and mitigate the risk of large impacts. Also used as a method is a small questionnaire to examine the knowledge primary school students have of climate change and the implications of those.

### 3.1.1. Case studies

Case studies are commonly used when you are interested in conducting an evaluation (Crang & Cook, 2007). Since the study aims to evaluate the local communities strengths and limitations in regards to resilience this aligns well with the use of case studies. For this study the examination area will be two case studies of two chosen communities in the northern coastal part of Denmark. The location of the case studies can be seen on figure 11.



Figure 11: Map of Denmark

One of the reasons that the case studies is in Denmark is that access to the chosen case area is highly important. Given that I as a researcher am more familiar with the Danish system in terms of policies, social structures and existing organizations I presumed that the access to needed data would be greater and that fewer barriers would exist. Also a better understanding of the existing data on hazards, climate and the environment would be the case.

For this study two case studies have been chosen due to the time limit of the thesis, which minimize the amount of in-depth cases it would be possible to work with. It was decided to have two case studies since measuring resilience can be very challenging. However, comparing the resilience and the strengths and limitations of the different approaches in two communities, is feasible. The cases are chosen based on a wish to have somewhat similar cases as regards to size and main hazard they are exposed to. A dialog was formed with my previously professors at Aalborg University of possibly interesting case studies. The case city of Løgstør was first chosen because of the city experiencing storm surges regularly. Furthermore, the city is small in Danish standards making it possible to get a good overview of the community. When choosing

the second case study a number of factors had to be similar to Løgstør so comparison would be possible. In particular, these were size of city/community and flood exposure. Based on these factors and a dialog with the coastal directorate in Denmark Thyborøn was chosen as the second case study.

Community cases are by (Yin, 2014) seen as less specific cases and are therefore more challenging to define than for example group cases. The concepts of a community presented in chapter 2.3. presented knowledge, which have been applied in determining the unit of analysis since community case studies are not easily defined in regards to beginning and end of the selected case (Yin, 2014).

## 3.2. Applied methods

The following is a presentation of the applied methods for this study. The methods are chosen to best answer the main objectives and it was from the beginning the intention that the study should be qualitative, therefore the methods are predominantly qualitative. Also the time frame and resources of this study has been taken in to account.

### 3.2.1. Document analysis

In chapter 4 literature and statistical data is used to gather a contextual knowledge concerning the situation of the two case studies. In connection with the gathering of relevant data a document analysis has occurred and also an evaluation of whether the applied references are valid.

The largest part of the applied literature in chapter 4 has been located on the internet through a search on selected keywords. With the aid of keywords, it has been more proficient and easier to navigate the internet search while making it more specific. By preselecting keywords, it is determined that the internet search became more relevant and efficient. Such keywords were storm floods, community resilience or climate change and was in particular helpful during the literature search for chapter 2. In some cases, the keywords have functioned as a starting point for the snowball method where already found literature and their references lead to new relevant material.

The applied literature is attempted to be examined through triangulation by comparing a number of sources to retrieve correct and relevant data. This occurred when finding data for the literature review where several books and articles on the same subject was examined to better comprehend and present a correct application of the different concepts of climate change.

## 3.3. Interview

The main method for this study is interview. Through the interview it is possible to uncover an individual's personal views and beliefs and interviews are perceived as one of the primary methods for collecting qualitative data (Crang & Cook, 2007). The reason interviews are the

main method for this thesis is because it is possible to retrieve information that would not be available through use of literature review or observation. A questionnaire would not give the option to ask in-depth question or follow up on interesting earlier unknown topics.

The interviews were semi structured and conducted in person. Focus groups discussions were considered but were deemed to unlikely uncover information that couldn't be retrieved through standard interviews. The advantage of using a semi-structured interview guide is the possibility to let the research participant steer the conversation to areas they find important in regards to the chosen topic. There is more room to improvise questions that later on can be added to the interview guide. After performing an interview in the first case I gathered necessary follow-up questions that have been used in other interviews. Therefore, the interview guide was updated and re-evaluated after performing the first interview. I recorded the interviews and transcribed them afterwards. This was due to the fact I was able to focus more on follow-up question and body language while interviewing without taking notes. However, I did encounter one research participants who were not comfortable with being recorded and in this case I had to rely on the notes from the interview and make them extensive.

Regarding where to conduct the interview I initially planned to conduct interviews outside the research participant's homes and in more 'neutral' settings such as a café to establish a professional environment. However, none of the locals had such a concern and I was invited to their homes to conduct the interview with all research participants. It did however not become an issue concerning creating a professional environment given that all research participants were serious and focussed on the interview questions. In the event of interviewing employees of the municipality I encountered them at their workplace. The same applies for the expert at the coastal directory.

### 3.3.1. Respondents

In regards to the research participants from the municipalities and other official institutions purpose sampling was used. I examined beforehand who were most likely to have knowledge capable of shedding light on the main objectives and working points. Creating contact with employees from the municipality, the Emergency Services and the Water Supply institutions was done through their official webpages contact information. This proved to be an effective approach and all the intended interviews were accomplished. In Lemvig municipality I received an invitation to be part of a meeting on climate adaptation and future challenges regarding natural hazards in Thyborøn with different actors connected to the topic. This provided a different view on resilience in not only Thyborøn but also Løgstør and made it obvious that the Water Supply Institution was an important stakeholder in preparing small communities for storm surges and floods in general. It also provided me with an interesting insight in how municipalities communicate and how they solve problems. Prior to the interviews with the municipalities an

examination of the policies and current plans for climate adaptation was done. Also a short evaluation of any potential challenges and limitations in regards to preparing for storm surges was made to be able to receive more detailed answers.

The expert interview was arranged through a contact at the Danish coastal directorate. It was intended to be an interview face-to-face but due to unforeseen circumstances the interview was conducted over telephone and email. The expert was chosen based on recommendation from my main contact at the Danish coastal directorate and an interest in interviewing a person with extensive knowledge on storm surges and preparedness for these in a Danish coastal context.

Purpose sampling was not the case when interviewing and getting in contact with the locals. Instead random sampling and a snowball sampling occurred in both case cities. On figure 12 it is possible to see the web through which the connection with the locals were made. On arrival in the cities contact was made with the local museum, in both case cities, that had knowledge about locals who had experiences with storm surges and had a central role in the local community. It is therefore possible to argue that a purpose sampling was then performed by the gatekeeper from the museum. When explaining to the gatekeeper what research participants I was interested in, the description was; someone with knowledge of the community, who had experienced storm surges and possibly felt the repercussions of the impact. Furthermore, an interest in speaking with research participants of different genders, background and ages was expressed. This interest was fulfilled given that the research participants in this study are diverse in terms of gender, occupation, age and whether they have always resided in the case cities or migrated later in life.

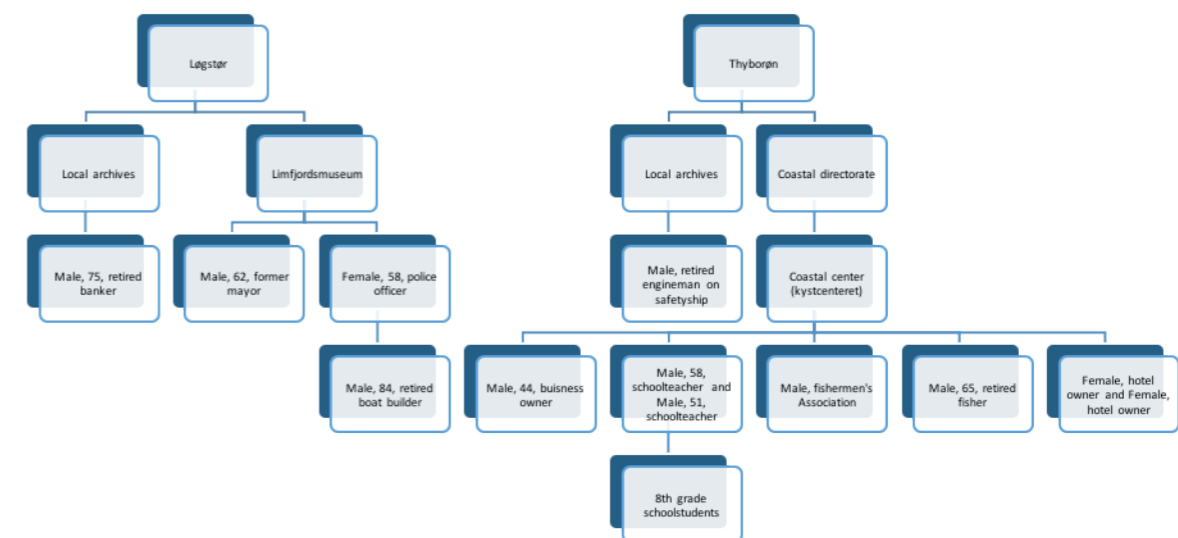


Figure 12: Web of contact with local research participants in Løgstør and Thyborøn.





It has in particular been a challenge to create contact with locals in Løgstør compared to Thyborøn. In Thyborøn the gatekeeper from Kystcenteret, that was made contact with through the coast directorate, was very invested and helpful in creating contact with research participants for the study. The gatekeeper arranged the meetings with almost all the locals in Thyborøn and gave a short explanation of what the interview was focusing on. Because of the gatekeeper's approval and interest in helping with contacting local research participants a certain amount of trust was granted me before the interview given the gatekeeper is a respected member of the community. In Løgstør the gatekeeper from Limfjordsmuseet was helpful with contact information of a few locals that had knowledge of the community and had experienced floods. However, creating contact with additional locals proved a challenge given that small communities in Denmark tend to be somewhat closed off towards outsiders. Therefore, a higher number of interviews were conducted with the locals in Thyborøn than with the locals in Løgstør.

On table 2 an overview of all the conducted interviews is presented. In total 21 interviews were conducted for this study each between 20 – 60 minutes of length except two interviews, which were conducted through email.

Table 2: Research participants

City	Locals	Employee municipality	Official institutions
Thyborøn	8	2	2
Løgstør	4	2	3
General			1 (expert)

### 3.3.2. Types of interviews

Throughout the study three types of interview was applied; telephone interview, face-to-face and e-mail. The different types have been applied to interviews with different research participants were they were assessed as the best approach at collecting data based on different factors such as time and approachability.

The most applied interview type was the face-to-face, which was used to collect all the interviews with the locals, employees at the Water Supply Institutions and municipality employees. All of the interviews were, as previously mentioned, semi-structured some more than others. The interviews with the Water Supply Institutions were borderline unstructured with mostly categories and topics noted that was of interest for the study. The reason behind favouring the face-to-face interview is because follow-up question can be made not only on what the research participants say but also on facial expressions and body language. Furthermore, often unpre-

dicted topics arise that is easier to further explore when conducting face-to-face interviews. However, it is the most time-consuming type of interview of the three types used in this study but it is assessed that the benefits far outweigh the negatives in terms of time spent traveling and transcribing.

The e-mail interview was used with the Danish Home Guard (Danish: Hjemmeværnet) and the expert interview. The advantages in conducting written interviews are plenty such as it is possible to get in contact with people over great geographic distances, people who have a busy schedule and they are time-saving in terms of traveling time and the unnecessary need for transcribing. Furthermore, an advantage is that the research participants have the possibility of forwarding the interview questions if they feel someone else also would be appropriate for answering the questions. This occurred with the Danish Home Guard who forwarded the interview questions to a higher ranking operative.

The telephone interview was in this study used to create initial contact and ask tentative questions to the research participants. Through the telephone interview a more in-depth face-to-face interview was always scheduled. The telephone interview made it possible to evaluate and consider whether the contacted person would be relevant to interview for this study and also made it possible to ask more in-depth and complex question during the face-to-face interview because the time could be spent more wisely.

### 3.3.3. The design of the interview questions

General for all the interviews is, that it has been the priority to uncover how communities were prepared for storm surges and what factors that either enhance or diminish community resilience. The questions are based on literature studies on the topic and the already occurred natural hazard. The model from Norris on adaptive capacities of community resilience and Cutter's dimensions of resilience baselines have been taken in to account when the interview guides were constructed. All questions were open except the intro questions regarding occupation, age and time period residing in the city.

The questions prepared for the locals focused on their experiences and understanding of the local community and storm surges. The questions can be divided in to several categories such as; introduction, experiences with storm surges, mental & physical impact from storm floods, preparedness, knowledge and understanding of risk, local community, communication and satisfaction with the municipality.

The questions for the municipality and Emergency Services focused on practices instead of merely opinions giving the nature of the research. They were aiming at uncovering the success of the current climate adaptation measurements and the preparedness plans for current and future impacts. Also the municipalities and public institutions were asked about the local community and whether the locals have been included in the planning process as a resource.

It was important that the questions were not leading in any way and that it did not appear as



though the interest was to dramatize the storm surges events and their impact on the case cities. The intent was to have neutral questions that in no way were weighted and to exclude own assumptions from leading the questions.

### 3.3.4. Coding of interviews

All the interviews have been transcribed to improve the coding process and make it more approachable. Since transcribing interviews are very time-consuming some interviews only have the core part transcribed that were deemed relevant for the study. The interviews were coded based on the modified model presented in chapter 2.2.1, which is the analytical approach for this study. Beyond the already expected variables connected to the dimensions of resilience presented in chapter 2.2.1. others emerged throughout the coding process. These were then categorized after which dimension of resilience they perceived to be linked to. Several variables arose during the interviews with the locals and the municipalities that beforehand were unpredicted. The coding consisted of assembling quotes and citations from the interviews that indicated the presence of one of the variables under the dimensions of resilience. All the interviews were examined for strengths and limitations in terms of enhancing the community resilience.

### 3.4. Questions for 8<sup>th</sup> grade school students

In addition to the conducted interviews a small case study of a class of primary school students in Thyborøn was conducted. The study focussed on their knowledge on climate change and the impact the change already has and will have on the city. The small case study was conducted due to an interest in how the future generation of Thyborøn perceive climate change and the local community.

Five questions regarding the student's knowledge of global climate change, how climate change would affect Thyborøn, whether the students have any concerns regarding climate change's impact on Thyborøn, how Thyborøn could prepare for an impact from floods and what advantages and disadvantages they experience living in Thyborøn were handed out to around 15 students both female and male. The class teacher gave permission for the students in the 8<sup>th</sup> grade to anonymously take part in the study and the questions were previewed by the class teacher before they were distributed to the students. An attempt to obtain permission from the students' parents, given that the pupils are under 18 of age, was rejected by the class teacher as unnecessary. During the period where the pupils answered the questions the teacher was present alongside me, however the class teacher gathered the answered questionnaires to maintain anonymity. The processing of the data collected from the school students are especially sensitive given that the students are underage so no identification indicators were collected throughout the case study of the primary school students. The coding of the answered questions proceeded like the coding of the interviews.

### 3.5. Application of GIS (Geographical Information System)

In this study GIS have been applied to provide general information and understanding of the case studies. In the following the application of GIS will be described.

For the different GIS maps data from the Danish Geodatastyrelsen have been used. The Digital Elevation Model (DEM), Kort10 and Corinne Land Cover are all available from Geodatastyrelsen under Kortforsyningen for the general public. In some occurrences the application of GIS has been illustrative as already existing data which didn't needed to be altered portrayed areas of Denmark. The data from Kort10 was already created and no further work was required to illustrate the chosen case cities except creating a polygon of the case cities.

Given the data available to download at Geodatastyrelsen do not have the exact format needed to run the tools in GIS they have been prepared beforehand. Both Thyborøn and Løgstør are low-lying flat areas with the city located by the fjord. To only get a view of the cities a feature polygon of the case city was created for both cities removing the surrounding water bodies.

#### 3.5.1. Impermeable surface map

The impermeable surfaces portrayed in chapter 4.2. are all hard surfaces creating a hindrance for water to percolate during heavy floods. When observing the landscape in Thyborøn during a fieldtrip it became evident that most surfaces was covered and that most locals had paved their gardens. To present a more realistic view of the impermeable surfaces a buffer of 1-meter determined through examination of satellite photos was created around all buildings. This was created using the *buffer* tool in Arc Map.

### 3.6. Positionality and ability to do research

Positionality can be explained as how a researcher is positioned to different power structures and in return how these power structures affects how the researcher understands and perceives the world (Moser, 2008). It is important to take in to considerations how who you are as a person has shaped your knowledge of the world. You may have some assumptions that you perceive as universal truths but are not perceived the same way by others. These assumptions have over time been created and influenced by your experiences. Your positionality may bias your epistemology but if you are aware of this you may prevent it from affecting your study immensely (Takacs, 2003).

I have grown up partly in a small fishing village, Skagen in the northern part of Denmark. My upbringing, beliefs and understanding of the world will most likely align with my research participants in both the case cities. Also the locals appeared more open and interested when I mentioned my background and connection with Skagen. This helped establish trust with especially the locals since they felt that I had a decent understanding of both Løgstør and Thyborøn.



Another factor to consider is the dialect the older generation of both case cities, and in particular Thyborøn, speaks with. This could potentially pose a challenge given that it can be hard to understand for outsiders. It did, however, not become a hindrance during the interviews in Thyborøn partly due to me having family in the north of Denmark that speak with a similar dialect. The fact that language was not a barrier helped gain the like of the locals and they were very willing to talk when they realised that their dialect was understandable to me. However, my relative young age could be a hindrance to my professional role as a researcher making me appear unexperienced. This could lead to the research participants viewing me as unserious and unqualified for performing such research. During my time in the field I did, however, feel very well received by the research participants and my position as a student or my age was, as far as I know, not a hindrance during any interviews. Everyone was extremely helpful and had an interest in the study subject despite my initial fear of being taken unserious. Also my position as a student appeared to make the respondents more inclined to speak about limitations in their community. This could be caused by an impression of me as an independent researcher having a more neutral view on the study subject. A solution to circumvent a negative first impression from the respondents would simply be to be prepared and show interests for the local's knowledge and community.

It is also highly important to take in to consideration how a researcher's personality possible can affect the study and collection of empirical data. (Moser, 2008) argues that when reflecting upon one's positionality one should also take in to consideration the researchers personality and how the personality could have an effect on the examination. One important personality trait when conducting interviews is the ability to interact with new people and interact accordingly in such situations. It may be uncomfortable to encounter strangers in their homes for a first time interview, which was the interview setting in this study. Here decent social skills and an open mind combined with the capacity to associate with strangers is essential. You are not encountering each other on neutral ground but are a guest in a stranger's home and the ability to act professional yet humble is essential. If a researcher has a shy or introverted personality such situations may be an unnecessary challenge and a hindrance to the research. Even though being in a stranger's house in the beginning made me very self-conscious I did not have any difficulties with interacting professionally and accommodating with my research participants. Having travelled and studied abroad has enhanced my natural ability to interact with people of different background and beliefs. It has provided me with the ability to meet people with an open mind-set and the capability of being relaxed in a new setting.

### 3.7. Ethics

An aspect that is important to consider when conducting research is the ethically one. Is it possible that the research will do the research participants any harm? Will harm be prevented if

the research participants are anonymous in the study? In this study or when gathering empirical data, I do not foresee any part of the chosen topic to cause harm to the research participants when the thesis is made public. Resilience nor community resilience are not perceived as particularly controversial or harmful topics. The only problematic issue would be if some where to take offence if their community would be ranked as more or less resilient.

In an effort to get the research approved the Danish coastal directorate was early on contacted to inquire about relevant communities for the study. When conducting the field work in Thyborøn the Danish coastal directorate was helpful with finding gatekeepers. The Data Protection officials for Research in Norway has also been informed about the research objectives. The study has been permitted and the handling of gathered data has been approved.

The intent for my study is to have the research participants included anonymous since providing any information except work title, gender and age is irrelevant. All research participants have given their permission for their name and information to be public and applied in the study if necessary. Interviews with municipality officials are anonymous but often only one person in a smaller municipality have a certain work title. Even without a name it will thus be possible to identify who the research participant is. All municipality officials have given recorded oral consent for their names to be used.

Throughout the field trip all research participants have been given a brief explanation of the research study and consent is given on audiotape. Every research participant was not presented with the exact same explanation of the research aim given that the municipality has to have different information to answer the questions fully. However, the locals were still presented with a full and exact presentation of the research and the objectives. The municipality was not informed of the findings from the interviews from the locals despite one of the municipalities interests in conducting a similar study. This was decided based on the interests in asking the locals questions they may not be inclined to answer if the raw data would be presented to the municipality officials.

### 3.8. Methodological reflections

In this study a number of choices were made in regards to methods, the performance and the research participants. The significance of these choices will in the following be reflected upon.

A fundamental choice for the study was that the focus would be on four dimensions of community resilience. This has had a great impact on the results of the study given if other dimensions had been included other results may have emerged. By choosing to only focus on four dimensions it was possible to conduct a more in-depth examination of variables that could be improved to enhance the community resilience. Despite only having chosen four dimensions it was at times challenging to uncover essential limitations and strengths for a relative large number of variables. If given the chance to perform a similar study it would be beneficial to conduct



an initial round of fieldwork in both case cities and analyse the empiric data to pinpoint areas of interest and then return for a second fieldtrip to conduct an in-depth examination of a few chosen variables. This could have provided a more streamlined study where less relevant variables within the four dimensions of resilience could have been sorted out of the study. Then the main focus could have been of a smaller number of variables but with a less superficial examination.

The interview as the main method have proven to be a suitable choice for this type of study. It enabled me to get a better understanding of how the local communities were constructed and to get an insight in to the relationship between the local community and the municipality. This would have proven more challenging had another form of method been chosen. Initially GIS was intended to be applied to conduct an analysis of where in the case cities the water would flow during a storm flood with different water levels but this proved to be very time-consuming and unmanageable because of the flat terrain in Denmark. This would have added a different dimension to the analysis given that it would be possible to see if the Emergency Response Plans were accounting for the flow of the surface water.

In regards to the research participants it would have been suitable to have a larger spread in age for Løgstør. It would have been interesting for the study if a few of the research participants were younger to obtain a view of how the new generation perceive the risk of storm floods. This was met in Thyborøn where it also proved easier to create contact with possible research participants than in Løgstør. If a similar study were to be conducted interviews with the Storm flood Council would be able to shed some light on how well and fast different areas of Denmark bounce back after an impact.

Some of the critic that are often given to studies attempting to examine and measuring community resilience is a lack of subjectivity when choosing the variables for the different dimensions of resilience (Cutter, et al., 2008, s. 6). Here it may shine through, which ones the researchers believe to be important based on their positionality. It has been attempted to diminish this by using variables from existing models and by having an open approach when coding the interviews. Also critics point out that these approaches have problems with lack of availability for some of the variables (Cutter, et al., 2008, s. 6). This was the case for this study as well given that some variables had more empirical data able to shed light on the strengths and limitations than other variables. This was however expected from the beginning, which is why no ranking system is applied in this study. Furthermore, critics point out that there are difficulties concerning validating the results of the studies (Cutter, et al., 2008, s. 6). It is always a challenge when conducting qualitative research but I believe to have a large enough sample size and the strengths and limitations have been determined through both interview with the public institutions and the locals to get different views in the topics.

Overall it proved possible to answer the main objectives with the chosen methods and approach.

In this chapter the methods applied to examine community resilience have been presented as well as the methodological reflections. In the following chapter the study area that has been chosen for this project will be presented to give an insight to the layout and characteristics of the case studies.



Figure 13: Picture of Thyborøn

## PART 3

## ANALYSIS



Figure 14: Picture of Løgstør

## 4 Presentation of study areas

The empirical data gathered for this master thesis is based on the case studies of these two cities, Løgstør and Thyborøn. The following is a description of two chosen communities. Both cities are located in the northern part of Jutland along Limfjorden as is illustrated on figure 15. Limfjorden is the largest fjord area in Denmark with a 1500 km<sup>2</sup> water surface (Muslingebyen 2015). However, the fjord was only a true fjord from year 1100 to 1825 because the North Sea breached Aggertangen on the western shore during a winter storm granting Limfjorden access to the oceans both west and east of Denmark (Muslingebyen 2015). The water level in Limfjorden rose quickly and to prior unseen levels due to the breach from the ocean. Afterwards the landscape was forever changed and instead of the breach closing as in other instances it became wider over the following years. The channel is now approximately 1 km in width (Lemvig Kommune 2015). However, this was not the first of the storm floods occurring in this part of Denmark. Already in year 1624 the ocean washed over the isthmus near Thyborøn for the first time in a long period (Sørensen 2015).

The breach had large consequences for the cities located along the fjords shore. The previous freshwater turned salt and the former tranquil fjord started flooding yearly (Sørensen 2015).

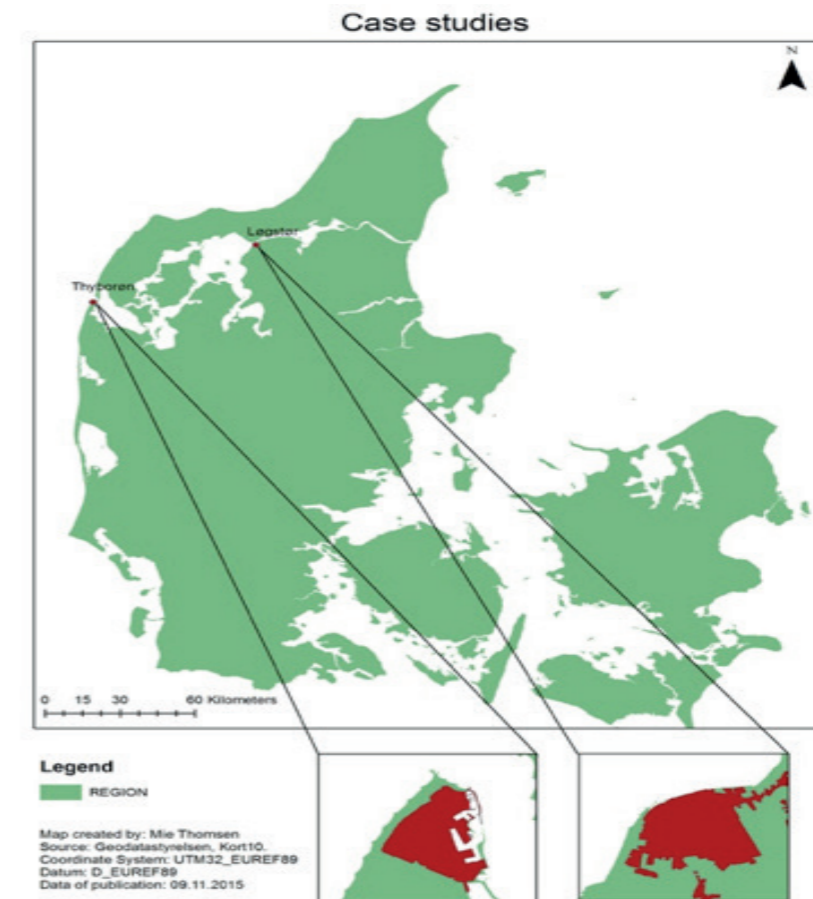


Figure 15: Map showing the location of the case cities

### 4.1. Løgstør

Løgstør is located inland by the edge of Limfjorden and was in 2006 measured to take up an area of 218 km<sup>2</sup> (Danmarks Statistik 2015). The city has expanded toward south and after the 1900 the locals began to settle above the old coastal cliff (Gyldendal Redaktionen 2014). On figure 16 it is possible to see the infrastructure of Løgstør.

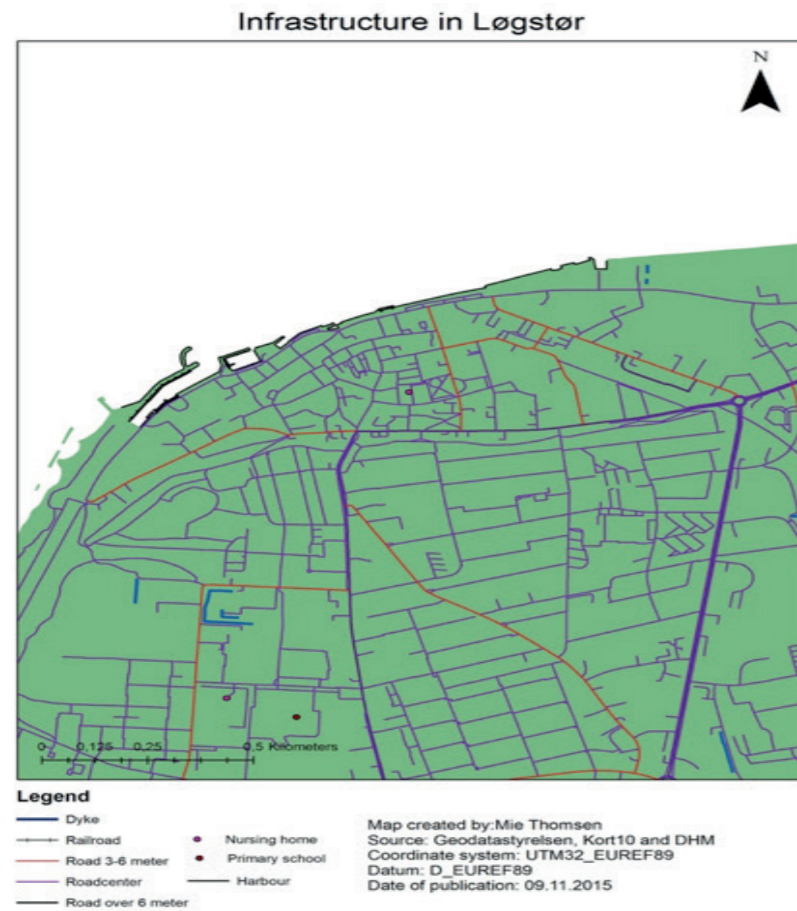


Figure 16: Map of the infrastructure in Løgstør

The city is part of Vesthimmerland municipality and in Region Nordjylland (Vesthimmerlands Kommune 2016). In 2015 the city had a population of 4220 people divided between 2188 females and 2032 males. Ever since the foundation of Løgstør in 1516 the population have been steadily rising (Danmarks Statistik 2015) (Muslingebyen 2015). However, from about year 2000 the net migration has been negative showing a trend that people are now moving away from Løgstør. Often the younger population move away to pursue a higher education, which is not offered in Løgstør. Likewise, more people in Løgstør pass away each year than the influx of new-borns. Where as only 17 were born in 2015, 67 people passed away the same year. Almost 50% of the population, 2109, is over 50 years of age showing that it is an older population that are inhabiting Løgstør (Danmarks Statistik 2015).

The city was founded for the purpose of a herring fishing industry, which have later on altered to mussels when the water in the fjord changed from freshwater to saltwater. Today the mussel

industry is one of the primary industries in Løgstør in combination with tourism (Muslingebyen 2015). The old fishing industrial area now houses wood and metal industries and the harbour is used for smaller yachts (Gyldendal Redaktionen 2014). The tourism industry has over the years progressed to an important function in Løgstør with the Limfjordsmuseum as the primus motor. The city is renowned for their sizeable gathering of volunteers who are devoted to making Løgstør more appealing to tourists as well as locals (Vesthimmerlandsmuseum 2009).

Løgstør has since the breach at the west coast experienced several large floods from Limfjorden. The areas surrounding Løgstør is higher than the area upon the city is built. On figure 17 it is possible to see how low lying the city is. The red area is toward the fjord and is hardly any level over normal water level for the fjord, which can be seen in the legend on the map to be at 0,29 m. Also it is possible to see on the map that Løgstør has a rise in topography where the red area is changing in to a green, which is the area the city is expanding towards in regards to new residential zones.

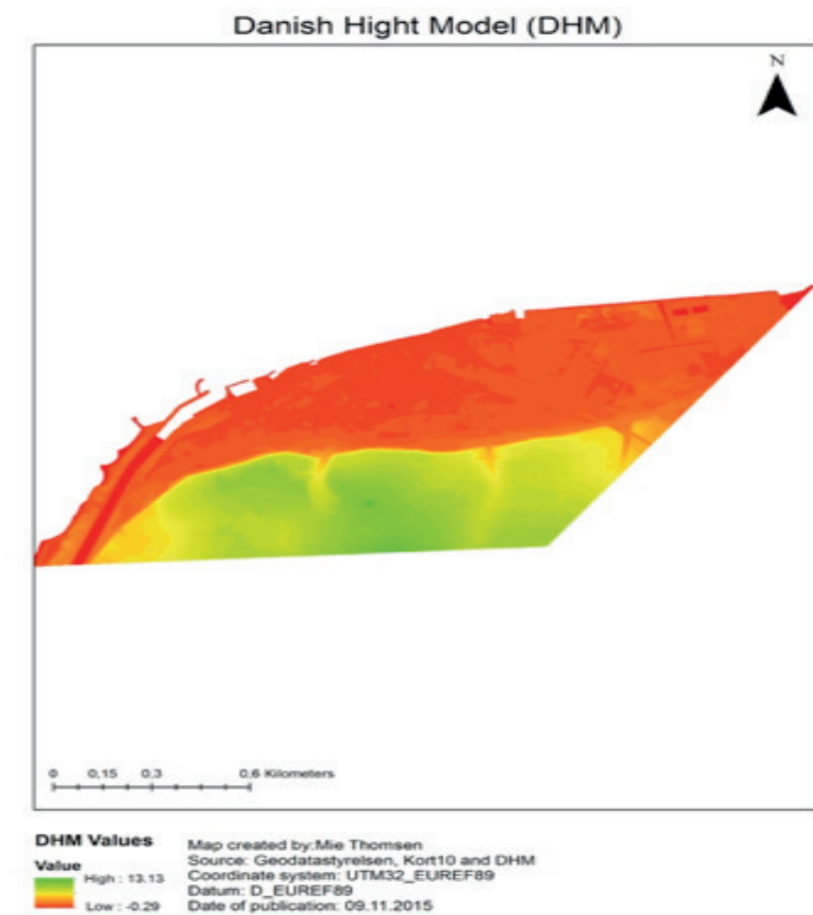


Figure 17: Map of the Danish height model in Løgstør

Also the fjord narrows significantly where Løgstør is located as can be seen on figure 15. These two aspects cause water to be pressed on to the low lying area of Løgstør during severe storms flooding the buildings near the waterfront. Quite a few older and valuable buildings are located

near the waterfront, which leads to larger economical loses during a flood. The distribution of the values of buildings can be seen on figure 18. The value is calculated in Danish crones by Kortforsyningen.



Figure 18: Value of buildings in Løgstør

The municipality had in 2005 numerous mitigation measurements installed to prevent the water from penetrate the city. Among those are a seawall and several pumping stations as the main technical instalments. The coastal protection can be seen on figure 19.

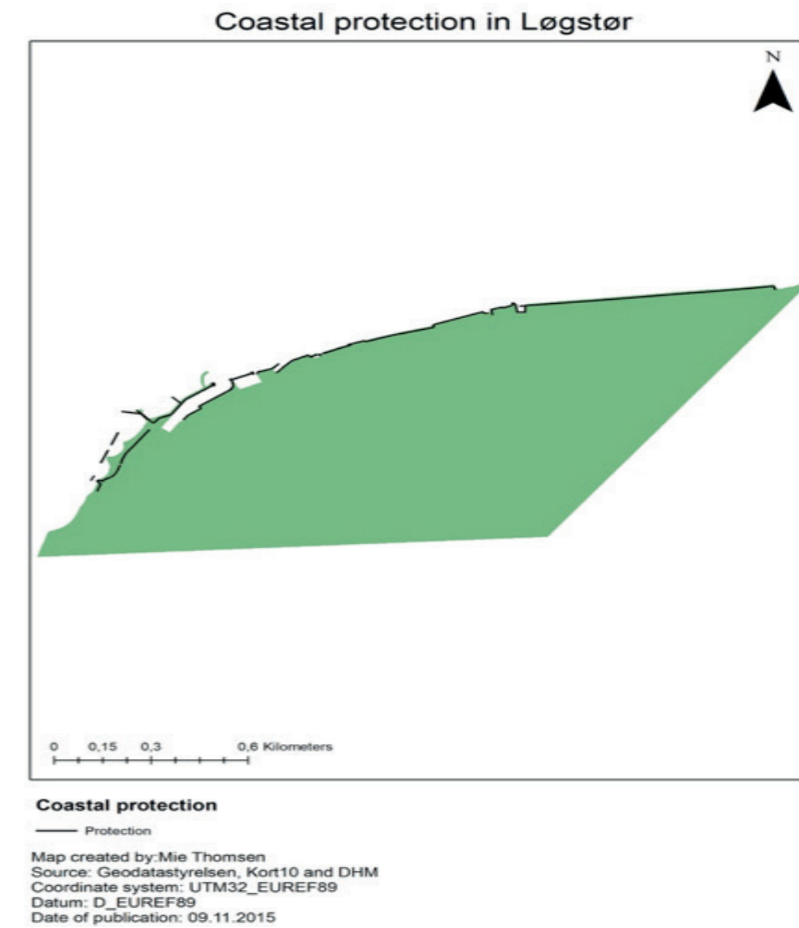


Figure 19: Map of coastal protection in Løgstør

One of the larger challenges in the future for the municipality regarding planning for climate change is the predicted water level rise in Limfjorden. The city has not experienced any mayor floods since the instalment of the water barrier along the waterfront, however with a rise in the water level the wall will not be sufficient in height (Male, municipality employee Løgstør). This will be discussed more in detail in chapter 5.

## 4.2. Thyborøn

Thyborøn is located on the west coast in the middle part of Jutland covering an area of 42,44 km<sup>2</sup> including Harboøre. The city can be argued to be somewhat isolated given that it is located on an isthmus. As can be seen on figure 20 the city is covered by dikes. The largest dike in the city can not be seen on the map given that the data was not available for GIS. The dike is installed parallel to the beach and are presumed to withstand a flood the size of a 1000-year event. On the map it is portrayed as the road running parallel to the coastline on the left side. This is because a road is built on top of the dike. Within the city a number of smaller dikes are blending in with the everyday scene preventing water from penetrating from the harbour to the settlements.



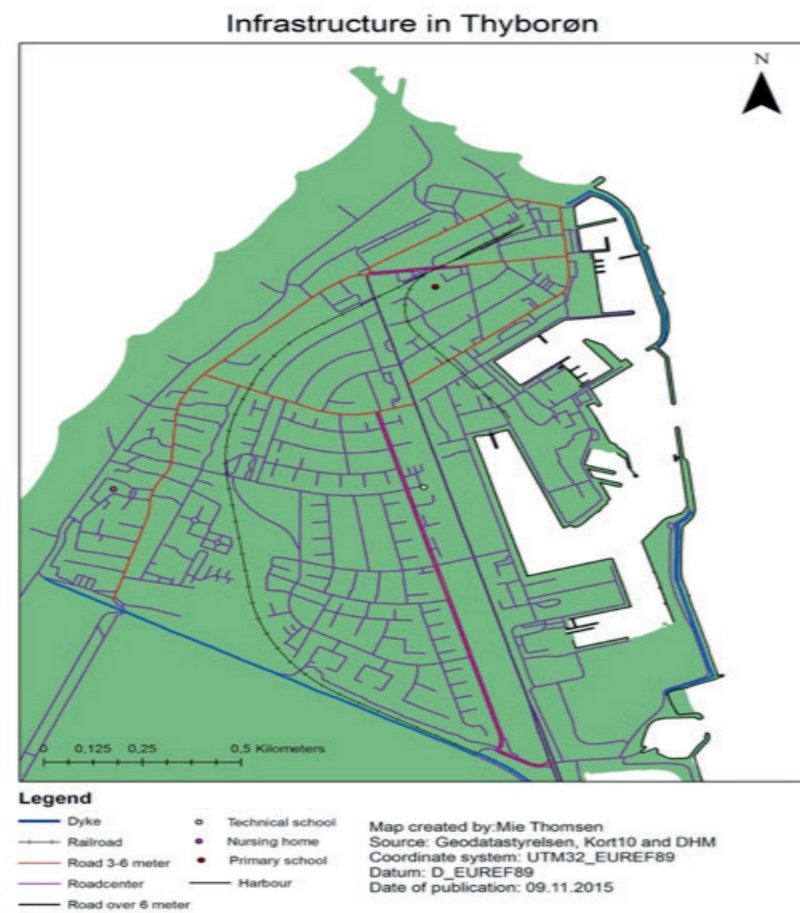


Figure 20: Map of the infrastructure and critical buildings in Thyborøn

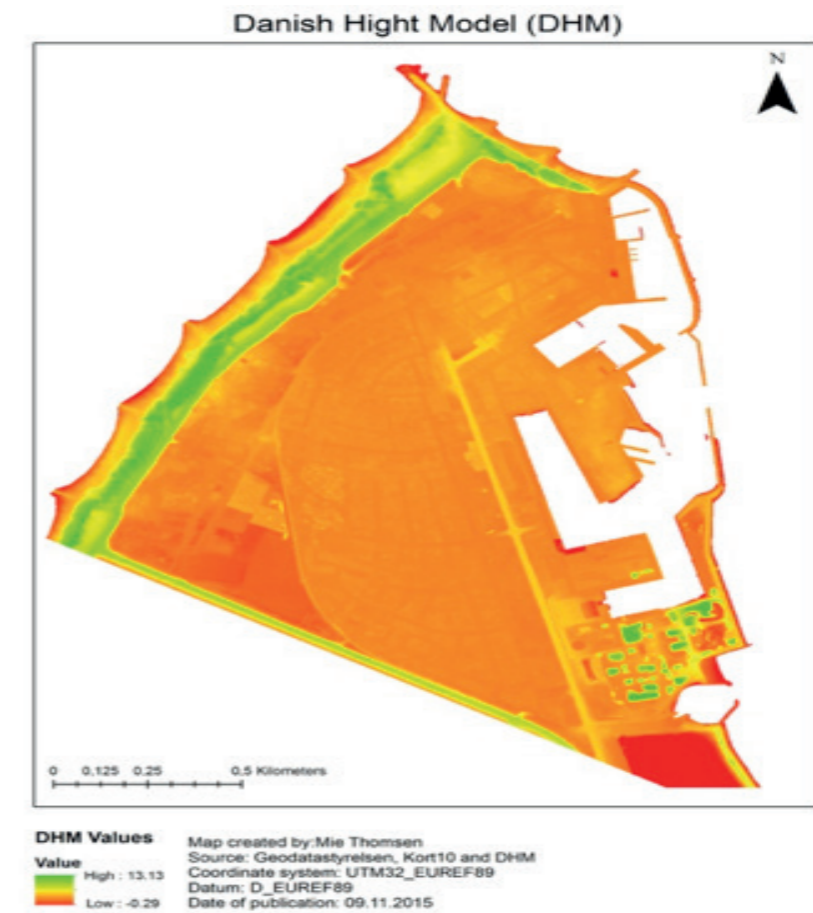


Figure 21: Map of the Danish Height Model (DHM) in Thyborøn

These smaller dikes were installed between year 1875 and 1933 and contributes to Thyborøn having the topography similar to a bathtub (Lemvig Kommune 2015), which can be seen on figure 21. The long green line line running along the beach on the left side of Thyborøn on the map is the 1000- year event dyke. Beside the dyke Thyborøn is almost the same low height above water level throughout the entire city.

Thyborøn is part of Lemvig municipality and in region Midtvest (Lemvig Kommune 2016). Thyborøn had a population of 2104 people in year 2015 divided between 1096 males and 1008 females. There is a large older population given that 986 people living in Thyborøn in 2015 were over 50 years old (Danmarks Statistik 2015). This aligns with the overall trend in Denmark of an aging population in the more rural and isolated areas. The city has over the years struggled with a declining population due to a number of factors. Since 1995 the net migration has been negative with 37 people moving from Thyborøn in 1995 and steadily rising until 114 people moved out of the city in 2005. Also a larger number of people pass away each year than number of children being born. In 2015 Thyborøn had 10 new-borns and 29 deaths (Danmarks Statistik 2015).

Education is one of the influencing factors on migration given that Thyborøn only offer an academic education until the age of 15 where as any further education must be taken outside of the city. Often girls migrate to pursue a higher academic education where as the boys more commonly follow in their fathers' paths working in the fishing industry or a related industry (Male, 58, local schoolteacher).

Thyborøn is still existing today largely due to the fact that the Danish state was previously

interested in upholding the city as a rescue and recovery base for stranded ships and shipwrecks. In 1874 a commission with focus on preventing further storm floods and the oceans erosion of the isthmus was set up. They decided to construct groynes along the coast as we see existing today (Sørensen 2015). The groynes was constructed from year 1875 to 1933 and have prevented the coastline from retreating (Lemvig Kommune 2015). The channel to the fjord was secured by law in 1914 even though further discussions ensued in the coming years (Sørensen 2015).

Fishing and the related professions has always been the focal point for the city's development. Still to this day the harbour as well as the fishing industry play a large role in the city's economy (Sørensen 2015). This has led to Lemvig Municipality becoming one of the municipalities in Denmark where the population have an above national average income. Over the years' tourism has also become a main industry with museums, the beaches and a Coastal centre drawing in visitors. The community itself has been successful in gathering local volunteers for festivals and the like during summer peak (Palle Røn 2016).

One of the city's larger challenges planning wise is the lack of undeveloped land. Hardly any space within the city borders are available for improving the infrastructure or for climate change mitigation measurements. The municipality no longer have any vacant parcel of land in Thyborøn, which proves it difficult to expand the city. In connection with the former problem the city also struggles with impermeable surfaces (Lemvig Kommune 2016). As seen on figure 22 several areas of Thyborøn are covered by impermeable surfaces leaving very few large areas bare for water to percolate. The residents in Thyborøn have to percolate rainwater on their own land, which is a challenge given that many have chosen to cement their plot. To add to the issue, the groundwater table in Thyborøn is high with lager inland lakes appearing after intense rainstorms (Lemvig Kommune 2016). The map portrays buildings in Thyborøn with a 1meter buffer to represent the cemented gardens.



Figure 22: Map of impermeable surfaces with 1-meter buffer around the buildings in Thyborøn

Figure 23 portrays where the most valuable buildings in Thyborøn is located. It is possible to see that the most valuable buildings in monetary terms are located away from the waterfront. However, one of the most valuable buildings for the fishing industry is located right at the waterfront on the harbour but is not in this calculation included as a valuable building since it does not include industrial buildings.

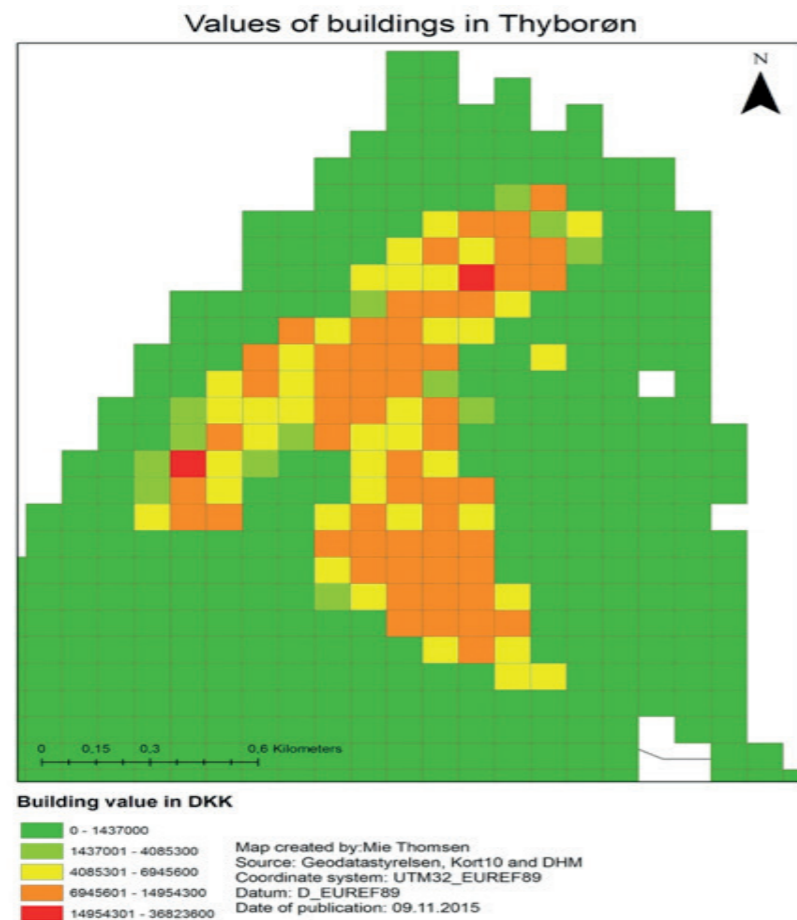


Figure 23: Map depicting the value of buildings in Thyborøn

### 4.3. Summary

The two cities chosen as the case studies are both located by Limfjorden. Given that both cities experience floods from the same source enables one to compare the flood occurrences and the local communities' reactions in the two cities. The communities' similarities such as tourism as a main industry, fishing as a former main industry, an older population and challenges with outmigration to name a few makes it more relevant to compare the community resilience of the two cities. However other factors differ such as the size of the cities as well as the challenges they face regarding climate adaptation. The challenges they face are much alike, however, the already implemented precaution actions differ significantly.

In this chapter the two case cities have been presented giving an understanding and visual comprehension of the type of local communities that have been examined. In the following the strengths and limitations of these two communities will be examined to understand how well the local communities are prepared to handle storm surges.

## 5 Strengths and limitations in regards to enhancing community resilience

The following analysis is centred around the modified model of community resilience presented in the chapter 2, section 2.2.1. The four main classes of community resilience identified for this thesis; community competence, social capital, institutional capacity and information & communication function as the frame for the analysis. The conducted interviews of the locals, the municipality and the remaining actors listed in the methods are the empirical foundation of this analysis. The perceived strengths and limitations of the case cities in regards to enhancing their resilience towards storm surges are the stakeholders own assessment of their associated communities. Therefore, the opinions presented throughout the analysis are not necessarily similar to the understandings and observations that I, as a researcher, experienced during my stay in the case cities. However, these views and experiences will not be taken in to account until a discussion of which limitations may enhance the resilience is presented in chapter 6. In order to validate and assess the thoughts and beliefs of the different stakeholder's theory on community resilience will be taken into account to examine which of the limitations that would be most appropriate to work with in the future.

The analytical approach is based upon figure 7 in chapter 2, section 2.2.1.

### Box 5.1. Local primary school student's perception of climate change

During the time spent in one of the case cities, Thyborøn, an opportunity to gather information regarding primary school students understanding of climate arose. Five questions regarding the student's; knowledge of global climate change, how climate change would affect Thyborøn, whether the students have any concerns regarding future climate change impact on Thyborøn, how Thyborøn could prepare for an impact from floods and what strengths and limitations they experience living in Thyborøn, was handed out to around 15 students both female and male from 8<sup>th</sup> grade.

#### Responses from the pupils

When asking the pupils generally about their knowledge of climate change it was evident based on the responses that their knowledge was limited. Nine out of 15 pupils answered that they knew nothing or very little of the concept while the remaining students were aware that the earth would become warmer in the future and that it was related to a change in the weather.

Only few was knowledgeable about the impact from climate change and mentioned that the ice on Greenland was melting and that the global sea level was rising as a consequence of climate change. Overall it was evident that young people in the 8<sup>th</sup> grade are not well-informed or educated on climate change on a global scale yet not through their education and only limited through the media.

However, a few students were aware of how future climate change would in particular affect Thyborøn. Half of the pupils responded that the city would be flooded and would not continue to exist in the future due to Thyborøn being a low-lying city. A few said that the harbour would be damaged and that the water from both the ocean and the fjord would rise causing problems for the city. The other half of the pupils were not aware of how climate change would affect Thyborøn. The responses from this question made it evident that the location of Thyborøn and the low landscape that could be flooded was the most known consequence of climate change for this area of Denmark.

When asked if they had any concern regarding future changes in Thyborøn caused by a changing climate two thirds expressed no concern and revealed that it is not a subject they think about at all. One fifth was concerned with the low-lying nature of Thyborøn and expressed concerns about whether Thyborøn would survive in the future. A few revealed that they had no plans to continue residing in Thyborøn and was therefore not concerned about the city's survival. During a conversation with the class teacher he revealed that the girls partaking in the study was most likely to leave Thyborøn to pursue careers outside the city borders. It was reasoned that females have a harder time finding jobs in a city with fishing as the dominating industry. Given that young people in 8<sup>th</sup> grade already has decided that they will not continue to reside in Thyborøn it paints a picture of a city losing strong resources early on.

The majority of the students, who had suggestions as to what Thyborøn could do to better handle storm floods in the future, proposed building embankments, heightening existing dams or further develop the existing groynes. None suggested mitigation measures instead they focused on solution where you improve the infrastructure. One student suggested heightening the ground the city is built on or simply building higher buildings.

Lastly the pupils were asked about advantages and disadvantages they experienced when living in Thyborøn. Of positive attributes the picturesque nature and beach was mentioned by one fifth of the pupils. Peace and quiet and the fact that everything is within walking distance was mentioned by a few students. Half of the students regarded the fact that everyone knows each other as an advantage and a few mentioned that the collective and unity was a benefit. However, the disadvantages outweighed the positive and especially the weather was mentioned as a disadvantage. It rains often, its very windy, its very cold and the looming climate change were pointed out by several students as negative attributes. The location and size of the city was also stated as negatives given that its far to the nearest metropolis and that everyone knows everything about each other.

Overall the answers from the students painted a picture of limited knowledge concerning global climate change and slightly more when asked about how climate change would affect Thyborøn. However, it was not a topic that many of the students was concerned about on a daily basis nor did they in particular have suggestions on how to prepare for and prevent storm floods besides building higher dams. Some students did indeed have knowledge on the topic but it was still somewhat limited to only one answer or one suggestion.

The reasons behind the students lack of knowledge on the subjects are unknown however it could possibly be related to the municipality's policy of not sharing information regarding risk or exposure to floods. This will be discussed in section 5.4.

Also important to consider is that the students listed more negative attributes and disadvantages to living in Thyborøn than positive. Some students only listed disadvantages and was unsuccessful in presenting advantages. This paints the city in a somewhat negative light given that the future generation of the city have multiple parts they are currently unsatisfied with. This is likely to contribute to the high outmigration, which the municipality is battling currently.

## 5.1. Community competence

### 5.1.1. Local initiative towards floods

Whether or not a community is proactive in containing the prevalence and impact of storm floods can be examined through the local initiatives aimed at mitigating floods, adapting to the impact of the floods or helping the community bounce back after an impact. The community resilience model by Norris stress that it is important that a community can take action after an impact.

A male, 75-year-old, retired banker in Løgstør told how he had experienced that the local community came together to raise money for the people affected by the storm flood in 1981. After the flood Lejernes klub, which was a local club released a flood stamp for a limited period of time. (see appendix 1). This stamp was printed in connection with a benefit for the locals suffering from the impact of the storm flood. The benefit was organised in the sports hall, Løgstørhallen. They raised roughly around 70.000 DKK, which helped cover the damages that the locals did not get covered by their insurances. Support could be applied for if your property had been damaged in the storm flood. This can be seen as an example of a community gathering their resources for a cause they believe in and aid their neighbours who experienced severe flood damages. This is not a mitigation measure but help the locals adjust to the new reality after the impact in 1981 and contributes to the community bouncing back to the condition prior to the impact. It is unclear whether the benefit contributed to the community rebuilding back stronger or simply repairing their damages and bouncing back to their old condition. According to a retired boat builder a storm surge insurance or storm surge council was non-existent back then so

there was no requirement to either build back better or to build back at the same level of quality.

Today the municipality have secured the area surrounding the harbour against storm floods so the locals are not upholding the same amount or voluminous initiatives as previously explains the municipality. One informant told that when they are alerted to a possible flood in the cinema, where he is a volunteer, the 'jungle drums' commence and information is passed around in the local community. They protect the cinema by bordering it up with sand bags. It may not be equivalent to the initiatives that the locals used to have towards floods prior to the initiatives from the municipality was implemented. But today the locals still prepare some vulnerable buildings for water damages.

However, the local community has earlier shown that they are very capable of getting initiatives that they are passionate about off the ground despite lack of funding or back up from the municipality. A Female, 58-year-old, police officer told how the local community raised money for Lanternen. This is a culture – and sports center that the mayor of Vesthimmerlands municipality was not concerned about funding. She explains how the local community fought for Lanternen in almost ten years and in the end went around and collected money in the community to raise a start-up capital. They succeeded in this and collected 1000 DKK from each local resident and in the end Lanternen was built because of the perseverance from the local community. She ends the story by saying that you can gather a lot of people and support in the local community if there is a needling cause. This portrays a very resource strong local community that can accomplish large initiatives without the help of the municipality.

Given that Thyborøn does not experience floods nearly as often as Løgstør it is understandable that they do not initiate the same amount and extent of local initiatives. Unlike Løgstør, Thyborøn seem to have less local initiatives that focus on mitigation or adapting their social and natural environment to be better equipped and prepared for current and future storm floods. Currently none of the locals were able to recall any such initiatives having ever existed. When the storm hit in 2005 and the city experienced water in the street no one contacted the local hotel owners to warn them about high levels of water surrounding their property. The female hotel owner told that: " *The harbour drives around 24 hours a day but we didn't receive a call when we got water in [our hotel].* ". They also note that the reason why no local initiative is yet organised is that floods are currently occurring somewhat rarely. The last very big flood was in 1981 and it came very unexpected. If floods occurred every year all the locals were convinced that some sort of preparedness contact list would be organised or a similar initiative would be prepared.

### 5.1.2. Volunteers

Volunteer work demonstrates an interest in the community and in enhancing the attractiveness of residing in the city for not only the tourists but also locals. It is also a way to evaluate how

much time and effort the locals are willing to put in to their community.

Several of the locals mentioned that the volunteers in Løgstør is a large asset to the city. They expressed how Løgstør is the city in Vesthimmerlands municipality with the largest activity level and engagement from local volunteers and how the surrounding cities tend to envy the commitment of local volunteers in Løgstør. A few of the research participants are themselves volunteers in several organizations because they have an interest in making Løgstør a great place to live. Both the municipality and former mayor perceive the volunteers as a strong resource for the city in regards to both helping prepare the city when alerted to storm floods and to make Løgstør an appealing place to be. When warned about a storm flood the volunteers help prepare sandbags for the emergency services (storm flood preparedness service) and deposit the bags in strategically chosen places in the city for the local residents to retrieve. During a storm surge around 3000-4000 sand bags are used with an extra 1000 on stock. The storm flood emergency service has 60 volunteers on contract that all have some background in fire brigade training since no uneducated volunteers are allowed in the storm flood emergency services.

One of the task the volunteers have taken on is to actively attract new people to move to Løgstør. The former mayor explains how the volunteers have created an embassy with the purpose of getting more people to move to Løgstør. When it was made public known that a number of public agencies is being moved from Copenhagen to Aalborg the volunteers in Løgstør made goodie bags with treats and information about Løgstør to bring to the agencies in an attempt to attract the people required to move with the agency. According to the informant's own words the intention was to lure people to Løgstør and the initiative was all done by local volunteers.

Løgstør is known for their large gathering of volunteers who have started initiatives ranging from festivals to a culture- and sports centre. A female, 58-year-old police officer tells that earlier on Løgstør didn't have nearly as many volunteers as today probably due to a lack of need for them in a provincial town. But given that the community has changed over time certain initiatives to hold on to the locals living in Løgstør and make the city attractive to tourist have become necessary.

Overall Løgstør appear to have a large gathering of volunteers who are willing to spend their spare time making Løgstør a more appealing place to be. The volunteers are perceived by the official institutions as a resource that can be called upon to prepare the city for storm floods, which contributes to enhancing the resilience of the community.

Volunteers and volunteer work was not such a prominent subject with the research participants in Thyborøn. Still some locals mentioned being active in different voluntary associations and appreciating the work put in by some volunteers to create summer events and celebrations. A male, 58-year-old schoolteacher recalls how the community themselves built the current Sports Hall. Every Sunday for a long period of time volunteers gathered to build the hall and there was never a lack of workers. According to the informant it is not a problem to gather volunteers

and free hands for such projects. This indicates that the local community is capable of finishing large projects on their own and that the volunteers are a decent resource for the local community. The municipality also mentioned that if the local community wants something done it happens immediately. Even if the municipality is not supporting the initiative the local community have no problem getting it done on their own. However, their gathering of volunteers can in no such way compete with Løgstør that is known far and wide for their gathering of local volunteers. Still, it is a smaller resource that are enhancing to the community resilience.

### 5.1.3. Local understanding of risk

One of the described aspects of community capacity in the model by Norris is the locals understanding of the risk, towards in this case, storm surges. When conducting the interviews with the locals some questions were aimed at examining this issue. Therefore, they were asked whether they felt the municipality had informed them adequately about the risk in regards to storm surges and if they have any worries about the future in connection with the community's exposure to floods.

When talking to the locals from Løgstør it was evident that they are well aware that Løgstør is highly exposed to floods due to its surrounding natural environment and the climate change occurring. A male, 75-year old, retired banker explains that; *"Floods are a natural part of living in Løgstør. As soon as there was wind from north-west we could risk experiencing floods so it is something you get used to when you live here."* From the informant's quote it is clear that he is aware of the potential risk as well as when that risk is most prominent. Growing up he has experienced several floods and are thus understanding of the high risk of floods. It is, however, not something he fears instead he has adapted to a life where floods are a part of living in Løgstør. A female, 58-year-old, police officer took into consideration the topography of the city when building a new house. The family looked at the contour lines of Løgstør to identify an area with a low risk of flooding. She is aware of why floods are occurring in Løgstør and explains that: *"The problem is that there is a narrow passage at Aggersund. Until they built the Aggersund bridge during the war, Løgstør never experienced vast floods because the passage was wide enough. They narrowed it to pin the bridge and back then there was surrounding meadows that could absorb the excess water. So now we experience up to a meter difference in water level on the shores of the bridge. Since the bridge was built the water levels under floods has risen every year. And it's not only caused by climate change but also the narrowing of the passage for the water."* She is aware of the circumstances that have led to floods hitting Løgstør particularly badly. She continues by saying that she prepares her property with sandbags and boards in front of the doors because: *"In Løgstør we know that it can be intense"*. She is aware that the risk is high because the exposure is equally high. She feels as though they are well protected from the most common storm surges, however, she knows that: *"But it [the seawall] can't hold of*

*the water if it's over 1,80 m [over normal water level]. Those times we have a flooding at 2,30 m then we have to take the damage"*. The female police officer perfectly understands the risk but is willing to compromise the exposure to floods on behalf of maintaining the aesthetics by the waterfront. They have chosen to live near the water and therefore wants to be able to actually see it. Several locals mention that they are not interested in building a massive seawall to hold off any future potential water level given that they want to enjoy the views of the fjord and attract tourists to the city. She also mentions that when you live in Løgstør you are aware that you have to do something yourself to secure your property from flood damages. That some mitigation measures and a level of preparedness by yourself is needed. She points out that if you move here from another place you might have to realize for yourself that the weather is something you have to keep yourself updated on.

The former mayor concurs that the newcomers may have a slightly idyllic image of what living in Løgstør is actually like. Some of them aren't fully aware of the risks and exposure towards storm surges that the location of the city is dealing with. He explains that newcomers have often first experienced Løgstør in summertime where everything is peaceful and quaint with its small cosy streets and open atmosphere. He argues that these newcomers aren't getting the image of how Løgstør also can be with stormy weather and water levels 2 meter over standard level. Only then you get an idea of how living in Løgstør also can be like. He has experienced through his job that this group of people have higher demands and expectations of the municipality to secure the city. That they are not accepting that their private properties are getting damaged by floods. In his experience there is another group of locals that have a very different understanding of and attitude towards floods, and have accepted that choosing to live in Løgstør is choosing to be at risk of storm floods. He says that when talking to this group they often express that; *"This [floods] is something we have to get used to and it's the way it always has been. It happens every now and then and sometimes it's worse than others."* He agrees with the police officer when concluding that the older generation and the locals who have grown up in Løgstør are more accustomed to floods occurring and experiencing damages whereas the newer generation as well as newcomers expect the municipality to fully secure the city. The newcomers and younger generations do not accept damages on their property, which can be seen as this group not understanding the risks of living in Løgstør and near the fjord. To expect the municipality to be able to 100 % secure Løgstør from storm floods is highly unrealistic given that the municipality has no certain way of predicting the type of impact that might hit the city in even ten years. Also there is always bound to be a residual risk that cannot be prepared for given unforeseen circumstances may occur during a flood event.

The Emergency Service in Løgstør mentions that; *"Many of the locals are familiar with the progression of a storm and begins to shut off their houses when alerted of storm."* The informant also mentions that many of the locals follow the development of the storm closely and are good at leaving the city when alerted to severe flooding. The municipality remarks that the locals

who are born and raised in Løgstør are better equipped at handling a flood. They explain that those locals are more calm when alerted to a possible flood. They also have knowledge regarding what a storm might develop into. They argue that such locals understand the risk better and prepare their houses by securing them with sandbags and plates in front of their doors and windows. The municipality explains about newcomers that: "Before a storm we can clearly see who experience it for the first time because they wait in securing their property until it [the storm flood] is coming. And then it is usually too late.". They confirm the theories regarding locals who are born and grow up in an area with frequent flooding events have a better understanding of the risk and how to prevent unnecessary damage by preparing themselves and their property.

The Danish Home Guard was called in to aid during a storm flood in 2005 and Company Commander for the police company in Himmerland, that have been linked to insertions in Løgstør for the past eight years, experienced that some locals who in the beginning stage of the storm surge did not want to evacuate. He says; "There was a small number who wouldn't leave [their home]". Also the Home Guard experienced issues with curious onlookers who removed the Home guards shut-offs to examine why the area was closed off for the public. The risk was not perceived as enough to keep spectators from the most exposed areas of the city even though the event turned out to be one of Løgstør's most comprehensive storm floods in recent history.

Several locals and public employees mentioned that after the municipality implemented their initiatives of climate adaptation measures and safety measures towards floods the locals slowly began lacking in preparing their property when alerted to possible storm surge. That their understanding of risk was affected by the initiatives the municipality implemented and that they no longer felt the need to themselves prepare accordingly before a storm. This is mentioned throughout the research on the subject that as soon as the public institutions begins to ensure a city from flood and flood damages the locals tend to stop their employing their own initiatives and fully rely on the municipality or public institutions to safeguard the city.

Overall the locals in Løgstør appear to have a good understanding of the fact that living in that city put you at risk of experiencing floods and getting your property damaged. Not only are the locals aware of the present risk but also the past and the future ones. Sometimes the risk is not perceived accordingly to its seriousness but that might be contributed to the fact that flooding in Denmark is not known to lead to fatal injuries. Also locals who have lived their entire life in Løgstør seem to have a better grasp on the risk and how to act accordingly than newcomers. The fact that the locals are aware of the risk may help enhance the community resilience.

In Thyborøn most of the locals are aware that a risk of storm floods exists but hardly anyone appear to be worried of that risk or understand the level of disaster risk. The younger generation, in particular the school students, were unaware of any risk of storm floods in Thyborøn. This is interesting given that they will be the ones, if they choose to stay in Thyborøn, who will experience in the future a heightened level of disaster risk because of climate change. The lack

of knowledge on the risk could be contributed to them not having experienced the large flood in 1981 that caused extensive damages. The older generation remember the large flood in 1981 and floods occurring before then. It was evident that even though the locals were aware of the potential risk of storm surges only few of them perceived it as a significant disaster risk level that needed to be taken serious. They understood that there was a risk due to the location of Thyborøn but they all mentioned that it is not something they worry about or even ever think about once in a while. A male, 44-year-old business owner says that: "It has only occurred two times over a period of 30 years, so it is not in my consciousness.", which is backed up by a male, retired engine worker on safety ship who says: "I never think about floods. It is not life-threatening, its just there. I see nothing to fear from it.". When looking at information from the Danish storm council in chapter 1 the statistic estimated that Thyborøn have experienced at least four storm floods within the last 25 years. The fact that none of the research participants in Thyborøn see the city being at risk of floods may be due to the lack of damages on private property caused by previous floods. It is currently primarily the area near the harbour that experience the consequences of a storm surge. These buildings are mainly shops and industry related to the fishing industry. Private property may not be in current danger of floods but a male, 51-year-old schoolteacher recall an incident during the storm in 2005. After having checked on a friends shop during the storm he recalls how on the trip home he was close to being hit by flying debris such as roof tiles. This made him reflect about the safety of going out during a storm flood and whether it was a risk worth taking. He explains that: "I was not happy with the situation. It made me reflect upon whether this [going out in a storm flood] was a good idea. A box came flying at eye level and I realized it was time to get home.". They may not fear the risk of storm floods but they are still aware that other dangers than water in the streets is associated with this hazard. The locals respect the weather but have learned to live with the rougher weather at the west coast. Strong wind is common and it is understood that the harbour must be secured in times of storm. All locals mentioned that securing unfastened property and boats with rope was a precaution that needed to be taken during a storm given that the risk of damage would be very high without this type of preparedness.

Everyone was more focused on the challenges in the future, which can be contributed to the prognoses of rising sea-level that is common knowledge among the Danish population. A female hotel owner says that: "I believe we will prepare for floods in the future. By then we will have taken some precautions.". There is more a common understanding that there will be a future risk of floods in Thyborøn. This opinion is shared by an older male retired fisherman who believes that: "There is no need for concern about water in the streets in my lifetime. Maybe within the next 30 years because of the rising sea-level and that Thyborøn is fairly low-lying. Today and in my time is definitely not in risk of storm floods.". He makes it extremely clear that he does not see any current risk of storm floods even though he lived in the city in 1981 where the big storm flood wrecked havoc and caused a great deal of damage. A male, 58-year-old

schoolteacher points out that as long as they in Thyborøn look down at the water from the dykes and not up then the risk of floods is not that threatening. When the day comes that the water level has risen extremely then a few locals mentions that a cooperation with the Netherland and their solution with dykes would be effective.

A male retired engine worker on a safety ship says that newcomers sometime have a difficult time handling the water and weather and move away again after a few events. This can be seen as them not understanding the risk or the exposure to rough weather that is in Thyborøn when they chose to move there. Once they fully understand the risk they decide to relocate. A male, 65-year-old, retired fisherman agrees that the newcomers are not as aware of the risk since they didn't experience the big storm flood and break through of the dyke in 1981. The event back in 1981 is what made him more aware of the risk of storm flood and the younger generation born after 1981 haven't seen how extreme the weather can get here.

The municipality told that back in the days before any of the dykes were constructed the locals had initiatives towards floods but they no longer exist. It is the same as in Løgstør were the security towards floods implemented by the municipality keeps the locals from upholding their own security measurements. The unpreparedness and the mixed understanding of the risk is a limitation to community resilience.

#### 5.1.4. Building the problems away

When attempting to lower the risk of storm floods in an area different approaches can be decided upon. The area can adapt to the floods by for example leaving vast green belts in flood zones to absorb the surface water or build dams and levees to keep the water from reaching the city streets. Both Løgstør and Thyborøn have chosen to build their way out of the impacts from storm surges by constructing seawalls and dams along the fjord shore.

Løgstør have implemented several technical and infrastructural solutions in their attempt to minimize the risk of water flooding the city during intense storms. All these initiatives will be presented in the variable *climate mitigation/adaptation and future plans* later in this chapter. Most of the adaptation measurements are structural but they have a clear interest in combining this with greener solutions.

The municipality in Thyborøn explains that one of the largest obstacles that they face when wanting to improve the community resilience and further prepare the city for storm surges through a built environment is a lack of space. As depicted in chapter 4, section 4.2. Thyborøn is running out of open green areas in the city proving it difficult for the municipality to implement any additional measurements. The two informants explained that: " *Currently we only have one small available slot but when that is gone there is 0 km<sup>2</sup> available space in Thyborøn. There is not even room for expansion of private property.* ". An interest in a water basin implemented to collect large amounts of surface water either from floods or extreme rain was expressed by the municipality but have yet to be constructed because of no available space in the city for it.

The limited amount of space restricts the municipalities options for preparing the city for future hazards. Many of their ideas or implemented measurements in other cities in the municipality region are simply not doable in Thyborøn despite the fact that almost all of the locals believe that any future and current risk of floods can be prepared for by a built solution. Many locals mentioned building higher dams to prevent the water from entering the city but the water from the fjord is currently entering through the harbour, which would be a challenge to close of from rising water levels. Currently the city is fenced on all four sides by dams and levees. These protections were all built a long time ago before the city grew denser, which made it possible to implement them. Furthermore, studies are currently being conducted on Thyborøn concerning sinking land areas by the Coastal Directorate. During my fieldwork in Thyborøn drillings were conducted throughout the area of Thyborøn to create a map and overview of the sinking landmasses. Areas where the harbor is built on the seabed are in particular experiencing sinking landmasses. Thyborøn is experiencing a sinking at 3-7 mm yearly with new problems arising like the water in the sewers running the wrong way suddenly because the landmasses are not sinking at the same rate throughout the city (Miljø- og fødevareministeriet, 2014). It adds up to a sinking at half a meter in the span of 50 years. This also have a large affect on the preparedness for floods given that the sewers need to be able to handle large masses of water coming in fast and still have the capability to transport it away from the surface and not have it rise up through basements.

Even though there are several future challenges and no available space for instalments most locals believe that it will be possible to build protective barriers or instalments that will minimize the risk of flooding. The fact that there are no available slots for climate change adaptations in the city is diminishing to the community resilience.

#### 5.1.5. Type of local community

When talking about type of community it is understood as the perceived characteristics of the local community by the locals themselves and the municipality. The characteristics could be for example open or closed community, self-reliant or forward thinking. The type of community is helpful to determine how they may adapt to changes not only climate related but also economically and social. Likewise, it is an indicator of how the community may prepare for and react to a natural hazard.

When addressing the type of local community in Løgstør, the female police officer lives in she reflects on the changes it has undergone over time. She recalls how it started out as a small, closed off provincial city, which she believes to have been a very closed community. They used to have the attitude where no one should come and tell them how to do things. Forced by necessity they realized that Løgstør had no future unless they opened up and became tourist minded. From the informants comments it appears as though the community is capable of being flexible and are open towards changes. Flexibility is an important part of community resilience given



that a stagnated community that is not interested in being inspired by new ideas or adapting to a changing climate is more likely to be hit hard from a flood. The former mayor has a very similar observation of the community as the police officer. That the community previously was a closed fishing village but have developed into a more multi ethnic community. That the composition of the local community has changed over time and that they have received a group of resource strong residents who use their mental resources on starting initiatives and on the community. This fairly new group of people in Løgstør are more open and are interested in establishing activities to make Løgstør a great place to reside. The former mayor considers these to be a huge influence on the nowadays openness of the community as well as being a strong resource for the locals. He also states that everyone is exceptionally helpful not only in critical situations but also on a regular basis. A male, 75-year-old, retired banker believes that the community is totally closed off until you get in. When you get in and are somewhat accepted then the locals tend to realize that the newcomers have resources and talents that contribute to the community and to the city's welfare. A way to let in the newcomers in the community and the society is for example through volunteer work. Often once you've showed an interest in the city and community you are easily integrated. In that way Løgstør can be viewed as an open community but closed off at first glance. He does however point out that sometimes people move to the city who doesn't fit in and who he says about; *"There are also people moving to the city that we can't be bothered with. But I believe that's just how it is."* The former mayor raise the same point arguing that: *"Some of the people who move here we could have happily been without. Some of them are really difficult to deal with even though they themselves believe they have great ideas."* This is backed up by a male 84-year-old, retired boat builder who says that: *"Back in the days some outsiders moved here and wanted to start a Residents' Association but there was absolutely no need for it. Everything was going just fine so it was given up eventually."* So even though the city according to the locals have gone through a transformation from more closed off to open and forward thinking it is still a community where everyone will not fit in. At first glance the community appears very open but there are still aspects of the community that is somewhat closed off.

Thyborøn is somewhat isolated at its isthmus and therefore you only encounter the city if that's the end destination of your journey. This is a factor that should be taken in to consideration when discussing the type of local community that exist in Thyborøn. When considering its location, the fact that half of the research participants that are locals refer to the community as a little closed off is not surprising. However, the municipality believe that the community is far more open than what the locals themselves think. A male, 65-year-old, retired fisher perceived the community as a little bit closed off but argues that it is due to the nature of the people living in that part of Denmark – western Jutland. But he believes the city has undergone large changes not at least within the industries where it used to be a smaller fishing villages and now has a

lucrative larger fishing industry. He also reflects on the cultural opportunities that the city offers to the locals and how they have increased over the past five to ten years. There is a development and a fairly large one, which can be attributed to the city's wish of holding on to its residents. Whether these initiatives are mostly local where not explained by him. A disadvantages of living in a small community is by the retired fisher's opinion the fact that everybody knows everything going on in the town and mudslinging is bound to occur. This was pointed out by several locals and some of the primary students. This could potentially make it difficult and unappealing to move to the city and thereby have difficulties with attracting new human resources.

When talking to any of the official institutions they all stress that the local community is extremely independent and original. One of the employees from the municipality says that: *"It is probably the most independent local community in Denmark. Even an island cannot compare."* He continues by explaining that the locals are very proud to be from Thyborøn, which is not surprising since the local community by his account have; *"Lots of money, a strong willpower and the needed physical resources."* These are all very important properties to possess as a local community when working with community resilience. The local community are able to implement things fast and efficiently, which comes through as driven. On top of that the community is perceived by the municipality as very forward-thinking business wise especially within the fishing industry. They are very knowledgeable within their primary industry and have been able to expand the harbour for millions of DKKs. It is the largest business area in all of the municipality with over 1000 employed at the harbour alone. The municipality has always seen the local community in Thyborøn as very ambitious with large goals for the future despite the fact that the population is steadily decreasing. One of the nicknames granted Thyborøn by the official institutions is "The wild west" because they do things their way and get them done regardless of any obstacles. There is a strong soul in Thyborøn that do not exist many other places in Denmark. They are eminent at looking at the opportunities present and then work from there. Once again this description of Thyborøn is advantageous in regards to a strong community resilience towards any hazard because they have the resources to recover quickly.

The independency came through clearly when speaking with all the locals who in different ways explained how the local community took care of things themselves and that asking for help was hardly ever necessary. One of two female hotel owner said that: *"Women here are great at creating workplaces themselves because it is a difficult society for us."* Likewise, they said that they are used to dealing with everything themselves because it is not expected that help from outside is coming. This and similar opinions showed a small divide between the local community in Thyborøn and the municipality. Everyone expressed independence in Thyborøn and that no help was expected from the municipality. This divide might have led to the independence present today. Even though no help is expected from the community several locals tells that the locals themselves are good at helping anyone in need. That they had been better at standing together than previously and that if asked there was always a helping hand or two.

## 5.2. Social capacity

### 5.2.1. Attachment to place

Attachment to place has the ability to explain why so many people return to or stay in a place despite understanding the level of disaster risk and knowing the hazard they expose themselves to. The research participants were asked if they ever considered moving away from their city of choice because of the risk of storm surges and if they perceived the city as attractive to live in despite the floods.

In the variable *Local understanding of risk*, it was argued that the locals in Løgstør appear to accept that flooding is a problem and that they have a good understanding of the level of disaster risk they are exposed to in regards to storm surges. Despite knowing and understanding the risk none of the research participants would consider moving from Løgstør because of storm floods. For them to truly consider it several research participants expressed that the floods had to occur on a more regular basis. Also because ever since 2005, where the municipality implemented the securities and became better equipped and prepared for the floods, the locals have not been truly bothered by high levels of water in the streets. So they do not see any reason to leave. Also they feel very attached to Løgstør partly due to all the initiatives and events constructed by the locals that makes the city more appealing and inviting to reside in. A male, 75-year-old, retired banker says that: “*It is absolutely an attractive city to live in. So much is happening in the city.*” and continue by saying that he would never consider moving because of the floods and that they do not in any way diminish his attachment to Løgstør.

Some locals expressed a draw to the fjord and a wish to live as close by it as possible. An informant said that: “*Enthusiast wants to live on the harbor. Why the houses are perceived as so valuable I do not know. There are people who only wants to be there. They thrive the best by the fjord.*” (Male employee at Water Supply Institution). This depict a picture of locals having an attachment to the fjord and the area being perceived as high value. He continues by saying that people who are born and have grown up in Løgstør prefers to live by the water. Even though they are from the city and have knowledge of the areas where the water is most likely to penetrate the city they still want to live in those areas. One of the most flooded streets in Løgstør is Fjordgade right by the waterfront and they still want to live there. He explains that:” *They have decided that here is where I want to live so you just have to wear rubber boots in high tide... People who are born here are extremely proud. They do not understand that some people want to be other places*”. This shows a significant attachment to Løgstør and not only do the residents born in Løgstør not wish to live anywhere else they also cannot fathom why anyone would not be content living in Løgstør.

The municipality has experienced a growing interest from the residents to live by the harbor and close to the fjord since the municipality in 2005 installed the seawall and other measurements. One of the employees says: “*I believe we have experienced that it is much more exclusive housing by the water since we made the first large flood proofing down there.*”. He contin-

ues by saying it is more attractive to live by the water now and that the locals are feeling very much secure. It is now very attractive to reside by the fjord even though it is labelled as a high risk zone. The locals are feeling secure, which could be argued to be a false security because the seawall is admitted by the municipality to not be of the proper height to withstand the coming storm surges. It might have been a more secure solution to develop areas of the city that is not considered high risk but as learned through the interviews the locals feel an attachment to the fjord and wishes to live close by it.

In *Local understanding of risk*, it became evident that the older generation have a somewhat different understanding of the current level of disaster risk towards storm surges than the younger generation do in Thyborøn. This is interesting in the light of how the older generation also appear to be more attached to Thyborøn than the younger population do. When speaking with a male, 58-year-old, schoolteacher he revealed that a large part of the younger girls moves away from Thyborøn when they are pursuing a higher education and do not return when that the education is obtained. This could be contributed to the fact that there are not many career opportunities for females in Thyborøn making it difficult for them to stay. It may also be contributed to the fact that the city does not offer many cultural activities for the younger population, which the primary school students noted as a disadvantage for Thyborøn. The young females may be attached to the place but if there is a lack of opportunities this will hold them back. Even though there are no lack of jobs for males there is currently a trend of them moving away with their partners because of a lack of female jobs as expressed by an informant. In the case of Thyborøn most of the males are employed in the fishing industry where there are few jobs suited for women as expressed by an informant. The labour market is quite divided according to gender because of the main industry. Furthermore, there is a lack of jobs for educated people that are not interested in working in the fishing industry. The fact that the city is losing human resources in the shape of young people could become a hindrance to the community resilience. Furthermore, the municipality explained that fewer children are being born each year making it difficult to fill up school classes at Thyborøn primary school. This is a future challenge given that the population number is already decreasing because of people moving away and is bound to decrease further with less children being born. This is currently causing the municipality to consider what type of city Thyborøn will be in the future. The older generation may be very attached to the place but it is imperative that a younger generation feels an attachment as well so the city has the resources to maintain or enhance the inherent community resilience now and in the future. The older generation appear more attached to the place than the younger population do. It could simply be because they have resided for a longer time in Thyborøn and thereby created deeper connections with the place. Most of the older research participants are retired males that have been an integrated part of the community through the fishing industry. None of them would ever consider moving because their family and entire social network is in Thyborøn

creating a strong attachment to the place.

The municipality mentioned that the locals are very proud to be from Thyborøn. This shows a strong connection to the place. A positive attachment where Thyborøn is perceived as a place to be proud of. This was evident in how the locals spoke of the independent community and the beautiful nature surrounding Thyborøn.

One of the gatekeepers at the coast centre explained in an informal conversation that whenever she leaves the city for more than a few days she gets homesick. She feels a strong attachment to Thyborøn and didn't understand why anyone would want to live somewhere else. Even when she goes for an errand in the larger cities she explained feeling a positive calm when returning to Thyborøn again. She would never consider moving from Thyborøn because this is where she calls home despite being informed through this study about the current and future level of disaster risk from storm floods.

Such a strong attachment is positive in regards to community resilience because it proves a willingness to govern and protect the place.

### 5.2.2. The ability to live with risks of flood and storms

Living under a level of disaster risk in certain periods of the year can over a long period of time be influential on the mental health. A male, 84-year-old, retired boat builder from Løgstør is the only research participant in this study who has mentioned that the storms and floods has an effect mentally on the locals living with the risk. This may be because of his relative high age given that theory argue that the older generation experiences a higher level of stress during the catastrophe. He says that: *“So mentally you are nervous every time it is [ a storm] happening. You never learn to relax when it is happening. So it is both physically and mentally that you feel an impact. But everyone is good at helping each other not least mentally.”* He also says that after everything has settled down he is always extremely tired because of a lack of sleep. When the storm is going strong he finds it impossible to sleep even though he says that there is nothing you can do but wait until it blows over. He explained that the community and the locals were great at helping each other after an impact and the fact that they would stop and talk about their experiences was a big help in overcoming any mental imprints. That everyone was in the same boat made it easier to talk together and to work through the incidence together.

The uneasiness appearing when the weather forecast alert to an incoming storm may have an impact on the quality of life for some locals in communities experiencing severe or frequent storm floods. However, the remaining local respondents taking part of the interviews never expressed any indication that they are mentally affected by the storms. Several research participants explained that storm surges are simply a part of living in Løgstør. The fact that they did not bring it up does not necessary equal no affect mentally from the floods. A female, 58-year-old, police officer brought it up indirectly by pointing out that the presence of the Home Guard made her feel safe in an otherwise unpleasant and frightening situation. It was comforting that

help was close by and that the possibility of being evacuated was present every two hours. The safety net the Home Guard represented helped her and her family through the flood without feeling too vulnerable. The damages to the house they rented by the fjord made it impossible to continue living there while there was construction on their new house. The fact that her family invited them to stay the duration of the construction was a much needed safety net because as she expresses it: *“If we had to continue living in the flood damaged house we would have been extremely upset and devastated.”* Even though her and her family was fortunated enough to temporarily stay at her family's house during their time of need many local residents don't have the same opportunity. An informant says that: *“Just when the water is flooding in they are shattered but you pull yourself up again after. People are used to getting by on little and the weather is something you cannot change.”* (Male employee from the Water Supply Institution). This picture indicates mentally strong residents that are capable of pulling themselves up again after a devastating blow. This is a community where the local residents always have struggled with floods and have learned to get by on a small amount of resources. To be able to pull yourself up time after time shows a very resilient local community with a strong mentality.

Several of the locals in Thyborøn said that living in Thyborøn requires a tough mental health given that it is isolated, dark in the winter months and a little deserted. It is during these winter months that the risk of storm surges is most prominent. Not everyone is capable of making a life for themselves out there and it became apparent during the fieldtrip that a strong mental health is required to thrive in Thyborøn. This has always been a tough environment where nothing is handed to you. This came through in the research participant's answers. A female hotel owner said that: *“You handle things yourself. You do not expect anyone to come and help you unannounced.”* This attitude was underlining every interview showing the previously mentioned independence and ability to solve any problem without help. Having grown up in Thyborøn and gotten used to the weather and isolated existence could be what makes the residents in the community more resilient to smaller floods. Several informants rely how they often experience small floods were the water is just above the quay but none of them perceive this as a problem. You may clean it up and continue with your day as planned.

The ability to just live with the weather and the way it affects the daily routine is not necessarily a resilient approach. However, the locals can be argued to have a very resilient mental health given that it takes a lot to knock them out of course and shake their lives. This appears to be considered more difficult for newcomers who have not grown up with a harsh winter weather and therefore have not built up the endurance and resilience towards inconveniences created by the weather. This is said by an older male informant who recalls how newcomers move after having struggled with the weather.

### 5.2.3. Sense of community

Throughout the previously presented categories examples of sense of community has indirectly been introduced. These will only be brought up superficial in this category.

In Løgstør sense of community has shined through in *Local initiatives towards floods* where it was possible to see that the local community could gather enough support to realize the project, Lanternen. The large gathering of volunteers is also proof of a sense of community.

A male, 75-year-old, retired banker explains how he have experienced a sense of community in Løgstør, which is the fact that neighbours help each other out. All over the city neighbours have agreements that contain keeping an eye on each others properties and alarming the police in case of suspicious behaviour. The trust and helpfulness of the neighbours makes him feel a sense of community and belonging.

A male, 84-year-old, retired boat builder say that each person takes care of their own and that after Løgstør became part of the large municipality, Vesthimmerlandkommune (Danish: Storkommune) in 2007 there is less interaction between the locals because they no longer have any reason to be at the municipality centre. The structural changes of the Danish municipalities mean that Denmark went from having 270 to 98 municipalities (Danmarks Statistik, 2016). The structural changes appear to have impacted the sense of community in Løgstør in the shape of less interaction between the locals because they no longer have the municipality buildings as a meeting place for spontaneous conversation.

A male, 58-year-old, schoolteacher finds there to be a strong sense of community in Thyborøn among other things because everyone knows each other and that leads to a close-knitted community. Given that it is a small population, see chapter 4, it makes sense that the one community is tight given that there is not the possibility of several big communities as would be the case in bigger cities. Another male schoolteacher explains how he believes that there is now a stronger sense of community in Thyborøn than there was previously. It is something that have grown over the last few years where as before everyone was more inclined to go along with their own business. He says: " *Now we have got a Civil Association and are standing more together. We realized it was something to prioritize and the social aspect have improved.* ". He continues by explaining that they are better at supporting each other even though that is only something that have improved because it was already present considering the community have always supported the members in need. One of the female hotel owners share the same view about people being good at standing together and supporting each others ideas and projects. A male, 51-year-old, schoolteacher recalls how a widower with kids who lost her husband to the sea was helped by the community in terms of food and other basic essentials. From the story it was evident that people stand together and back up each other in times of hardship. He explains that the community gather around people in need because the community can aid in ways the public institutions can't.

### 5.2.4. Local knowledge

The local knowledge residents gather from growing up and living in the same area for a longer period of time can be a useful resource for municipalities when they design climate adaptation plans. It is also a useful resource for the local community because it helps the locals to better prepare themselves for the disaster risk level and to better secure their property from flood damages. The knowledge may be in several different directions ranging from local weather to where the water first penetrates the city to vulnerable citizens. However, it is not every municipality or local community that chooses to tap in to this resource pool. Several studies working with community resilience pinpoint local knowledge as an important factor in community resilience and in enhancing the inherent resilience. If the locals are knowledgeable about the risk, the hazard and the natural environment they may be better equipped at preparing for, handling, coping with and reacting to an impact.

All of the research participants from Løgstør are aware of the signs to look for and the conditions that have to be present for a storm flood to hit the city. They all mentioned that strong wind from north-west equals a risk of storm flood hitting the city. A male, 84-year-old, retired boat builder elaborated on the weather conditions needed for a storm. Back in the days the storm floods began as strong wind from south-west, which over a course of a few days would turn slowly to west and finally to north-west, which crashed everything. When it proceeded like that the direction of the wind would have pushed large amounts of water from the North Sea in the opening of the fjord by Thyborøn, which causes high water levels. He explains that it was always a three-day storm. However, this has now changed and it may not last more than three to four hours. A change of the storm patterns and climate have occurred in his opinion. However, the Emergency Services still perceive the storms to be three day storms. This was information all research participants brought up in different detail during the time with them and it was evident it was considered common knowledge in Løgstør.

The informant from the Water Supply Institution says that the water is in the city with lightning speed when the wind changes because the water is pressed in to the city, which is caused by the narrow pass in the fjord. Lots of people have had cars that drowned in water on the harbour because there is no time to remove them once the storm hits. The male retired boat builder explains that it is even worse if this occur during tide, which changes every six hours.

A female, 58-year-old, police officer applied her local knowledge, as earlier mentioned, when deciding on the location for her new house. She has always been aware that the city is built upon a number of smaller knolls running parallel to the fjord. The oldest houses in Løgstør are all located atop these knolls whereas the newer residential houses are all developed in the lows between knolls. She looked upon topographical maps to locate an area that was least likely to flood during a storm surge. The knowledge of the weather and natural environment made making an informed decision more attainable for her. Furthermore, when her new house was being

built local builders were on the project with knowledge of the weather and environment in this region of Denmark. This knowledge proved valuable during the first severe storm after the house was finished where only three roof tiles moved slightly. This is important given Denmark is one of the countries in northern Europe with the highest level of damages from storm even though we have one of the smaller number of yearly storms.

The informant from the Water Supply Institution points out that locals have helped develop solutions for climate adaptation in Løgstør. The solutions are built primarily by the locals and are based on their experiences living in a city troubled by floods. The municipality explains how local carpenters built the seawall that are currently operating at the harbour. Local knowledge is being valued as a strong resource and a respectful cooperation between the local community and the municipality have taken place in preparing and implementing solutions. One of the problems they currently face in Løgstør is when the Home Guard arrives to help during a storm flood. The informant explains that it can be quite difficult to keep track of them all when they do not know the area. For any help to be efficient it is best if they are a little locally known. Outsiders are not familiar with the layout of the city and therefore take more supervising than there are resources for during a flood. This helps demonstrate how important local knowledge is before, during and after a storm flood. Resources can not be used completely if a lack of understanding and knowledge of the area you are preparing and securing is absent. The local knowledge help make the process more efficient and specialised on areas that are most vulnerable during different levels of high tide.

It was evident that local knowledge in Thyborøn is something that is gathered over time and by having lived in the same area for a long period of the adult life. Having grown up in an area does not necessarily provide a person with local knowledge in terms of knowledge on hazards if the age is relative low. Based on the research participant it was clear that vast local knowledge was gained with age. The primary school students knew very little about hazard and the level of disaster risk in Thyborøn. Some were even misinformed see box 5.1. The older informants all had an extensive knowledge of the weather, the environment, the history of Thyborøn and the local community. They had all lived in Thyborøn their entire life and was happy sharing their knowledge of the area. These three research participants were in particular interested in information from the municipality and had a wish of more citizen involvement. The knowledge they contain would be relevant for the municipality who however have chosen to base their decisions in Thyborøn only on experts, tests and studies. It appears as though the more knowledgeable locals have a great interest in knowing what is occurring in the city they live in. They also wish to contribute to the solutions and to have the possibility of influencing the decision of the municipality.

### 5.2.5. Perceived and received support

Perceived support represent the support the locals expect to receive in situations of trial before, during and after a flood whereas received support is the actual support they obtain.

All research participants from Løgstør agree that no one who needs help in the local community is left without it. All you have to do is express a need for a helping hand and you will receive one. The research participants perceive the local community as very supportive especially during times of storm surges. The male, 75-year-old, retired banker highlights that older people living in flood risk zones are always receiving help in times of need and that a special attention is paid to them. It is important for him and the local community that no one stands alone and that help is giving to those in need. He also tells that the municipality is helpful in these situations with cleaning up the city after a flood and pumping out the water in the following days or hours. Because of their effort he does not experience a notable difference in the city before and after a flood event but only during it.

The male, 84-year-old, retired boat builder experienced during the large flood in 1981 that another local resident had gathered all his paint tubs that had disappeared during the flood from his boat workshop and delivered them in the following day. The same happened with wood boards for building his boats, which another resident had come upon and collected for him. Besides this type of support another one in the shape of discussing the events is something he highlights. People stop by and ask how everything is holding up after the storm and during your small talk you help each other out with minor repairs and such. It may not appear as a grand gesture of support but to know that the local community support each other is imperative.

The locals in Thyborøn all have a very similar view on perceived help as in Løgstør. They all highlight that all you ever have to do is ask and help will be there. The local community will not leave any behind in a crisis. However, given the strong independency in Thyborøn no one ever ask for any help. Not from each other and not from the municipality or the Emergency Services. The informant from the Emergency Services say that: " *They [Thyborøn] take care of themselves. They never ask for any help.* ". He continues by saying that Emergency Services do not provide any help after a flood given that they only take responsibility for acute emergencies and problems. The informant from the Emergency Service informs that removing floodwater after the storm has passed is something the local community themselves are responsible for. This is something the locals should prepared for. A female, hotel owner says: " *You are used to fend for yourself and do not assume help to arrive unexpected.* ". She continues by pointing out that when their hotel was flooded no one came to help but she is certain people would have come to aid if they were asked. This is characteristic for Thyborøn that you try to solve your problems on your own. A male, 44-year-old, business owner has a slightly different view on this matter. He recalls how other locals were ready to help when there was a chance of his business being flooded back in 2005. He perceives the local community as very helpful but still stress

that all you have to do is ask.

Overall the municipality and Emergency Services do not provide extensive help in cases of storm flood and it is expected that the local community themselves prepare for the flood and take care of the consequences of the storm in terms of removing water.

#### 5.2.5.1. Insurance

The female, 58-year-old, police officer is one of the few research participants in this study who have experienced damages from a flood. Her experience with claiming money from the insurance is a good one and flood damages for her was not an issue economically. Some things valuable to her but not in monetary terms were lost, which the insurance were unable to cover. Still she is content with the received support from the Storm Surge Counsel. When an event is deemed a storm flood by the counsel the damages will not be covered by the private insurance but by the council (Sweden, Federation of Finnish Financial Services, Finance Norway, & Danish Insurance Association, 2013). The female police officer did experience a long waiting time in the period where the council decides whether it is a storm flood or not, which means that it has to be a 20-year flood event (Larsen, 2015). She considered the applying process to be straightforward and was overall happy with the procedure. Knowing that it is possible and straightforward to apply for replacement of lost valuable is important in terms of community resilience. The inherent resilience is strengthened by the fact that it is possible to gain back what have been lost and that you can bounce back after an impact.

It may currently be somewhat easy to get loses from a storm flood covered by the Storm surge counsel but this may change in the future in line with floods becoming a more frequent event. Even though flood damages are covered by the Storm Surge Council it may change in the future if the loses rise uncontrollable. Also houses by the fjord have over the years been eroded by the saltwater causing them to ultimately loose value. This could prove a problem for house owners given that they will not receive the needed money for the necessary repairs because of the damage slowly done by the salt. It is known to erode the bricks and floorboards. The houses nearest the fjord is then slowly losing their value due to the floods and this will minimize the resilience in terms of bouncing back (Sweden, Federation of Finnish Financial Services, Finance Norway, & Danish Insurance Association, 2013).

The female hotel owners were the only research participants that have had experience in Thyborøn with claiming money because of damage from storm flood covered by the insurance. They found the process of applying for coverage a little daunting and more complicated than they hoped. After sending the request to their own insurance company it was shipped to the Storm Surge Council who first have to decide if it was indeed a storm flood. The case is not yet closed but they believe it is due to the fact they have never gone through this process before. It was evident that they were uncertain with how the process was prolonging and it may become

easier if it ever is necessary to apply again. They explain that they were not fully prepared for the storm surge and had therefore not taken their precautions by having all merchandise on pallets in the basement. However, they acknowledge that they have not followed up on the application to the insurance due to uncertainty of whether they would even win the case with the insurance. This feeling have led to demotivation and an uncertainty about whether it was worth the time and effort to report it to the insurance company. This is not beneficial for the community resilience if locals are feeling as though applying for damage cover after a flood is too time-consuming given an uncertainty of getting it covered by the insurance. There is a lack of safety net and the possibility of building back without any economical losses is important in terms of resilience.

### 5.3. Institutional capacity

#### 5.3.1. The effort of the municipality

This section describes whether the local community is satisfied with the effort the municipality has put forward to prepare and secure the community for floods. It also explores to what extent the local residents have trust in the municipalities' ability to protect the local community.

The local residents interviewed in Løgstør are all content with the municipality's effort and they all believe that the current climate adaptation measurements are capable of stopping the city from being flooded. As put by the retired banker: *"We can cynically say that we haven't had water in the streets since 2005. I think what the municipality has done is satisfying and we are pleased with it."* In this instance he spoke for all the volunteers at the local archives who wholeheartedly agreed. The female police officer shares the same view and further say that they never even experience smaller floods with small amounts of water in the streets since the municipality finished the security measurements at the harbor. Not only is she pleased by the security of the measurements but also the ecstatically pleasing solutions. She believes that it has heightened the environment by the harbor and is surprised at how well the municipality has combined tourism and climate adaptation making floods a draw for tourists. The history of the city and the history of floods is something the municipality and the local museum have made an attraction and a sometimes positive characteristic of Løgstør. She continues by explaining that the municipality is very well prepared for the floods and when alerted to the first storm in November they close of the open parts of the harbor towards the fjord with concrete blocks and plates leaving them put until spring. She is very pleased that the municipality is ahead of the floods instead of opening and closing the harbor all winter.

Even though some of the initiatives have been relative expensive one informant said that: *"The seawall is something the municipality has done correct. It was expensive but not compared to all the damages it has prevented"*. (Male employee Water Supply Institution). He perceives it as a great initiative from the municipality despite the fact that the solution was an expensive one.

This also shows trust in the municipality and their ability to determine what solutions would work best for Løgstør.

Even though all research participants expressed a satisfaction with the effort from the municipality in securing and preparing Løgstør for floods one research participant thought they had been dragging their feet initially to get started. The male retired boat builder says that; *“It took them [the municipality] a long time to get started but now they are.”* He elaborates by saying you can not fully judge them for being too slow due to a lack of understanding of the large floods. This was an occurrence that no one initially knew how to handle so it took a while before the municipality decided what way to best protect the city. He says: *“Finally they got it sorted and now there is a system to it. It works fine.”* He concludes by relating that he is currently happy with the effort from the municipality and that everything after his opinion runs smoothly.

In Thyborøn the municipality have not implemented any climate adaptation or mitigation measurements in recent years. The break of the dyke in 1981 resulted in an enforcement of the affected dyke so it now should withstand a 1000-year event but nothing else appear to have been done in terms of preparing for storm floods since then. The municipality are currently examining the situation in Thyborøn and will not be implementing any measurements until these studies are complete. It is therefore difficult for the locals to evaluate if they are content with the effort of the municipality and their instalments. One of the schoolteachers says that he would have liked that the municipality were better at maintaining all the dykes in and surrounding Thyborøn. If they are not maintained there is a risk of them weakening over time and if or when an intense storm flood hits they will not be strong enough to keep the water from entering the city. As earlier explained there was a breach of the dyke towards the sea in 1981, which caused massive floods in the city. If the municipality is not maintaining the dykes it is possible this could occur again in the future. One of the female, hotel owners expressed a dissatisfaction with the Emergency Services effort during the storm in 2005. She thought that they made sandbags available too late making it impossible to use them to prepare buildings. The sandbags were put out after her opinion when it was too late to secure their hotel from flood. All research participants also expressed a dissatisfaction with the lack of information and communication from the municipality. This will be further examined in the resilience dimension *Information & communication*.

### 5.3.2. Emergency services

The Emergency services cover a broad aspect of different institutions and organizations that in time of disaster are able to be of aid. In this study the Emergency Services examined are the Danish Emergency Management Agency (Beredskabsstyrelsen) for Vesthimmerland municipality and for Lemvig municipality and also the Danish Home Guard that aids the entire country. The Danish Emergency Management Agency is the main institution whereas all municipi-

palities have their own smaller department of Emergency Services. After the interviews were conducted and the information gathered the structure of all Emergency Management Agencies in Denmark were changed with plans on implementing the new changes sometime in 2016. The Emergency Services in the future have to cover larger areas because the different municipalities Emergency Services have been ordered to merge so they are now one Emergency Service in charge of all of the northern part of Denmark (Nordjyllands beredskab) and one in charge of the north-western part (Nordvestjyllands beredskab). This was a concern for both municipalities and they expressed an apprehension towards the new structural changes. This could lead to the municipalities having to take more responsibility not only of the planning aspect but also the more physical aspect of disaster preparedness. Both municipalities in particular Lemvig made it clear that they would have to take on a larger role simply because of proximity to the flood zones. The evaluation of the Emergency Services will however be on the previous structure given that information concerning the new was not available during the time period of this study and because it is uncertain when in 2016 the changes will be implemented fully.

The informant from the Emergency service in Løgstør explained that the institution is around 40 years old and existed before the large storm flood in 1981. Now they have a higher number of volunteers and pumps. They have multiple departments for example the dyke preparedness service. In times of high level of disaster risk, the Emergency services all gather in a commando station in Falck where an overview of the situation's development is kept. It is also from here emergency personnel is sent on assignments. He continues by explaining that when an alert of storm flood is received maps over Løgstør is projected in the commando station with flood zones marked. Based on that information it is decided where the emergency personnel are distributed in the city. The maps are used to take surface water and sewers in to account when deciding where to place additional pumps. The situation is then evaluated and monitored from the commando station. Different protocols are connected to different levels of water in the fjord but it is only with a water level of 1,70 m over normal level that a rapport over the event is produced. A collaboration with DMI during storm floods is imperative to have accurate information on the prognoses of the storm flood. In situations of extreme floods the informant from the Emergency services explain that they contact the Emergency Management Agency, police, the home guard and a similar volunteer base in the nearby city, Aars for additional help.

Over the years the Emergency Service has gained more equipment and now have several generators in case of blackout, extra pumps and two kinds of boats; one for sailing in the streets and one for the fjord. The boats are for evacuating and rescuing residents from flooded houses. In addition, the city is still pumped free of water a few days after the storm has passed (Male employee, Emergency Services).

In Løgstør the Danish home guard have been called in a total of four times since 2001 for different flood events to help with manpower and technical resources. One of these times they were called in the situation didn't develop in a direction that the local emergency services couldn't

handle themselves. However, the local emergency services explained that they preferred to have back-up available if the storm flood event would be too intense for the new pumps to handle. The Home Guard are only contacted for support when the local emergency services predict that they are not able to cope with the development of the flood event themselves. The Home Guard is contacted by the local police or the Emergency service early in the process, sometimes 24 hours prior to insertion, before any water has flooded the city. The informant from the Home Guard explain that their role is in particular evacuating local residents, securing houses from burglars, setting and securing roadblocks, food delivery and safety check of the flooded area including removing fallen trees. In 2005 the Home Guard had between 60-70 people helping in Løgstør, which is their greatest forte – the almost unlimited amount of people available for aid in times of disaster.

The informant from the Emergency Services in Thyborøn explained the history and structure of the institution. It goes back to the 1800 century but was created because of fires. The Emergency Services have 44 fulltime firefighters and out of those, 17 are working with Thyborøn. The Contingency Associated have around 10-12 volunteers, which can be called upon in case of an acute event. In case of a storm surge in Thyborøn the informant explain that their primary job is to secure the buildings at the harbour. Therefore, sandbags are handed out to those who wish to barricade the doors. The sandbags are on stock for short amount of time but the volunteers are called in to prepare more when alerted to high levels of water. Some employees from the Emergency Services tend to be down there in advance to monitor that everything is prepared. During the storm they have a few men driving around making sure everything looks okay so they are prepared to help in case it is needed. To help predict the intensity of the storm the Emergency Service have water meters both in the ocean and in the fjord. Furthermore, data from DMI is applied to give an indication of the development of the storm. The Emergency Service do not have the same amount of equipment as the one in Løgstør but it is due to a lack of current need. Instead they explain that they borrow from the Water Supply institution when pumps are needed to supplement the few they have themselves. Equipment for handling a storm flood in Thyborøn is not prioritized once again due to the large gap of years between the intense floods.

#### **5.3.2.1. Robust Citizen and Youth fire brigade**

The Emergency service in Løgstør explains how they use a group of problematic young kids as a resource for the community by including them in a youth fire brigade. Once a week for a year the kids are taught in procedures for fire and flooding. This resource is applied during floods in Løgstør. The program is considered highly successful and most of the kids sign a contract with the fire brigade/ emergency service as volunteers when turning 16. This is a way of teaching the kids about hazards and how to cope with them. It enhances the resilience because the younger generation gets an understanding of the risk in Løgstør and are given tools that can help prepare

the city.

Lemvig municipality has just launched a new project called “Robust Citizen” with the aim of teaching the residents in the municipality how to prepare for and act throughout any natural hazard with a special focus on floods and storm surges. There will be a seminar on how to prepare your property for different hazards and how to contribute to sharing that knowledge in your local community. However, when speaking with the head of the Emergency Service he explained that he did not believe that any of the locals in Thyborøn would sign up for the project since they prefer doing things their own way and are very independent. The project has not yet been fully launched so it is unclear if any locals from Thyborøn will participate.

#### **5.3.3. Emergency response plans and the continuity of the plans**

Emergency Response Plans witness a willingness to prepare for storm floods events and an understanding of the risk. Whether a municipality keep up the continuity of the plan shows that they reflect upon strengths and limitations. The community resilience will be enhanced if the Emergency Response Plans are taken up to evaluating after an impact so it is possible to improve upon weak areas.

Løgstør made an evaluation report of their experiences and the development of the storm flood in 2005. This clearly details the progression of the storm and how the municipality and the Emergency Services reacted to the consequences of the flood. Throughout the storm surge the plan show how they learned of their weak points and what needed to be improved upon so they were better prepared and better equipped at coping with a future storm flood. Løgstør have now an Emergency Response Plan for floods and storm floods from 2013 (see appendix 2). The plan works with three degrees of preparedness, which is normal preparedness, enhanced preparedness and emergency preparedness. The normal preparedness is introduced 18 hours before the possibility of a critical situation storm flood. The water level will then in 18 hours be at 140 cm over normal level while continuously rising. The enhanced preparedness is introduced 6 hours before it is expected the water level to be at 160 cm over normal level. Lastly, emergency preparedness is introduced an hour before it is prognoses to have a water level of 170 cm over normal level or if a breach on a dike occurs. The police are in charge of alerting the population and introducing the different levels of preparedness. The locals are alerted when the water level is at 140 cm over normal level. It is mapped how many vulnerable locals are in the flood area so they can be evacuated before the impact. So elders and socially impaired are taken in to account, which was pointed out by the informants from the municipality. The plan is somewhat tight and there is less room for flexibility, which can be seen as diminishing to the community resilience. The model by Norris stress that flexibility before, during and after impact from a natural hazard is of utmost importance

Different processes and procedures are introduced at the levels of preparedness according to the plan. In the appendix it is possible to see the action chart for the three levels of preparedness.



It is evident that there is a clear instruction as to how any institution related to preparedness should act throughout the event. After a storm flood with water levels over 170 cm it is required that an evaluation report is constructed by the Emergency Service so they can reflect upon their effort. This is constructive for the resilience given that it requires the emergency services to pinpoint weak areas and enhance them before the next impact.

The Emergency Services in Thyborøn explain that they have plans for evacuation in collaboration with the Home Guard, the police, the Danish defence and the Danish Emergency Management Agency in case of fire or a breach on a dike. But the informant explains that: “*We do not have any special plan for Thyborøn and the harbor in regards to storm flood and floods.*” (Male employee at the Emergency Services). He explains that because Thyborøn is an autonomous harbor they themselves have to be interested in making a plan with the Emergency Services. Currently there are beginning discussions about possible making some sort of plan. The reason why they don’t have one is as he says: “*Because we haven’t met any challenge we couldn’t solve and we don’t expect to.*”. Because most of the docksides have been elevated by one meter it is not expected that larger amounts of water than previously will affect the area. However, not having an Emergency Response plans for storm surges can not be considered reinforcing to the community resilience and is therefore a limitation.

#### 5.3.4. Water supply institutions

The Water supply institutions are one of the public institutions that are very involved in flood preparedness. This was discovered during a meeting in Lemvig municipality where different actors related to flood adaptation was invited to discuss the current and future situation in Thyborøn.

The water supply in Løgstør were in the early days of floods largely involved in the flood protection and strengthening the community resilience but ever since the Water Supply went from being part of the municipality to now being a joint-stock company owned by the municipality they lost influence. The informant from the Water Supply Institution explains that now a day they are only in charge of running the pumps when water is drained from the city whereas they before were part of the planning process.

However, two third of the research participants mentions their surprise with how well the water in taps and toilets as well as sewers functions during a flood. This is the work of the Water supply institutions and their ability to early on predict a need for non-return valves and separate run-off water and sewer lines. The preparedness of the Water supply institution in Løgstør have helped enhance the resilience to storm floods given that certain problems and challenges are avoided due to their instalments.

The Water Supply institution in Thyborøn is more involved with preparing for storm floods

than Løgstør. The operational manager tells that they are currently the ones that are pulling the strings to get started in Thyborøn. Often they contact the Emergency Service to let them know that problems may arise during the alerted flood. The Water Supply have maps with quotas of the water level different manholes are capable of coping with. Based on that it is possible to see what areas will be flooded and who needs to be evacuated. They also register how much surface water they remove with the pumps during a flood to be better prepared for future events. They cooperate with the police and the Emergency Services by sharing knowledge. The informant tells that normally a flood last 10-12 hours but it depends on the wind direction. The informant then explained what they so far have implemented; high water level closure in the harbour area and valves at the auction centre because they experience floods at 20-30 cm almost every time. When new sewage pipes are installed the Water Supply institution pay close attention to climate change and how that might affect the pipes. The fact that they take it in to account enhances the resilience because of the awareness and preparedness.

One of the remaining problems is open manholes with covers that have small holes. The Water Supply Institution experience that the water run down there and then they cannot pump it away and people have flooded basements. He explains that when the water runs above the quayside then all they achieve by pumping is to recirculate the water. Another instalment that is planned for the future is large pools for containing excess water during a flood and an extra pumping station in one of the residential areas in the city that often struggle with surface water.

He finishes by saying that in the past other values were important and a flooded basement was not something that was seen as a big issue. But because people utilize the space in a different way then the values have changed and the floods affect the citizens in Thyborøn more now than previously.

#### 5.3.5. Interoperable communications

Interoperable communication is in this study defined as the communication between the municipality officials, the police, the Emergency Services and the Home Guard who are being summoned during storm surges that the city themselves do not have the resources to contain.

The former mayor of Løgstør explains how he saw an improvement of the interoperable communications from the first severe floods until today. At first there were misunderstandings of who had the power to forcefully evacuate exposed citizens, which led to a multi-handicapped man refusing to be evacuated and the municipality not having the jurisdiction to do so. After the incident it became evident that if the police had been contacted they would have had the jurisdiction to order people to be evacuated. This was a lesson learned and now there is better understanding of who has the different competences. Cutter stresses in theory that there is a difference between lessons learned and learning in regards to the adaptive resilience process, which will be discussed further in chapter 7. The informant stresses that it is now a part of the Emergency response plan, who has certain competences and jurisdiction. He acknowledges that

during the storm in 2005 the interoperable communication left a lot to be desired. It was a learning curve and the experience have helped them improve the weak points of the communication and understanding of the different roles and responsibility.

The female, 58-year-old, police officer recalls in 2005 a faulty communication regarding an emergency generator. A mistaken evaluation of risk and interoperable communication led to the emergency generator that was placed by a low hanging electric fuse box that was expected to flood to be moved. The emergency generator was moved to the nursing home that was flooded and a half hour after the move the power went in the harbor area. A lack of interoperable communication led to the harbor area being unnecessary flooded because the power to the pumps blew. This has since then been corrected through a collection of the preparedness plans in the Emergency response plans. Also all electric fuse boxes have been raised so they are now at least 2 meters over ground level.

The informant from the Home Guard have experienced an improvement in interoperable communication between the public institutions and the Emergency Services. He mentions how they are interested in developing a good relationship and understanding of each others strength and weaknesses, which are important in times of crisis. This improvement in communication have happened through mutual tasks and drills where different emergency services and public institutions have been invited to work together. Also a change for all emergency services to a system called SINE have improved the interoperable communication, which was a problem during the flood in 2005 where the mobile network broke down. This led to difficulties in interoperable communication and diminished the resilience but this is no longer a challenge during floods.

In terms of interoperable communication in Thyborøn the municipality points out that they are a relative small municipality in Denmark so the cooperation between Emergency Service, the Water Supply Institution and the municipality is extremely integrated. It was clear throughout the interviews that all know each other well and a few years back all three institutions had offices at the municipality building so they have always worked close together. The informants from the municipality points out that they work extremely well together and have always stressed sharing knowledge. They often have informal meetings to inform each other of news and plans. As the informant says: " *Small municipality – close cooperation. No need to convene any large meetings. When something happens we simply react.* ". This closeness between the different institutions may be why there is not any detailed Emergency Response Plan because the cooperation is so ingrained that they have no need themselves for guidelines on who have what responsibility. During the fieldwork a meeting with many different actors with a connection to climate change in Thyborøn was held. Here it was possible to observe the interoperable communication between the municipality, the Emergency Services, the Coast Directive, the Water Supply Institution and several others. It was possible to see that many different opinions and

suggestions were taken in to account when evaluating the climate adaptation plans that are currently being developed. From the meeting it was evident that the interoperable communication is present and contributing to enhancing the resilience towards floods because many different views are listened to.

### 5.3.6. Cooperation and citizen involvement with locals

Local knowledge can be vital in the process of implementing the most successful climate adaptation measurements not only to secure the locals support but also to get a better understanding of what installations may function best in different types of situations. When the municipality is open to cooperation with the local community different aspects and solutions are likely to arise that will make the implementation smoothly and more successful. Cooperation is also a good way of combining resources and enhancing the resilience by letting the locals participate in securing the local community. This way they are more likely to take ownership of the implementations (Bye, Lein, & Rød, 2013).

The municipality employees in charge of implementing adaptation measurements in Løgstør decided early on to involve the local community in the process. The former mayor tells how it all began back in the 90ties with involving the locals and having public meetings to try and start a dyke guild. This was however not of interest to the locals and therefore they are less involved today than if they had agreed to a dyke guild back then. This does however not mean that the locals were excluded from any citizen involvement but that their decision did limit some of their inclusion.

The male, 75-year-old, retired banker remember that the local community was invited to information meetings regarding the plans for adaptation measures to prevent damage from storm surges. The locals living in the flood zones were in particular invited to cooperate. This is backed up by the informants from the municipality that recalls how the locals were invited back in 1998 to a meeting regarding how you best secure yourself in case of storm surges and also concerning the municipality's plans. There was an interest from the locals in having the municipality start securing the city but none in helping with economic contribution.

Locals also cooperate by delivering information about flood and relevant local knowledge through the municipality's webpage. This is something the municipality have taken in to account when preparing the Emergency Response Plan and security measurements. It was also local entrepreneurs that helped develop and build some of the adaptation measurements to climate change such as the sea wall. The locals were invited to be a part of forming the initiatives and the fact that it is local work may influence the way the locals take to the instalments positively.

Cooperation between the municipality or any other public institution and the local community does not appear to have taken place. The informant from the Emergency Services explain that

they do work together with employees from the harbor but no one else. The municipality plan to involve the local community in the future but as of now they are not involved. The informant from the municipality were uncertain when they would cooperate with the locals but they knew it would be in the shape of a pumping guild. This would require citizen involvement and for them to be interested in working with the municipality. Given that the municipality so far have not included or cooperated with the locals in any sense it is possible that they are less inclined to aid in the future. However, that depends on whether the municipality inform the locals of the level of disaster risk they are exposed to. If that is the case the locals will probably be more declined to aid even if they so far have felt excluded. No citizen involvement is not enhancing to the community resilience given that theory from chapter 2, section 2.2.1. explains that it is important to involve the local citizens.

### 5.3.7. Zoning & building standards

Both cities are located right by the fjord with the possibility of nearly the entire city flooding if the storm is severe enough. However, certain areas of both cities are more likely to flood even during smaller storms with lower levels of water. If any critical buildings such as power plants, nursing homes, hospitals or valuable buildings for the main industry, heritage or infrastructure is located in the flood zone it would prevent the emergency services from easily evacuating fragile residents or exploit assistive devices for clearing flood.

The nursing home in Løgstør is located in a flood zone which are causing the Emergency Services challenges during a storm flood. The chief of the Emergence Services pointed out that the nursing home is located at an unfortunate dwelling because it is currently on the border of the flooding area. The location of the nursing home can be seen on figure 16 in chapter 5. On the map it is possible to see that currently two nursing homes are located in Løgstør but only the nursing home closest to the waterfront is located in a flood zone. This causes several problems under a flood event one of them being that the nurses cannot access the nursing home and assist the elders because of high levels of water. Evacuating the elder residents is also a process made more complicated and time-consuming by high levels of water according to the informant from the Emergency services.

The former mayor made it clear that during his time as mayor there were implemented certain regulations for buildings near the waterfront and in flood zones. He explained that every time a building or renovation project is instigated within the flood risk area of Løgstør the municipality require for the building socket quota to be at 2,10 meter. He rationalized that it was decided to have it at that level so the dwelling wouldn't be affected immediately during a flood. The socket regulation was also to attract attention to the risk of flood damages. It was decided that they would change the building standards early on to be prepared for the rising water levels during floods. He also worries that some of the newer homes are not formed for floods whereas older homes are better equipped at handling storms because the locals themselves prepared

their property adequately prior to the initiatives from the municipality. On figure 18 in chapter 5 it can be seen that buildings of high value is located by the fjord, which gives another incentive to regulate the building standards in the flood areas.

The nursing home in Thyborøn is located within the flood zone, however, most of the city is labelled flood zone without the water often reaching the area of the town where the nursing home is located. The nursing home can be seen on figure 20 in chapter 5. It may not be causing any problems or concerns currently but are certainly going to develop in to a concern with the rising water level from more intense storms. The road running parallel to the ocean on the left side is in reality a dike, see figure 20. The one build to withstand a 1000-year flood so the location of the nursing home is currently not a great concern for either the Emergency Services or the municipality as they expressed in the interviews. It is mostly the harbour area that experience floods and the water seldom reach in to the rest of the city. Smaller dikes are located around the city to keep the water contained at the harbour. Still the municipality have in their Climate adaptation plan for 2014-2017 suggestions to how the residents can protect their property. The plan says that residents shall themselves secure their properties for a water level of 10 cm over terrain. It is deemed by the municipality that this should not be a challenge due to curbs and plinths. The municipality plan to launch a campaign focused on how to climate-proof a building. It is suggested by the municipality to proof a building if any of these features are present; light boxes in terrain level, outdoor entrance to basement, descents to garage, leaking plinths or a street level above plinths level. A rapport has been created with suggestions on how to remedy these problems. The informant from the Water Supply say that many of the houses in the old part of the city have basements, which are easily flooded during extreme rain. These are bound to be flooded too during an intense storm surge so it has been suggested to cement the basements because it is becoming increasingly difficult to get pay-outs from the insurance companies.

The fact that the municipality plan on launching a campaign on how to climate-proof property is a strength for the resilience. People will be better prepared for large amounts of water if they follow the guidelines and suggestions for proofing their property.

### 5.3.8. Climate mitigation/adaptation and future plans

The climate adaptation plans implemented today in Løgstør and Thyborøn did not occur overnight or all at once but was slowly constructed over several years. All municipalities in Denmark are since 2013 required to construct climate adaptation plans so they are prepared for the predicted changes in climate.

Løgstør Municipality began a more focused climate adaptation planning after the big storm flood in 1981. The flood in 1981 was defined as a 100-year flood event even though a similar severe storm flood hit Løgstør only a few years after. The informants from the municipality explains that the storm came as a surprise and nothing along the lines of preparedness or storm

flood adaptation measures were installed. The municipality had begun the process of planning for coping with storm surges but nothing was implemented. You simply tried to handle it by getting people and cars away from the flood areas because there were no means to keep the fjord at bay. The informant from the Water Supply Institution tells that one of the first larger climate actions was to raise the quaysides, which was done in 1995/1996. Before that the pumping stations were constructed in the time period of 1981-1990. The current five pumps are very efficient and can move 2000 litres of water per second. That equivalent empties the entire Limfjord in a matter of 38 days, which was calculated by the Water Supply Institution. The municipality informs that the project with the seawall and stonework in front of the wall begun in 2003 and was nearly done in 2005 almost in time for the large storm flood. The storm surge in 2005 came with the highest water level ever recorded in Løgstør and was higher than the seawall almost at 2.20 meters. It is predicted that the wall can withstand water levels of 1.90 meter due to waves pushing water over. However, the recorded water level was at 2.28 meters before the measurement equipment broke down. This can be viewed as insufficient planning given that the wall could not contain the very first storm surge to hit it. The former mayor tells that after the flood in 2005 Løgstør was granted an extraordinary loan on 5 million DKK by the minister of foreign affairs to secure the harbour from floods and to rebuild the damages. That money was used for the last instalments.

Other problems such as manhole covers catching air at high tide and flood water running in the sewage pipes have been corrected. Now non-return valves are installed so when the water in the city reaches a certain level the valves close. The challenge of emptying the city from surface water was later on solved by implementing a more elaborate pump system. All these changes were done by the Water Supply Institution.

The flood in 2005 revealed a very vulnerable power system, which was improved first thing after the flood. Now all electrical installations are required to be at least 2 meters above ground level and a mobile generator is available that can supply everything required to run during a storm. The municipality says that the current climate adaptation plan has existed for many years but under the name Storm flood Adaptation Plan. This shows that the municipality planned for and was aware of the risk of floods long before it was required by the Danish government to make climate adaptation plans in the municipalities.

Most of the instalments and measurements in Thyborøn was implemented a long time ago as mentioned in chapter 5. Only the Water Supply Institution have implemented any climate change proofing since the last big flood in 1981. What they currently have in Thyborøn is a large number of dikes as seen on figure 20, wave breakers and a seawall or a so called a high water protection device with a height of one meter. It is uncertain if this device has been maintained over the years but it is meant to keep the water only in the harbour and not in the city. In the Climate Adaptation Plan it is deemed that a service level of 10 cm is present in regards to

floods. This means that the municipality and Emergency Services expect the locals to be able to cope with a water level of 10 cm without getting a flooded property.

#### *5.3.8.1. Future climate adaptation plans*

In Løgstør they are currently aware of what needs to be implemented and strengthened to be able to cope with storm surges in the future. Since the seawall was not sufficient from the beginning the municipality is aware that someday within the near future it will have to be improved in terms of height. One of the last areas of the city that needs to be secured is the Limfjordsmuseum located by the fjordshore on the left side of the city. This part of the city is slightly raised and the water level during storms is currently not high enough to wash over the area.

The fact that the municipality is aware of areas that need to be improved in line with climate change's consequences becoming more prominent shows great insight and local knowledge of the environment.

The municipality sees Thyborøn as more of a future project in terms of security instalments. Nothing needs to be implemented today but something must be done within the next years by their account. They have a wish for a simple, practical solution. In the period 2014-2017 the municipality is gathering data attempting to examine the new challenges related to land subsidence and sea-level rise. One of the initiatives that the municipality is interested in realizing soon is a pumping guild because the Water Supply Institution cannot keep up with the large amount of surface water. The solution in Thyborøn will mainly be to pump away surface water and to build instalments to minimize the consequences and impact of climate change. Some other solutions may be implemented along the way such as increasing the height of the dike running along the main road to the city. This is however the only barrier that the municipality intend to improve or enhance in the city. This is because that dike separates the city in areas that are easier for the municipality to work with. It also separates the housing area from the harbor making sure no polluted water reaches the residents. However, the fact that certain areas of the city can be separated can be a problem in regards to evacuation plans. The municipality mentions that they have to improve the current plans on evacuation because there is only one main road leading away from Thyborøn. There is also a coast road but it hasn't been maintained over the years and would not be suitable for larger evacuations in case of flood or fire. This is currently not a strength for the resilience that the infrastructure is not capable of accommodating an evacuation of the entire city.

#### *5.3.8.2. Most efficient implementation*

In Løgstør the most efficient climate adaptation measurement is by the local community considered to be the seawall because the municipality managed to make it blend in with the surroundings while also letting it make the harbor area more attractive for tourist. The fact that it is not

obvious that it is a climate adaptation measurement could be seen as a very well implemented instalment.

However, the municipality themselves are pointing at the alerting process as the most efficient tool to minimize the level of disaster risk. The fact that people are able to prepare for the storm flood is crucial. 20 years ago the water would simply wreak havoc on the city and now one was prepared to cope with the flood. Today, it is very helpful that the locals are enlightened and aware of any level of risk.

### 5.3.9. Amenity

An unanticipated variable that influence the community resilience is the value of attractiveness of the city, amenity. When smaller cities rely on tourism as a main industry amenity is a priority that not only locals consider but also the municipality take in to account when constructing climate change adaptation plans. The adaptive measures are not allowed to diminish the atmosphere surrounding tourist spots and are weighted almost equally important in some places as reducing the risk towards natural hazards.

In Løgstør it became evident during the interview with the municipality that not only is amenity taken in to account but it also directly affects the decisions regarding adaptive measures towards storm floods. Male employee at the municipality explains that: " *It has been important throughout the planning process that we kept the amenity. That when you drive along the harbor you can actually see the water.* ". He recalls how they parked the car at the harbor and one person stayed inside while a colleague held up a wooden board at the waterfront to determine at what height it was still possible to get a view of the water when being in a car. He continues by saying that: " *Now it is beginning to cause us [the municipality] problems because the water level keeps rising. So at some point we will have to do something that increase what [the seawall] we have.* ". When asked if they planned on increasing the height of the seawall to prevent water from intruding the city streets during intense storm surges both employees at the municipality seemed somewhat reluctant to that idea. The employee responsible for emergency preparedness acknowledges that the current protections at the waterfront is not sufficient in keeping the water completely out and said that after the large storm surge in 2005 two to three storm floods have pressed water slightly over the seawall and smaller amounts of water has been in the streets just along the harbor. These storm surges did not cause any damages but with the prognoses for the rising water level it may only be a matter of time, which the municipality is very aware of. The planning employee at the municipality says that: " *We looked at the prognoses 10 years ago when planning the sea wall but the most important thing was the amenity. We made a few experiments with wooden boards to see what we actually could allow of a height. It needs to be possible for people to drive along the harbor and see the water. It was very important for us.* ". Once again the municipality express that the view of the water is more important than a long term adaptive measure instalment against storm floods. The municipality

was from the beginning of building the seawall aware that it was not a sufficient height if any future prognoses was taken in to account. Not only was the view of the water important for the municipality but also the materials that the sea wall was built of. It had to blend in with the surrounding environment so instead of diminishing the atmosphere at the harbor the seawall aimed to enhance it. The planning employee says that the aesthetics had to fit the look of the harbor so the sea wall is made of wood to appear maritime and function in the summertime as a sitting area for tourists.

Several of the locals in Løgstør agrees with the municipality that they want to be able to see the water from the harbor. As presented in *Local understanding of risk* none of the locals are interested in living behind a wall. The back-up from the local community makes it possible for the municipality to priority the amenity as highly as they have so far.

The amenity value was never mentioned by either the locals in Thyborøn or the municipality during the conducted research. It does not appear to be prioritized very highly considering the dike protecting the city from the ocean is cemented and large enough for cars to drive on top of it. This dike obstructs a view of the beach and the ocean. Few properties in Thyborøn have an ocean view due to storm flood protections. These dikes were all installed before the employees that are currently working with the climate adaptation plans were employed at the municipality but they appear satisfied with having prioritized securing the city from a 1000-year flood event despite constricting the views. If not for the dikes there is a great possibility that Thyborøn could not be located where it is today so the amenity value would have to be down prioritized over security and minimizing the exposure. The fact that the municipality and the local community all respect and understand the dikes are need to be that high show an understanding of the necessity of minimizing the exposure due to the location.

## 5.4. Information and communication

### 5.4.1. Information

Information provided for the locals regarding flood and preparedness is imperative for them to understand the risk and to adequately respond to and prepare for it.

When talking to the municipality in Løgstør it was evident that no information was provided for people moving to the city on how to prepare for and cope with floods. The employee responsible for hazard preparedness meant that Løgstør is well known in all of Denmark for their problems with floods so it is currently common knowledge that Løgstør is located in an area with a high level of disaster risk from storm floods. The informants from the municipality therefore perceived it as unnecessary to provide any information of the risk. Information during floods is most often through television where the supervisor for preparedness planning is interviewed and relies any important updates. Also the radio is involved during floods to provide informa-

tion to the locals. As presented in *Cooperation between locals and municipality* the municipality invited the locals to a public meeting where information on plans for climate adaptation measures was presented and open for discussion. The flow of information and the openness of the planning process is an important factor in establishing trust and confidence in the municipality and their ability to cope with floods. The former mayor recalls how a webpage with information on the development of the storm in 2005 was created for the locals. An employee updated it throughout the 36-48 hours of the storm flood. Information was also provided through the radio and still are. Today though most information is online or on television.

The female police officer has received information on how to best prepare her property before a storm surge. Likewise, information on where to gather sandbags is communicated by the Emergency Services prior to impact. A large part of the local community has experienced storm surges several times and have already obtained necessary information and knowledge.

Overall the locals in Løgstør express that the municipality have been good at sharing information on the risk of storm floods as well as the planning process for climate adaptation. The fact that newcomers do not receive any information but have to somewhat gather it themselves can be seen as a limitation. This could possibly affect the newcomer's resilience to floods given that they are not informed of the disaster level of risk and on how to best prepare themselves. However, Løgstør is currently not experiencing a high number of in migration.

No information is provided for the local community in Thyborøn about the level of disaster risk or the climate adaptation plans the municipality is currently constructing. All of the research participants said that the municipality offers no information about the current or future situation in Thyborøn. This was something they all thought would indeed be relevant information to share with the people residing in Thyborøn and one of the schoolteachers said that: "I would like some public meetings about what is going on or at least some information meetings. I think that is only fair." Another male schoolteacher agrees that they should inform the locals or at the very least give information about the current studies they are conducting on the land subsidence given that he is certain the locals in the end will pay the bill. He ends it by saying that: "We would like to know some more. We are the ones living here." One of the female, hotel owners says that it is not from the municipality that they get their information but instead from their insurance company. She continues by saying that the municipality is not visible in Thyborøn in any way and that they never rely any information voluntarily without having been asked first. She says: "The municipality is not great at alerting the local community for floods."

The municipality is aware that the locals are lacking information about climate change and the repercussions from these on Thyborøn. They have discussed internally what degree of knowledge should be shared. They rely that they are aware that for anyone to understand the issues then knowledge is necessary. However, they see it as though there is a divide between making people feel threatened, telling them about a threatening picture and simply giving them

updates or knowledge on the current situation. They explain that this is a divide they have not learned to balance yet in the municipality. Instead they have chosen to not inform the local community about anything yet. Given that the municipality is conducting drills around the city the lack of information seems to have affected some of the locals. A male, 58-year-old, schoolteacher is worried about the situation and the lack of information is causing him to believe the worst regarding land subsidence.

Even though the current approach is to wait to inform the locals until all research and studies conducted by the municipality are finished they initially wanted to have information meetings with the locals. They were also interested in constructing an online platform where communication between the municipality and the locals would be possible. Here the locals could report their local knowledge on hazards and the consequences. This was dismissed further up in the municipality chain with the reasoning that they weren't ready for that yet and that they might risk that the locals would expect action immediately after reporting a problem. The interviewed employees at the municipality started off interested in laying all knowledge on the table without trying to spare the locals so they would be capable of understanding the situation and then the municipality would answer any question they were capable at. Some questions would go unanswered due to uncertainty and missing information. They reconsidered this approach due to a fear of not being prepared for some questions. Another reason is that they believe it is still too early to start a dialog and discussion because the issue won't be pressing in their opinion until maybe in 25 years. They would like to have a model that will give more answers before opening up a dialog and providing any information.

They are aware though that this approach may lead to the locals feeling overheard and not included but this is not something that appears to have an effect on the chosen method. Furthermore, they argue that it is also a question on how you wish to solve the future challenges in Thyborøn. One of the employees say: "Is it going to be based on emotions or knowledge. Investments can be based on impressions and feelings. That is too expensive." A mix between the two was not considered in any way and it was evident that the municipality wanted to base their solution mainly on collected data from experts.

Lack of information may diminish the resilience given that the locals are unaware of the risk and exposure they are living in.

#### 5.4.2. Communication between locals and the municipality

Communication in this study is somewhat overlapping with information in the sense that the sharing of information often leads to a communication between the different actors. However, in this study information is primarily seen as the municipality sharing knowledge with the local community whereas communication is seen as a sharing of knowledge going both ways.

The municipality in Løgstør had an open telephone line where any local resident could call to inform about local knowledge regarding hazards but in particular floods. This was a way of

sharing information in a controlled way between locals and the municipality. Communication have always taking place on the information meetings hosted by the municipality. There have since 2005 not been any information meetings given that the municipality have not implemented any large measurements against storm flood.

Currently there is in Thyborøn no communication between the local community and the municipality regarding hazards and climate change adaptation measures. This is something both parts agreed upon during the interviews as non-existent. Local people expressed a dissatisfaction with the lack of communication. The male, 58-year-old, schoolteacher says that: *“I know they have built a lot of climate change adaptation measurements in other parts of the region but I don't think they [the municipality] have done anything at all out here. They haven't even held any meetings or the like. I hear other municipalities do this.”* A male, 44-year old, business owner replied when asked about citizen involvement that it was something he never have heard about occurring in Thyborøn. Even though the research participants from the municipality had an initial idea regarding a digital platform as previously mentioned it was decided further up in the municipality that this should not be launched. It was instead decided upon a different type of communication approach. This approach is considered a limitation when trying to enhance community resilience because the approach focus on involving the local community very late in the process of climate change adaptation. The tactic from the municipality is to have gathered all information and relevant data on the current situation as well as the present one before inviting any locals to an information and communication meeting. To involve the local community this late in the process would make it difficult to take advantage of the local knowledge and inputs given that a solution to any challenges in Thyborøn is already planned by the municipality. The municipality reveal that they do plan on involving the local community but it is not yet in the plan when it will happen.

#### 5.4.3. Trusted sources of information

The storm in 2005 striking in both Løgstør and Thyborøn had very dramatic prognoses from Danmarks meteorologiske institut (DMI). The storm was predicted to be more intense than prior storms with water levels estimated at meters over normal level.

The former mayor and the police officer remembers how no one believed the prognoses of the development of the storm. Everyone was certain it would never be realistic given the high height of water level that the DMI predicted because of the storm. Even though neither the former mayor nor the police officer believed DMI they have different opinions on their skills back then. Whereas he believes the prognoses was catastrophically and not nearly as precise as one could hope for she thinks they where extremely good but unfortunately no one believed it to be as extreme as it was. Not even the Emergency Services believed the prognoses from DMI, which turned out to be imprecise since the water level was above the predicted 2,20 m. DMI have over the years perfected their models and are now able to give very precise prognoses that

are trusted by the local community and the municipality. The former mayor says that the prognoses are now believable, which is a great help to the Emergency Services since they do not risk alerting the local community without suitable reason. If the local community was alerted often of floods, which turned out to be none threatening then they would eventually doubt the level of disaster risk and not prepare accordingly for floods.

The last few years the media have had more focus on storm floods especially in Løgstør. Ever since the big storm flood in 2005 Løgstør have been on the map media wise blowing up the stories and by the male, 84-year-old, retired boat builder's opinion making it more dramatic than it is. The media tend to portray Løgstør as a small city struggling immensely with storm floods and a place that gets flooded all the time. This picture is misconstrued given the impression that the resilience of Løgstør towards floods is low when in reality the locals do not perceive floods as a massive problem. It is correct that they would rather not experience floods in the future but the media do make it sound like a bigger problem than it appears to be for the locals.

Because of the lack of both information from the municipality and communication between the local community and the municipality the locals do not always express seeing the municipality as a trusted source of information. There is no distrust existing but they do appear to be more inclined to look for information in the media such as newspapers and radio. The male, 51-year-old, schoolteacher says that he found out about the land subsidence in Thyborøn through the newspaper and not through the municipality even though they were conducting drills in town. However, there is a fear that if the media portrays an image of Thyborøn being a city struggling with storm floods it will scare away any possible new comers. This is not only a concern for the locals but also the municipality that worry how the media may spin a story to be worse than the reality. Headlines like “The city that is drowning” would scare away many people while simultaneously creating a bad atmosphere. More trust is given to the radio, which is applied when alerts to storms are being informed and especially the older generation appeared to find it useful for obtaining any information before and during a storm. The male, 58-year-old, schoolteacher says that: *“We know that when it is windy and there is water above the quay we have to turn on the radio to know if we need to be evacuated.”*

#### 5.5. Concluding remarks

In this chapter I presented main findings from the two study areas. The presentation has mainly been organized around the dimensions and variables presented in figure 7 in chapter 3. However, also new, additional aspects that have surfaced during coding of the interview material, have been presented. The main findings and the relevance of the initial conceptual model in assessing the strengths and limitations of the two communities, will be discussed more in detail in the next chapter.



Figure 24: Picture of Thyborøn

## PART 4

## DISCUSSION AND CONCLUSION



Figure 25: Picture of Løgstør





## 6 Discussion, reflections and conclusion

In this chapter I will discuss the main findings, present recommendations for enhancing the resilience, reflect upon the definition of community and lastly conclude on the main findings and the relevance of the conceptual model.

### 6.1. Discussion of main findings

The strengths and limitations to enhancing the community resilience for the two case cities have been discovered and are in table 3 presented. The strengths are viewed as enhancing and the limitations as diminishing for community resilience and they are based on knowledge obtained from theories and observations gathered in the case cities. The *italic highlighted* strengths and limitations are based on theory.

Table 3: Strengths and limitations that can influence the community resilience.

	Strengths	Limitations
<b>Logstor</b>	<ul style="list-style-type: none"> <li>• Large network of volunteers</li> <li>• <i>Good local understanding of risk</i></li> <li>• Cooperation between municipality and locals</li> <li>• <i>Medium sense of community</i></li> <li>• Open local community</li> <li>• <i>High level of attachment to place</i></li> <li>• <i>Perceived and received support seen as similar by locals</i></li> <li>• <i>Citizen involvement in planning process and building implementations</i></li> <li>• Organized Emergency services</li> <li>• <i>Good local knowledge</i></li> <li>• <i>Trust sources of information</i></li> <li>• <i>Climate adaptation plans implemented</i></li> <li>• <i>Different building standards in flood zones than other zones</i></li> <li>• Locals satisfied with the effort on climate adaptation from the municipality</li> </ul>	<ul style="list-style-type: none"> <li>• High prioritizing of amenity</li> <li>• <i>Lack of flexibility in Emergency Response Plan</i></li> <li>• <i>Location of critical buildings in flood zones</i></li> <li>• Limited amount of local initiatives toward flood protection</li> </ul>
<b>Thyborøn</b>	<ul style="list-style-type: none"> <li>• Strong mental health</li> <li>• Rich local community</li> <li>• <i>Large local knowledge</i></li> <li>• <i>Strong sense of community</i></li> <li>• Independent community</li> <li>• Resource strong community</li> <li>• <i>Medium to high level of attachment to place</i></li> <li>• Security prioritized over amenity</li> <li>• <i>Good interoperable communication</i></li> <li>• Campaign on CC-proofing</li> <li>• Some volunteers - a small resource</li> <li>• Open community</li> <li>• <i>Acquires information from media as a trusted source</i></li> </ul>	<ul style="list-style-type: none"> <li>• Lack of available space/slots</li> <li>• <i>Lack of information on storm flood risk, planning process and data collection</i></li> <li>• <i>Lack of communication between municipality and local community</i></li> <li>• Lack of evacuation roads</li> <li>• No citizen involvement in planning process</li> <li>• No local initiatives toward flood protection</li> <li>• <i>Perceived and received support not always similar</i></li> <li>• <i>No Emergency Response plans for storm surges</i></li> <li>• <i>Climate adaptation plans in process (2014-2017)</i></li> <li>• Aging population</li> <li>• <i>Mixed local understanding of current and future risk</i></li> </ul>



As can be seen in table 3 a larger number of limitations are attributed to Thyborøn in comparison to Løgstør. The explanation for that may be that Thyborøn have not yet experienced storm surges to the same extent that Løgstør have and therefore they have not yet been required to take action and prepare the city accordingly. Whereas Løgstør have experienced large and damaging impacts from storm floods several times within the last 30 years they have learned from their previously shortcomings and enhanced the community resilience towards storm floods.

Both communities have a relative large number of strengths spread throughout the dimensions of resilience. Some of the surfaced strengths were not based in theory such as “*Open community*” and “*Large network of volunteers*” but still have a positive influence on the community resilience towards storm surges. These variables have been placed under the community competence dimension of resilience because they are perceived as either strengthening the community.

The dimension of institutional capacity is especially strong for Løgstør and the cooperation between the local community and the municipality can be argued to enhance the resilience substantially. The dimension of community competences is for Thyborøn particularly strong and the many resources of the local community have a positive influence on the community resilience.

It has been described in chapter 5 how the different strengths are perceived as enhancing to the community resilience. In the following an explanation and discussion of how the limitations are perceived as diminishing to the community resilience will be presented.

Some of the limitations are challenging economically to improve upon such as; location of critical buildings in flood zones, lack of available space/slots and lack of evacuation roads. If amended upon they would all enhance the community resilience significantly. Given that these are expensive and difficult, if not impossible in the case of lack of available space, to alter from limitations to strength these will not be the focus of the discussion.

The fact that the municipality in Løgstør explain how they were aware of the lacking height of the seawall, when it was built, but decided to not raise it because of the high prioritizing of amenity is a limitation to the resilience. When threatening the preparedness and deciding not to minimizing the risk of storm flood damages because of the ambiance of an area it is not constructive for the community resilience. Even though both the locals and the municipality agree they do not wish to barricade themselves away from the ocean it clashes with the population in Løgstør that is not willing to accept damages on their property. The expert interviewed says that a local community should have a general understanding of that there is no such thing as a 100 % protection against storm flood. There will always be a residual risk. However, by down prioritizing the amenity value the exposure to storm floods would be reduced.

The structure and organizing of the Emergency Response plan in Løgstør is tight not making much room for flexibility. This is a disadvantage given that every storm do not evolve com-

pletely similar and there must be room for unforeseen events (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007, s. 15). This could however be difficult to change simply because the Emergency Service for a number of years have followed this plan and making room for flexibility could be viewed as a back step. The Emergency response plan is built on knowledge from previously experiences with storm floods and have evolved since the large flood in 2005. Cutter however do point out that there is a difference between lesson learned in the coping faze during a flood and learning in regards to the adaptive resilience process (Cutter, et al., 2008, s. 6). A great deal of the knowledge Løgstør have implemented in the plan are lessons learned when coping with the flood. Løgstør have been able to implement these learned lessons before the next hazard hit thereby improving on the resilience. This continuously reflection on the plan is positive for the resilience.

Løgstør and Thyborøn experienced that once the municipality started implementing climate change adaptation measurements the locals stopped maintaining their own initiatives toward flood protection. The expert explains that this is diminishing to the community resilience because locals must reach the realization that preventing floods is a common task that cannot only be entrusted the municipality. Therefore, the locals should maintain their own initiatives to enhance the resilience by for example having a citizen preparedness service or the like. The expert explains that having locals interested in the topic and being actively involved in protecting the city can have a large positive effect on the consequences from a flood. Given that the cities, in particular Løgstør, are able to gather a large number of volunteers this resource may be one that could be taken benefit of to reinstate some of the local initiatives. Through information from the municipality the locals could be informed of ways to climate change proof their property and how to themselves minimize the risk.

The fact that the municipality in Thyborøn have decided upon an approach where they have chosen not to inform the local community of matters related to storm flood risk, planning and data collection is not suitable for the community resilience. This prevents the local community from understanding the level of disaster risk from storm floods, which have proven to be another disadvantage for the community resilience. Norris stress in his model that information and communication is essential for resilience by focusing on it as a dimension of resilience.

The expert expressed that citizen involvement in the planning process can play a significant role for resilience in particular in smaller communities out in the country that have to take care of themselves during a storm flood. Also it gives the locals ownership of the implemented measurements if they have been included in the process to some extent. Theories claim that the earlier the citizens are involved the easier the process of implementing any measures will be. Masterson explain that public participation is key to any planning process and that it helps to increase the publics awareness and understanding of vulnerabilities. He explains that by engaging the public and by better understanding the composition of the community it enables planners and community alike to better manage all phases of a disaster (Masterson, Peacock, Van Zandt,

Grover, Schwarz, & Cooper, Jr., 2014). It would therefore be an advantage to the planning process in the municipality, which they are currently working on, to involve the citizens. It would enable both community and locals to better manage a disaster and ultimately enhancing the community resilience.

All locals in Thyborøn described the community as helpful and all you had to do was ever ask for help. However, because of the strong independence it became evident that no one ever ask. Being independent is a strength unless it hinders people from drawing on the community resources in a crisis. The same pattern is evident regarding receiving help from the municipality. The locals never ask for any help and therefore do not receive help to the extent that would be beneficial for the locals. If they learned to ask for help when it is needed, then the gab between perceived and received support may become smaller. However, this is not a strength that is evaluated to enhance the resilience in great deal because it is still evident that if there is a crisis the locals will find a way to help the needing even if they do not ask for it.

The model by Cutter stress under the institutional dimension of resilience that Emergency response plans as well as Climate change plans are important for the community resilience. Lack of both a finished Climate Adaptation Plan and an Emergency Response Plan towards floods may reduce the preparedness and in turn affect the resilience in a negative way. Clear agreements between different institutions equals less miscommunication during stress and thereby a more controlled coping faze. It may be easier to not have a plan in a smaller municipality because the interoperable communication is tighter and because everyone involved with the storm surges are working under the same roof. Having these plans finished will however enhance the resilience.

Aging population was one of the categories under the variable *demographics* for the social resilience dimension in Cutters model. An aging population profile is a disadvantage to the local community since elderly people tend to be more vulnerable to health as well as safety impacts from storm floods. They may further have difficulties with complying with preparing properly when alerted to storm flood (Gurran, Hamin, & Norman, 2008, s. 21). Also the aging population profile brings with it challenges for what Thyborøn will look like 20-30 years in the future. The population size is declining with the young leaving to pursue careers in other cities leaving the older population behind.

It is impertinent that the locals have a clear and concise understanding of the risk they are living under so they can prepare accordingly. One of the reason for why the the local understanding of risk was perceived differently by the locals in Thyborøn could be that risk is not always shared equally and therefore some individuals will have a higher risk than others. Also the locals with a larger local knowledge appeared to more aware of the risk than the younger generation with a more limited local knowledge. It could be argued that the larger knowledge of floods enables the local to better prepare for floods and through that knowledge diminish his/her risk of being affected by the consequences of a flood. It could be argued that information from

the municipality will not lead to fear among the locals but instead a better understanding of the risk of floods enabling the locals to better prepare for a future hazard. A way to strengthen the local understanding of the risk of storm flood is through enlightenment.

Given that the local communities have limitations that influence the preparedness to storm surges it can be difficult to evaluate precisely how prepared they are to handle storm surges. However, both communities have strengths that significantly enhance the community resilience and intensifies the preparedness.

### 6.1.1. Relevance of the conceptual model for assessing the communities' strengths and limitations

The analytical framework is based upon the model “Community resilience as a set of networked adaptive capacities” from Norris and the model “Dimensions of resilience baselines and candidate variables” by Cutter. These two models on how to measure and examine community resilience functioned as an indicator for, which variables it was important to focus on when constructing interview guides. The two models were modified to create one model that functioned as the analytical approach.

In the empiric data a number of variables for the different chosen dimensions of community resilience have been discovered. An overview of the variables can be seen on figure 26. The variables are categorized depending on whether they are from either Cutters model, Norris' model or additional aspects that emerged in the empiric data during coding.

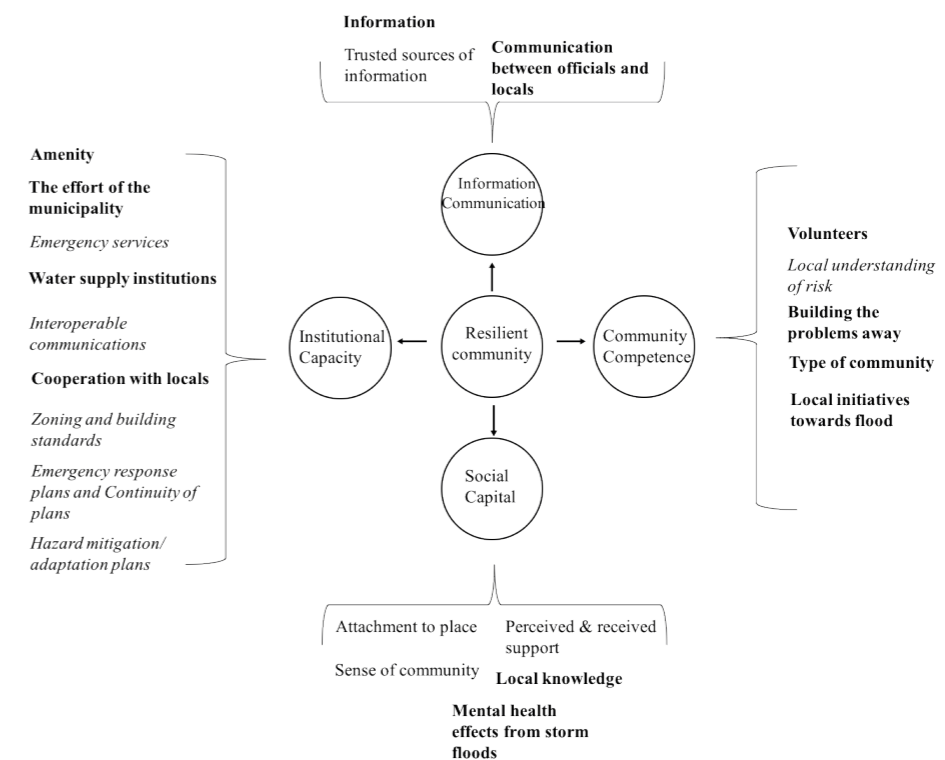


Figure 26: Variables found in the empiric data. Variables written in *Italic font* is from Susan Cutter; variables written with **Bold font** is additional variables found in the empiric data and variables in regular font is from Norris.

On figure 26 it is possible to see that a relative large number of additional variables that is deemed influential on the community resilience emerged in the coding process. The fact that such a large number of additional variables was found suggest that the variables from the model by Norris and the model by Cutter is not comprehensive enough for examining community resilience in a Danish context. Still all the variables from the two models were not examined because some were deemed irrelevant before the interviews were conducted because of knowledge gathered on the case cities and some variables were unable to be answered by the gathered empirical data. It could be argued that because those two models are constructed based on an American context some of the variables are less relevant to examine when working with Danish communities. The context, internal and external factors are different and therefore additional variables emerged in the empirical data collected in Denmark. Also the listed variables in the two models can be seen as guiding lines and not exhaustive variables. The four main dimensions of resilience selected based on the model by Norris and the model by Cutter functioned as intended by uncovering the strength and limitations of the communities when examined. They were not affected by the models having been constructed with a different context in mind like the variables. However, the conceptual model did function well as a guiding tool for how to examine the different dimensions of resilience providing valuable directing when constructing the interview guides and conducting the interviews. Overall the conceptual model for assessing the strengths and limitations of the communities in regards to community resilience functioned as intended. It made examining the community resilience in Thyborøn and Løgstør more focussed and efficient helping both in constructing the interview guides, conducting the interviews and as the analytical approach.

### 6.1.2. Is it possible to measure and compare resilience?

Over the years several models such as Norris' and Cutter's have determined what to observe when looking at Community Resilience. Cutter has suggested a set of quantifiable variables aimed at measuring and comparing the resilience of different places. But is it possible to do such with a qualitative study? It was deemed unreasonable to give a score to the different dimensions of resilience in this study because it is based on interviews and to some degree the beliefs of the community and the municipality. It would have been misrepresenting to compare the two case cities by any ranking system. Instead a relative scale has been applied to some extent to estimate if one approach in a case city is more enhancive or reducing to the resilience than another approach in the other case city. It may be better to describe and examine the difference in resilience between cases when conducting a qualitative study to get an understanding of different ways to approach adaptation to climate change and how they influence the resilience. It is not possible to say that Løgstør have a high resilience and Thyborøn a medium given that the cities have their strengths and limitations in different variables within the dimensions of resilience and to compare those would give a construed image of the situation. Also because Løgstør

have so far experienced larger impact from floods and also higher levels of water during a storm surge than Thyborøn. Therefore, it logically deducts that Løgstør would be more invested in preparedness and coping with the floods than Thyborøn are. Through this study it can be argued that Løgstør is slightly more prepared for, able to react to and coping during a storm flood than Thyborøn based on the fact that they have more knowledge within the field because of experience and because they have very clear and concise plans for such events. Thyborøn may instead be more capable at the recovery phase of resilience because they are a resource strong community. This is despite the fact that they are a more homogenous community with a more limited number of competences than Løgstør, which will be reflected in this chapter.

It is possible to see a tendency for a certain pattern. In Thyborøn the local community possess a large resource pool such as independent community, rich local community and strong mental health that can be mobilized before, during and after an impact from a hazard. This might aid the recovery both mentally and infrastructure wise. The local community might be better equipped at bouncing back and building back better because it's a rather rich community with resources. On the other hand, Løgstør have most of an advantage before and during an impact as there seems to be a good communication between the municipality and the local community as well as a very engaged municipality. This provides the local community with a better understanding of the risk and help enhance their preparedness.

### 6.1.3. Recommendations for enhancing community resilience

Some of the dimensions of resilience are for the municipalities stronger than others. Løgstør have a clear advantage over Thyborøn when examining the institutional dimension of resilience where as Thyborøn appear to be more advantageous within the social dimension of resilience. There will always be some dimensions of resilience that are stronger than others but it is evident that Løgstør should be focusing on their community competence dimension and Thyborøn on their information & communication dimension to enhance the overall community resilience.

By focusing in the information and communication dimension of resilience it would not only enhance this dimension of resilience but also positively affect other variables within the other examined dimensions such as; *local understanding of risk* and the *citizen participation*. Given that the community competence is a very strong dimension of resilience in Thyborøn there are a large amount of resources that the municipality would be able to tap in to. Therefore, strengthening the information and communication between the locals on matters of storm surge would not only benefit the locals but also the municipality in the planning process. It would be possible to overcome this disadvantage by simply having information meetings with the local community and thereby inviting them to participate in an open communication process. The fear the community have of not being able to answer all questions or spreading unnecessary alarm of the risk among the locals could be avoided by explaining that these consequences of climate change is prognoses to occur in the future but that they are planning and examining land

subsidence and sea-level rise to prepare for these impacts. Furthermore, the lack of inclusion and information can be argued to have created a little divide between the municipality and the local community. It is based on this that it is recommended that the local community and the municipality focus their efforts on first enhancing the information and communication dimension and thereafter looking to improving other limitations and working on keeping the strengths of the community resilience solid.

Given that Løgstør only have a few identified limitations that affect the resilience it may be easier to focus their effort on all three. However, it is recommended that they first look at the high prioritizing of amenity over the security. It is a limitation that is possible to improve upon but it does require an attitude alteration to change the opinion on the matter for both the municipality and the local community. All that is required is to add 0,5 -1 meter atop the wall and it would be capable of withstanding risks the city is currently vulnerable to. It is a limitation that is very impertinent for the resilience and if it was improved upon the community resilience would be enhanced considerably.

## 6.2. Reflections

As previously mentioned in chapter 2, section 2.3. the two communities have been defined as a small spatial unit according to Agrawal's definition of communities. It is evident based on the size of both the population and location of Løgstør and Thyborøn that this definition is met. A small population size is by the theory expected to provide a sense of community, which was existent for both of the cities in the empirical data and was deemed an advantage in regards to enhancing the community resilience. Agrawal has an additional two definitions, which when the case studies were chosen were not taken in to consideration. This does not necessarily equal that these two definitions are not met by the communities.

The second definition is a community as a homogenous social structure. This criterion is not really met by Løgstør given, as it was explained by one of the research participants in the analysis, that Løgstør over the years have become more multi-ethnic and multi-cultural. Also the size of the population at 4000 residents complicate the prospect of a homogenous social structure. Løgstør is located close to a larger city, Aalborg, which is contributing to a more mixed population because people reside in Løgstør and commute to Aalborg for education and career. Therefore, they do not experience people having to move away to pursue these. Thyborøn, however, are closer to meeting the criterion of a homogenous social structure than Løgstør. The city is very isolated and located in what is termed "fringe Denmark". These are areas of Denmark that experience population decline and an aging population profile. Because of the isolation and the small population, the local residents are closer connected and seldom have large groups of newcomers moving to the city and bringing new inputs in the shape of religion, race or status. The dialect is distinctive and a challenge to understand for newcomers. At the same time many of the residents are working in one of the two main industries; fishing and tourism giving them

the same careers and social circle thereby heightening interaction.

The third definition is as a set of shared norms and interests and are by Agrawal seen as following the first two definitions. One of the research participants in Løgstør mentioned that it was possible to gather the local community for some causes because of a shared interest. But since Løgstør do not really have a homogenous social structure one could think it is less likely that they will have a set of shared norms and interest. This shared interest is seen through the large number of volunteers. Løgstør also appear to be very open minded and open to outsiders, which is not necessarily the case for communities with a set of shared norms. Therefore, Løgstør is not perceived as fully meeting this criterion. Thyborøn are closer to fulfilling the two first definitions making it possible for the community to also meet the last criterion. There was no evidence from my data that either rejected or accepted that the third criterion was met by Thyborøn. There was evidence of similar interests on the matter of the Thyborøn canal's future but it did not bleed in to a shared set of norms. It may be that Thyborøn share some interests because it is a city with a larger, older generation that have grown up together and therefore have interacted for many years.

It could therefore be argued that Thyborøn is a tighter community than Løgstør because it is closer to meeting the definition constructed by Agrawal. This may influence the study and the resilience because a homogenous community could be limited because people are alike therefore having similar skillset and resources. A positive attribute for resilience is a community with diverse competences but a homogenous community are capable of fewer things. This may however be countered by the local community's many resources.

## 6.3. Conclusion

The conducted study has its background in the problematic of how vulnerable and exposed Danish low-lying coastal communities can be better at preparing for the consequences of a changing climate in particular more intense storm surges. The study aims at examining how two local communities can enhance their preparedness and ability to cope with such hazards through community resilience. In this study four dimensions of resilience was examined to discover variables that influenced the community resilience either by enhancing or diminishing it. In this chapter I will conclude upon the study and hence answering the main objectives. Furthermore, the conceptual model and how it has been applied will be concluded upon.

The main objections of this study, which is presented below, has been examined and a number of findings have emerged.

How well prepared to handle storm surges are the communities of Løgstør and Thyborøn and how can the communities enhance their resilience toward storm surges?

The enhancing and diminishing factors, which were presented in table 3 helps to answer the first part of the main objectives. It is evident that the strengths of the community resilience for both communities outweigh the number of limitations meaning that both communities are fairly prepared to handle storm surges. The findings presented in the table further shows that Løgstør is currently more adequately prepared to handle a storm surge than Thyborøn is, given that Løgstør have less limitations that will diminish the preparedness phase of community resilience than Thyborøn does. Løgstør is fairly well prepared due to extensive experience with high storm surges and a very organized Emergency service and engaged municipality that the locals express trust and satisfaction with. The cooperation between the municipality and local community have enhanced the resilience by better preparing the locals because of a realistic understanding of the level of disaster risk. By informing the locals and inviting to citizen participation the municipality have enhanced the resilience and in particular the preparedness of the local community.

The strengths of the local community in Thyborøn are more equipped at handling the recovery phase after an impact. The vast amount of community competences and resources enables the community to bounce back fast and build back better after an impact. The community do however have several limitations that diminish the preparedness to handle a storm surge in Thyborøn and the local community is therefore currently not adequately prepared for the consequences climate change will bring in the future.

It has been evaluated that the communities can enhance their resilience the most with the least amount of effort by in Løgstør focusing on security above amenity value and thereby raising the height of the seawall protecting the city. In Thyborøn they can enhance the resilience by creating a flow of information and communication between the municipality and local community on matters like risk of storm flood, the climate change adaptation planning process and the data collection on land subsidence and sea-level rise. Furthermore, it has been concluded that the dimension of resilience that is strongest for Løgstør is the institutional capacity dimension where as the community in the future should focus on enhancing their community competence dimension of resilience. Thyborøn are the strongest within the social capital dimension of resilience and should focus on the information & communication dimension of resilience to enhance the overall community resilience toward storm surges. Their main focus should be on facilitating public meetings with the local community.

The conceptual model functioned well as a tool for focussing interview guides and as an analytical approach when coding the empirical gathered data. As can be seen on figure 26 the models on measuring resilience by Cutter and Norris have been applied to construct the conceptual model for this study. The theory has been applied to assess strengths and limitations within the four dimensions of resilience and to ultimately examine how well prepared the two communities are at handling storm surges. In conclusion, as a framework for examining and enhancing

communities' preparedness for storm surges, resilience's scientific worth lies, in this case, not within if it can be easily measured and quantitatively compared but in, if it leads to assumptions on the variables that could be improved. The value lies in the more inspirational message within resilience than within vulnerability and in a possible understanding of the strengths and limitations of local communities that can lead to an enhanced preparedness.

Whether or not Thyborøn and Løgstør are well prepared to handle storm surges is still an unanswered question to some extent. The answer is still incomplete because all local communities are ever altering and adjusting to new institutional, economic, social and environmental realities thereby the community resilience is ever influenced and altered.

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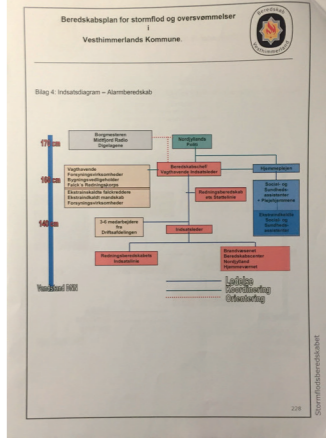
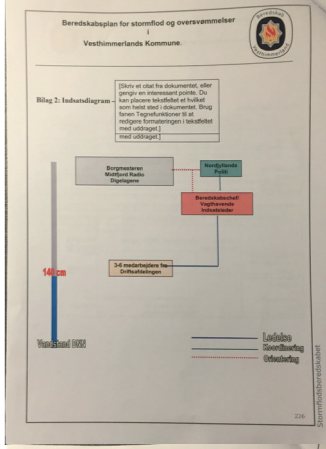
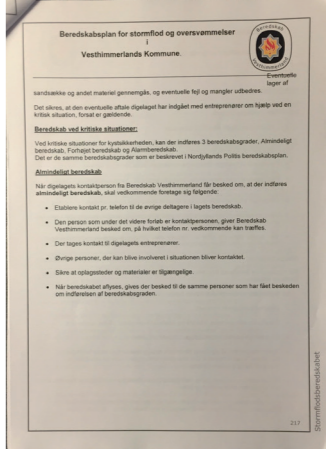
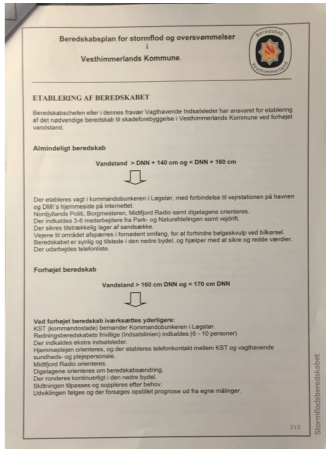
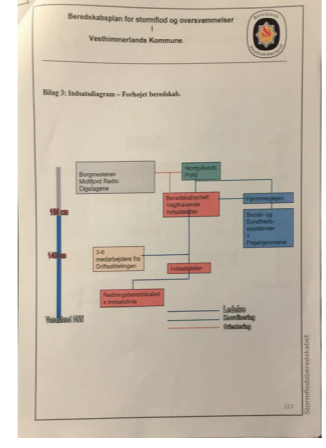
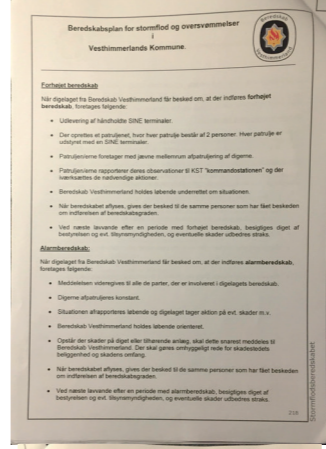
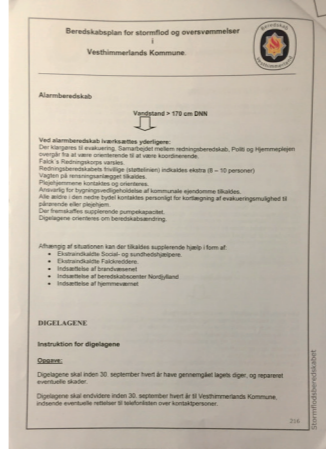
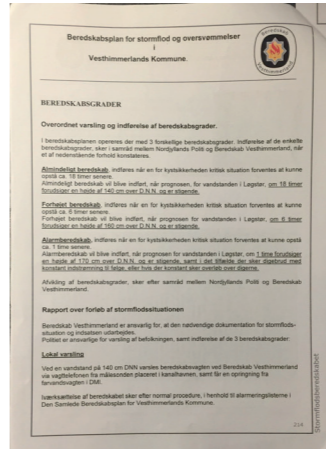
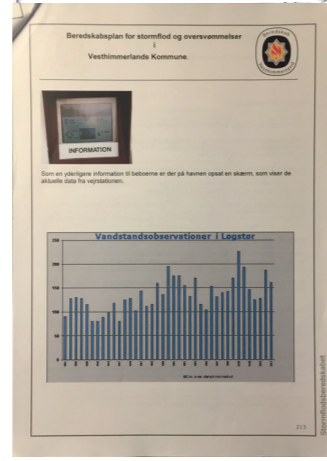
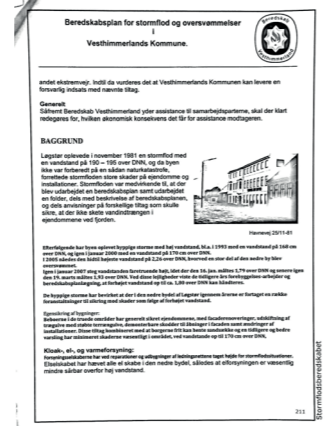
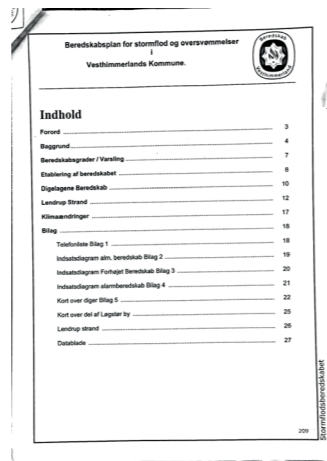
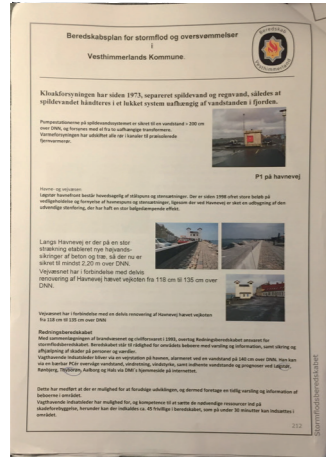
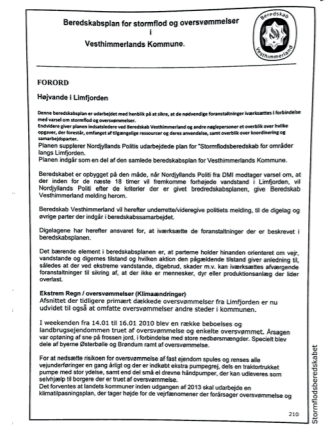
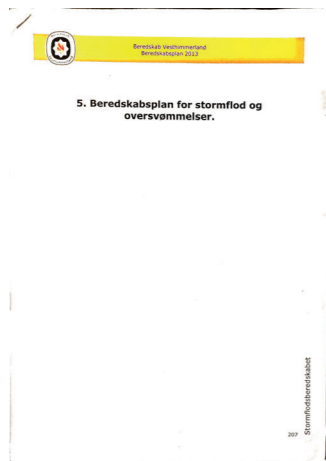
## Appendix 1

Picture of the storm surge stamps sold in Løgstør in 1981.



# Appendix 2

## The Emergency Response Plan to storm surges in Løgstør.



## Appendix 3

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### Interviewguide lokale

1. Intro spørgsmål; alder og beskæftigelse?
2. Hvor længe har du boet i Løgstør/Thyborøn?
3. Hvor mange oversvømmelser har du oplevet i din tid i Thyborøn/Løgstør?
4. I hvor stor grad har en oversvømmelse påvirket dig og din ejendom? Hvordan har det påvirket din ejendom - hvilke skader?
5. Har du oplevet varige skader efter en oversvømmelse?
6. Hvad skete efter en hændelse? Behøvede du at kontakte kommunen, forsikringsselskab, hjælpeorganisationer?
7. Var du tilfreds med den udbudte hjælp og skadeopgør? Hvor lang tid tog det før skaden var udbedret?
8. Hvad gør du, når der bliver varslet om oversvømmelse for at sikre din familie og ejendom?
9. Har du selv og/eller naboer gjort noget for å forhindre skade i fremtiden?
10. Føler du, at Thyborøn/Løgstør er en attraktiv by at bo i på trods af risikoen for oversvømmelser?
11. Har du kontakt til dine naboer i dit nærområde?
12. Hvordan vil du karakterisere dit lokalsamfund? (lukket, åbent, tæt sammenhold)
13. Har i et stærkt sammenhold i dit lokalsamfund? (Hvordan spiller sammenholdet ind før og efter en oversvømmelse?)
14. Hvordan har du oplevet, at dit lokalsamfund har arbejdet sammen før og efter en oversvømmelse?
15. Føler du dig som en del af dit lokalsamfund? Deltagelse i lokale organisationer og lag
16. Mener du at kommunen har oplyst dig tilstrækkeligt om risikoen for oversvømmelser og hvordan disse må håndteres?
17. Føler du, at lokalbefolkningen er blevet inddraget i forbindelse med kommunens planlægning af tiltag overfor oversvømmelser?
18. Hvilke af kommunens tiltag mener du, der har fungeret bedst i forbindelse med oversvømmelser?
19. Hvad savner du af hjælp/tiltag før og efter en oversvømmelse?
20. Overvejer du nu eller har du tidligere flyttet fra et område pga. truslen for oversvømmelser? (Hvad fik dig specifikt til at flytte?)

## Appendix 4

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### Interviewguide kommunal medarbejder

1. Intro spørgsmål: Ansvarsområde og hvor længe har du arbejdet for den pågældende kommune?
2. Hvornår begyndte kommunen at lave planer for håndtering af oversvømmelser? Hvorfor?
3. Hvilke udfordringer oplever i i forbindelse med klimatilpasning i Thyborøn?
4. Hvad gjorde kommunen før, under og efter sidste oversvømmelse? (2005)
5. Hvordan har i udvalgt hvilke tiltag der implementeres for at beskytte Thyborøn mod ødelæggelser for oversvømmelser?
6. Hvilke af kommunens tiltag anses som værende mest virkningsfulde?
7. Under udarbejdelsen af jeres klimatilpasningsplaner tages der højde for kommunens befolkningssammensætning? (lavt uddannet, ældre, socialt udsatte osv.)
8. Gennem samtaler med lokale i Thyborøn var det tydeligt, at de ikke modtager information om risiko osv. fra kommunen. Er det et bevidst valg og hvorfor?
9. På hvilke områder er kommunens og de lokales viden om oversvømmelser og konsekvenserne af disse forskellig?
10. I hvor høj grad har kommunen inddraget lokalbefolkning i klimatilpasningsplanerne? Og hvordan?
11. Har i oplevet negativ respons fra de lokale i forbindelse med implementering af tiltag mod oversvømmelser?
12. Thyborøn virker til at have et stærkt samfund af frivillige. Har kommunen kunnet anvende denne ressource i klimaplanlægningen?
13. Har de lokales interesse for beskyttelse mod oversvømmelser været konstant eller fluktuerer den?
14. Har kommunen præsenteret retningslinjer for, hvordan de lokale kan forberede sig på og håndtere en oversvømmelse? Og i så fald følges disse råd?
15. Det er beskrevet i teori om klimakatastrofer, at personer, der er opvokset i områder med oversvømmelser, er bedre til at håndtere sådanne hændelser? Oplever i denne tendens i Thyborøn? (skader, viden, håndtering og ressourcefuld?)
16. Har kommunen oplevet, at det er de lokale som tidligere har oplevet skader i forbindelse med oversvømmelser, der er mest opmærksomme på klimatilpasningsplanen og forebyggelse af fremtidige skader?

## Appendix 5

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### Interviewguide beredskab

1. Intro spørgsmål: Ansvarsområde og hvor længe har du arbejdet for den pågældende kommune?
2. Hvornår blev beredskabet dannet og på hvilket grundlag?
3. Hvor mange frivillige arbejder med oversvømmelser i Lemvig kommune?
4. Hvad er jeres primære opgaver før, under og efter en oversvømmelse i Thyborøn?
5. Hvor ofte bliver i årligt tilkaldt til en oversvømmelses hændelse i Thyborøn?
6. Har beredskabet haft et samarbejde med de lokale under stormflodsoversvømmelserne? Og hvis ja, hvordan?
7. Thyborøn har et stærkt netværk af frivillige. Har dette netværk kunne anvendes som en ressource for beredskabet under oversvømmelses hændelser?
8. Har beredskabets inddragelse og hjælp ændret sig i Thyborøn gennem tiden?
9. Vil du mene at Thyborøn er blevet mere resistent overfor oversvømmelser?

Andre spørgsmål:

1. Har beredskabet planer om at udarbejde en beredskabsplan for stormflod og oversvømmelser i kommunen? Hvorfor/ hvorfor ikke?
2. Anvender i ved stormflodsvarsel/ oversvømmelse data fra DMI (vandstande og prognoser) til at vurdere om i skal sætte ind i Thyborøn?
3. Varsler i lokalbefolkningen ved risiko for oversvømmelser, så de har mulighed for at forberede sig?
4. Hvor mange sandsække har i på et givent tidspunkt på lager? Forbereder i ekstra ved en oversvømmelses varsling?
5. Hvilke ressourcer har beredskabet til rådighed og hvilke anvendes ved en stormflodshændelse?
6. Hvordan er beredskabet opbygget? Hvor mange er tilknyttet beredskabet?
7. Hvem har i som samarbejdspartnere i tilfælde af en oversvømmeshændelse?