NORWEGIAN SCHOOL OF ECONOMICS
Bergen, Spring 2020

Use of Insurance Loss Data in Municipalities

A case study on the possibilities and challenges of implementing insurance loss data in the work on surface water measures

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Master thesis in Economics and Business Administration, Business Analysis and Performance Management

NORWEGIAN SCHOOL OF ECONOMICS

Abstract

Climate change has several consequences for modern societies. One example is increasing and more severe precipitation which can lead to an increase in surface water damage. In 2013, Norwegian insurance companies shared insurance loss data to a selection of Norwegian municipalities as part of a pilot project initiated by Finance Norway. The aim was to strengthen municipalities ability to prepare for increased uncertainty represented by climate change. This thesis aims to gain a richer understanding of municipalities climate preventive work concerning surface water, with the use of insurance loss data. Following research question will be addressed:

> *How have two municipalities in Norway implemented insurance loss data in their municipal work concerning measures on surface water, and what surrounding circumstances might explain this utilization*?

By interviewing respondents from two municipalities that took part in the pilot project, we have identified 12 findings, arranged into four themes. The first theme consists of four findings concerning municipal factors that influence how municipalities have to work with insurance loss data. The second theme involves two findings about the challenge's municipalities face in order to fully make use of insurance loss data. These are low data quality and unclear allocation of responsibility concerning management of surface water. The third theme concerns where insurance loss data can be implemented. We find that there are few conducted projects with insurance loss data. Nevertheless, the respondents identify potential projects where it can be beneficial to include this data. In the fourth theme, we identified four findings concerning how the challenges with insurance loss data can be faced. These are associated with a standardization of processes within a municipality and a standard format of reporting insurance loss data. The insurance loss data must also contain more detailed localization and dating for when a damage occurred, as well as better information about the reason for a damage.

Acknowledgements

This thesis is made as a part of a major in Business Analysis and Performance Management (BUS) at Norwegian School of Economics (NHH). The thesis is written with the support from Finance Norway, which has provided academic guidance and economic support. Mia Ebeltoft in Finance Norway was a tremendous source of information. We are very grateful for this!

We would like to thank Oslo and Stavanger Municipality for a great collaboration and allowing us to use their time for the interviews. Additionally, we would like to thank professors at NHH and representatives from Tryg and Gjensidige who helped us find the topic of this thesis.

We would like to thank our supervisor Professor Stein Ivar Steinshamn for his constructive feedback and advices throughout this project.

Lastly, we would like to thank family and friends who have helped us with spell- and grammar checking, as well as providing a big portion of mental support throughout a master project which turned out to be a greater challenge than we could have expected.

Bergen, 12.06.2020

Hanne Haavik Lina Bratten Due

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1. Introduction

It is frequently published reports and articles about how climate change is already affecting the world and what changes one can expect in the future. It is estimated that Norway will experience an increase in rainfall of 18% by the end of this century. The number of days with heavy rain are to double and the amount of rain on these days are estimated to grow by 19% (Hanssen-Bauer et al., 2017).

From 2008 to 2015, the number of weather-related water damage that were reported in Norway, increased from 19 300 to 30 400 (Hauge, Flyen, Almås & Ebeltoft, 2017). Prior to 2015, the yearly costs of surface water damage in Norway was estimated to vary between 1.6 and 3.6 billion NOK. However, over the next 40 years the yearly costs are expected to be between 45 and 100 billion NOK (NOU 2015: 16, 2015, p. 15). Damage on insured personal property and buildings due to surface water is covered by insurance companies. The insurance industry is thereby highly exposed to climate change which represent a severe challenge to their business model (Mills, 2009). At the same time, these companies gain valuable insights about the weather-related water damages. As insurance loss data are looked upon as highly sensitive data, Norwegian municipalities do not have access to this in their work on adapting to climate change. With access to this data, the municipalities would have a better basis for identifying vulnerable areas and make the right investments (Finance Norway, 2020).

Finance Norway initiated a pilot project in 2013 with an aim to address this asymmetric division between information and responsibility. The pilot project aimed to increase data and information sharing between the municipalities and insurance companies with an underlying motivation to improve the ability to prepare municipalities for the increased uncertainty represented by climate change (Brevik, Aall & Rød, 2014).

We are now in 2020, and the climate challenges we faced in 2013 have grown. What have the municipalities done with this data since the initialization of the project? Based on this, we have developed the following research question:

1.1. Research question

How have two municipalities in Norway implemented insurance loss data in their municipal work concerning measures on surface water, and what surrounding circumstances might explain this utilization?

The following sub-questions will help us address this research question:

1. *Which municipal factors can have an effect on how surface water measures are implemented?*
2. *What do the municipalities find challenging concerning implementing insurance loss data in their municipal work?*
3. *How can the municipalities implement insurance loss data in their municipal work?*
4. *How can challenges concerning the recording and application of insurance loss data be faced?*

1.2. Delimitations

In this thesis we will focus on insurance loss data related to surface water. This includes damage caused to infrastructure, buildings, water entering buildings and damaged interior and movables due to runoff water from impermeable surfaces.

1.3. Outline

In order to answer our research question, we have structured our thesis around five chapters. Chapter 1 consists of the introduction to our master thesis, while chapter 2 is the theoretical foundation and background. Our research methodology is presented in chapter 3. In chapter 4 we will present the empirical findings and discussion. Chapter 5 will conclude on our findings and come with some recommendations for future research.

2. Theory and Background

We will in this chapter present relevant theory and background needed to answer our research question. To understand why it is relevant to study how insurance loss data can be implemented in municipalities' surface water measures, we first need to understand how climate change is affecting the surface water. In an economical perspective, climate change can be understood as externalities. How the world's population respond to this climate change can be understood as mitigation- and adaptation-strategies. We will therefore in chapter 2.1 and 2.2 briefly present climate change and present how this can be understood as multiple market failures. In chapter 2.3 and 2.4 we explain how mitigation and adaptation-strategies help us face climate change. Chapter 2.5 will shortly present the Norwegian insurance industry and chapter 2.6 contains an elaboration of the pilot project and the DSB Knowledge Bank.

2.1. Climate change

In the report *Climate Change 2014* published by the Intergovernmental Panel on Climate Change (IPCC), *climate change* refers to:

> a change in the state of the worlds' average weather that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use (Mach, Planton & Stechow, 2014).

The United Nations Framework Convention on Climate Change (UNFCCC) additionally makes a distinction between climate change attributable to human activities and climate variability attributable to natural causes (United Nations Framework Convention on Climate Change [UNFCCC], 1992):

> a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Climate change is expected to have a broad impact on the world in numerous ways: affecting ecosystems, contributing to a loss of biodiversity, loss of sea ice and an accelerated sea level rise are just a few examples (Field et al., 2012; National Aeronautics and Space Administration [NASA], n.d.a). Climate change is also expected to lead to large financial cost. Both directly related to the damage that occurs, as well as to the adaptation of its potential consequences (Parry et al., 2009). By 2060, the cost of adaptation to climate change is alone estimated to be about 90 billion USD (Parry et al., 2009).

Global warming is understood as the main reason for climate change (NASA, n.d.b). The dominant cause of this global warming is extremely likely to be increased emissions of greenhouse gases like carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) (Core Writing Team, Pachauri & Meyer, 2015). With high confidence, a human-induced global warming of 1°C above pre-industrial level was reached already in 2017 (Masson-Delmotte et al., 2018). If the emissions of greenhouse gases continue to develop in the same pace as today, the worlds mean temperature is projected to rise between 2.6 and 4.8°C within 2100 (Core Writing Team et al., 2015).

An increased temperature on earth is associated with serious consequences (Masson-Delmotte et al., 2018). Among others, it is related to the expansion of floods, droughts, events with heavy precipitation and events with precipitation deficit (Field et al., 2012; Masson-Delmotte et al., 2018). Areas that have experienced an increase in precipitation during the time period from 1950 to 2012 is among others, northern Europe (Tang & Oki, 2016). The following figure shows the projections of the mean precipitation in the world at a temperature rise of 1.5°C and 2°C above pre-industrial level.

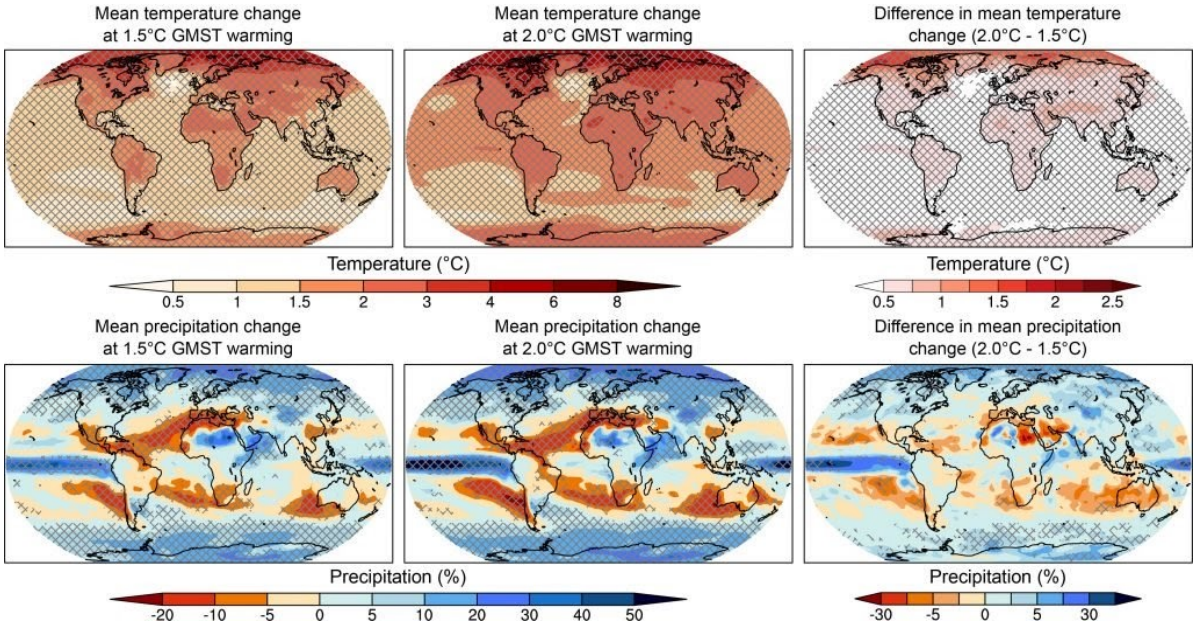

Figure 1. Impacts of 1.5°C of Global Warming on Natural and Human Systems. From "Global Warming of 1.5°C", by Masson-Delmotte et al., 2018.

Since 1900, the amount of precipitation in Norway has increased by 18% (Hanssen-Bauer et al., 2017). Both the Norwegian Environment Agency and the Norwegian Meteorological Institute (MET) states that this increase in precipitation is due to the rise in temperature (Ministry of Climate and Environment, 2019; Norwegian Meteorological Institute [MET], 2017a). Presuming the same growth in emission of greenhouse gases as today, projections of precipitation towards 2100, assert a further increase of 18% in Norway (Hanssen-Bauer et al., 2017). The following graph shows how the mean precipitation in Norway has progressed from 1900 until 2017.

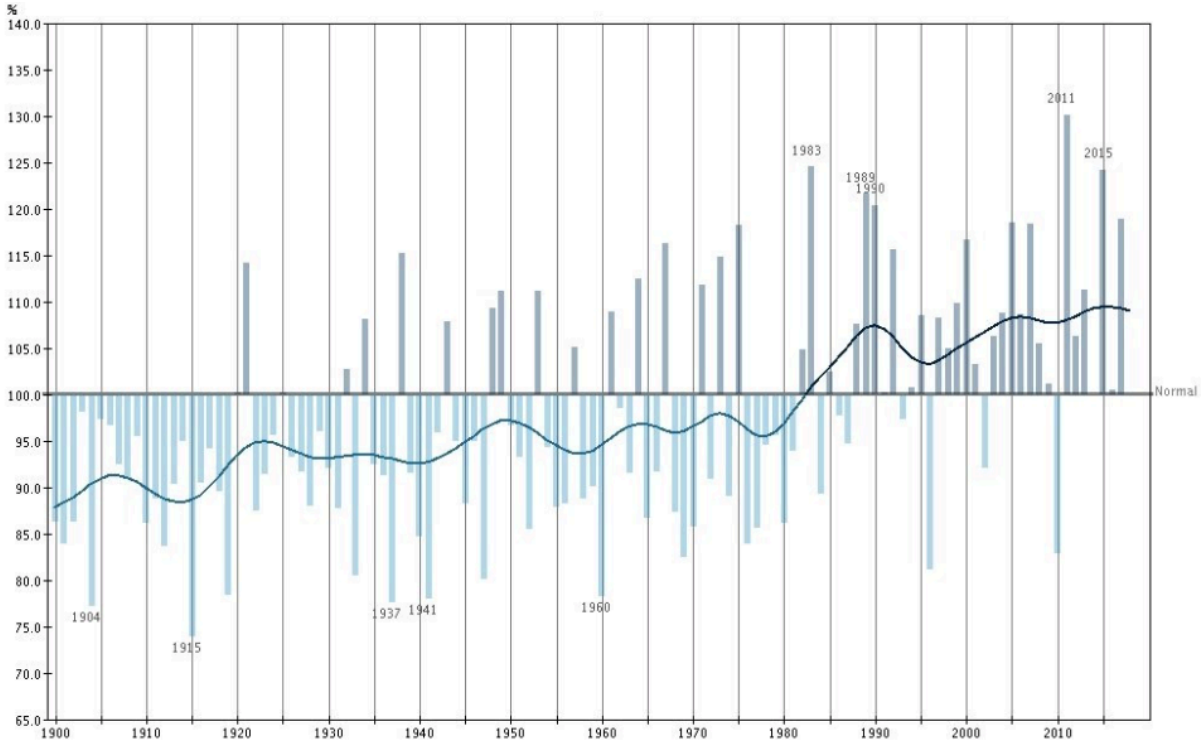

Figure 2. Precipitation in % of the norm. From "Climate from 1900 until today", by MET, 2017b (https://www.met.no/vaer-og-klima/klima-siste-150-ar).

2.2. Climate change as a set of market failures

Climate change impacts all parts of the world as it is disrupting national economies and leading to severe costs for countries, communities and people (United Nations, n.d.a). The world is facing a complicated problem where the culpability is hard to pinpoint between all involved parties. Climate change can from an economical perspective be viewed as multiple market failures (Bowen, Dietz & Hicks, 2014).

2.2.1. Market failures

A market refers to a system which facilitates the exchange and allocation of goods and services, where prices are determined by the forces of supply and demand (Gans et al., 2018). A market failure occurs when a free market operates inefficiently. The consequence of a market operating inefficiently is that possible equilibria in the market does not reach optimum. Individuals act with rational self-interest, and the market reaches a disequilibrium where the quantity supplied does not meet the quantity demanded. This results in an economically inefficient outcome, which often leads to a net social welfare loss (Gans et al., 2018, Schubert, 2009). With global climate change, several market failures can be identified (Bowen et al., 2014). These market failures are complex negative externalities, lack of information about

how to reduce emissions and the complexity of their consequences, lack of network effects with the aim of reducing emissions and a lack of incentives to innovate and develop sustainable solutions (Bowen et al., 2014). These market failures call for a package of interventions in order to face climate change.

2.2.2. A first market failure: Externalities

Externalities can be either positive or negative and can be defined as the effect that arise when the activity a person engages in influences the wellbeing of a third party without this person receiving any compensation for this effect (Gans et al., 2018). Positive externalities arise when the effect of an activity is beneficial for the third party, while an adverse effect will be a negative externality. Greenhouse gas emissions can be defined as the greenhouse gas externality. Emissions of greenhouse gases are side effects of economically valuable activities which have consequences that do not only befall the ones emitting them. Companies often do not consider the full cost of their activities, and therefore emit too much pollution. The society then ends up taking the full cost of the polluting activities (Gans et al., 2018; Stern, 2007). A negative externality such as the greenhouse gas externality can be illustrated by figure 3 (Schubert, 2009).

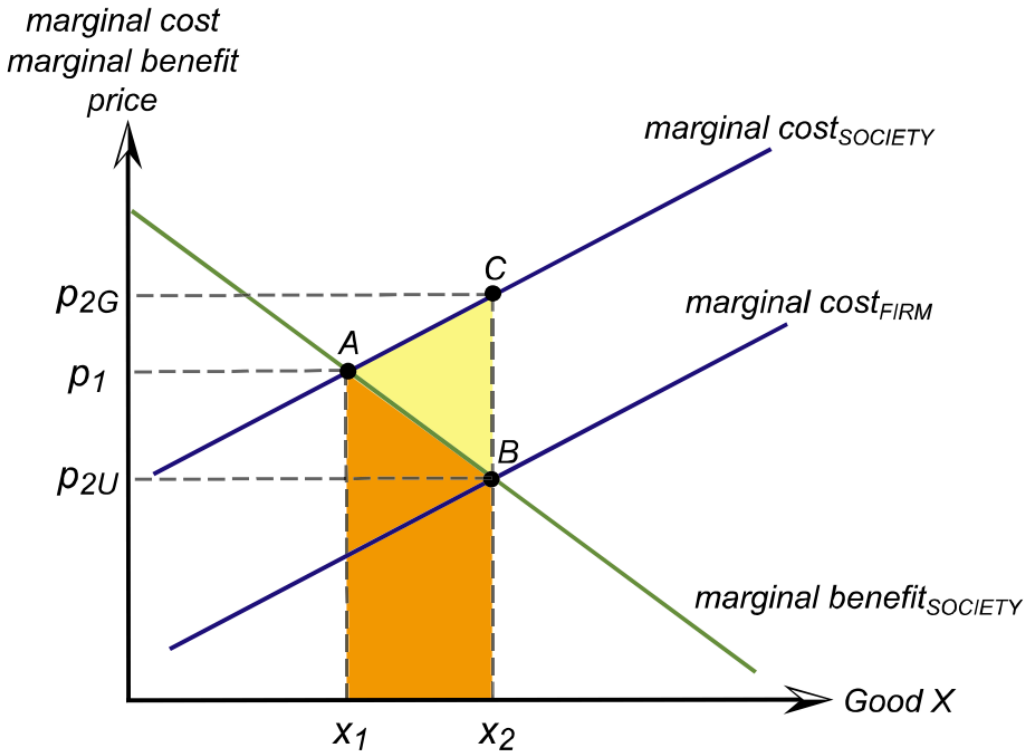

Figure 3. A negative externality on the market. From "Chapter 3: Internalization of Externalities", by R. Schubert, 2009 (http://webarchiv.ethz.ch/vwl/down/v-schubert/Umwelt/print_pdf/chapter3_eng.pdf).

In this model we see two lines for marginal costs, one representing the marginal costs for the firm and the other the marginal costs for society. We see that the economic activities create lower costs for the firm than what the actual costs are for the society as a whole. The equilibrium in this model is found in B where the marginal benefit for society meets the marginal costs for the firm. The social optimum, however, is located in A, where marginal benefit for society meets the marginal costs for society. The yellow area ABC represents the net social welfare loss due to externalities. In an economic perspective, negative externalities represent a market failure which can be corrected by internalizing the externalities (Schubert, 2009).

2.2.3. Internalizing externalities

The act of internalizing can in economic terms be defined as a corporation handling a transaction in-house rather than routing it to the open market (Schubert, 2009). There is a general belief that externalities can be internalized through governmental intervention such as taxes, subsidies and regulation (Schubert, 2009). There are two ways to motivate companies to internalize their externalities and hence reduce their output to the social optimal quantity. *Through prices*: Pigouvian (Pigou) tax and Price-Standard approach. A Pigou tax is a government-imposed tax where the tax rate equals the difference between marginal cost for society and marginal cost for the firm, for any amount of X produced. However, implementing a Pigou tax is an exceptionally complicated process, since all externalities must be known and quantified in order to identify the proper tax rate. In cases where it is impossible to identify all externalities, such as with climate change, an alternative could be to use the price-standard approach. The price standard-approach refers to setting a standard optimal quantity, which is as close to the theoretical optimal quantity as possible. This standard does not necessarily represent the social optimal quantity but is determined through political processes. Following, the tax rate is set according to this standard quantity. However, the process of finding the standard quantity is a complex and time-consuming process. There is also a reduced ability to evaluate the standard quantity. A possible alternative to this is to set quantitative restrictions (Schubert, 2009).

There are two ways of *regulating quantity of output*: Legal standards and tradable permits (Schubert, 2009). Legal standards are explicit limits of emissions and/or output, and tradable permits are typically cap and trade, which is designed to cap or limit emissions. Governments

issues a limited number of permits that allow companies to emit certain amounts of CO_2. This can be called market solutions in which prices are set in the market. However, the actual permits must be verifiable, and the permits must be generally recognized and objectively controllable. These conditions imply a need for substantial effort in regulation and administration of the market which could result in considerable implementation costs (Schubert, 2009).

A major challenge concerning the global climate change lies precisely in the *global* nature of the problem. All companies are subject to various domestic regulations, but there is not one international regulation holding a monopoly of defining and enforcing property rights for environmental goods (Schubert, 2009). Possible solutions are international treaties, which we will focus on in chapter 2.4 about mitigating climate change.

2.2.4. Other Market failures: Information failure, network effects and innovation incentives

We will very shortly mention the other market failures which is identified in climate change. A second market failure that can be identified is the lack of perfect information between buyers and sellers. Information failure can happen when participants of an economic exchange do not have perfect knowledge about the exchange and relevant surroundings. Concerning climate change, there is a lack of information about how to reduce emissions of greenhouse gases and about the full extent of their consequences (Bowen et al., 2014). Network effects is a third market failure. This is a phenomenon in which an increase in the number of people in a network improves the value of the network (Liebowits & Margolis, 1995). Some argue that the world calls for new solutions consisting of networks which do not yet exist (Bowen et al., 2014). Lastly, lack of innovation incentives negatively affects the development of new carbon-neutral solutions (Bowen et al., 2014). A solution could be to create economic, moral and social incentives to support innovation on sustainable solutions (Bowen et al., 2014).

2.3. Climate change response: Mitigation and Adaptation

When we acknowledge global climate change as several market failures, we are faced with the challenge concerning how to solve these challenges. Human responses to climate change can be classified into a two-pronged approach: Mitigation and Adaptation. We will define

mitigation as a reduction of harmful effects of something, while adaptation is to be understood as the act of changing behavior to make it suitable for a new situation.

2.3.1. Climate change mitigation

NASA defines climate change mitigation as "*reducing emissions of and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere"* (NASA, n.d.c). This can be done in a wide range of methods, including both complex, as well as very simple approaches. Utilizing new technologies, making existing equipment more energy efficient and changing customer behavior, are all examples of climate change mitigation activities (United Nations Environment Programme, n.d.a).

Through shared goals and agreements, the world has attempted to mitigate climate change for several decades. Already in 1997, the Kyoto Protocol was adopted. This was an international agreement where its 192 parties committed to limit their emissions of greenhouse gases with their own agreed-upon targets (UNFCCC, n.d.a). In 2015, the 17 goals for a sustainable development were presented. These are made with the purpose to achieve a more sustainable future (United Nations, n.d.b). One of these goals is "*take urgent action to combat climate change and its impacts*". The goal was included because the way climate change is affecting the whole world (United Nations, n.d.a).

The Paris Agreement is another international agreement. This entered into force in 2016 and was made with a more ambitious pursuit against climate change (UNFCCC, n.d.b). This agreement states that all countries in the world must reduce their greenhouse gas emissions. The agreement declares that the reduction of emissions must be large enough to limit the global temperature rise to 2°C above pre-industrial level. Preferably the temperature rise will be below 1.5°C, and this is the target the participating parties will strive to reach (UNFCCC, n.d.b). Even though the agreement entered into force in 2016, all parts of the agreement were still not finalized during the time this master thesis was written. In the fall of 2019, a meeting was held to settle the last parts in the rulebook of how the Paris Agreement should work in practice. The negotiations concerning the rulebook's parts did not result in an agreement (Knežević, Kjelland-Mørdre & Blomkvist, 2019). This elucidates how complex the processes of climate change mitigation are. However, the agreement requires all parties to put their best effort into climate change mitigation activities in order to limit the consequences of climate change (UNFCCC, n.d.b).

There have been debates regarding whether a substantial responsibility of climate change is to be put on developed countries with high emissions per capita (Klinsky & Brankovic, 2018; Lannoo, 2016). In 2018 Norway's emissions of CO_2 per capita were 9.43 tons (Knomea, n.d.). Figure 4 shows the CO_2 emissions per capita in Norway, compared to Australia, Canada, China, India, the United States and the world as a whole. The CO_2 numbers include emissions that arise from burning fossil fuels, manufacture of cement and the emissions that is produced during the consumption of liquid, solid, gas flaring and gas fuels.

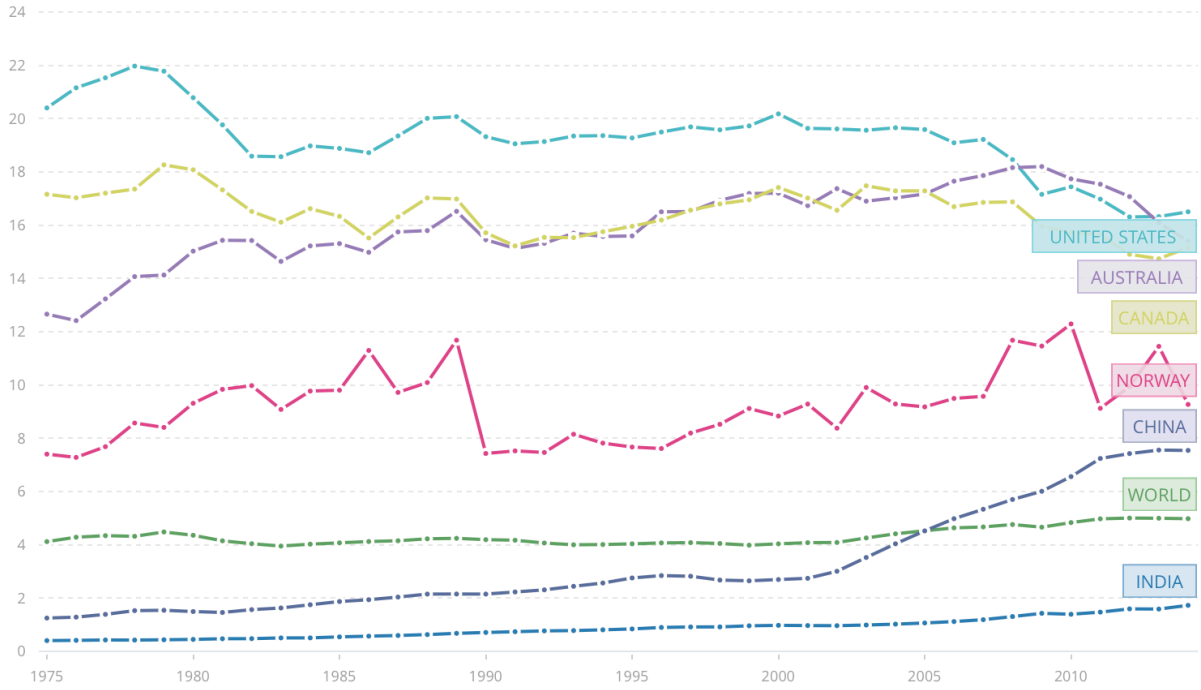

Figure 4. CO2 emissions (metric tons per capita) - Australia, Canada, China, India, United States, World, Norway. By The World bank, n.d.a (https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?end=2014&locations=AU-CA-CN-IN-US-1W-NO&start=1975t)

From this selection of countries, one can see that the per capita emission in Norway is far above India, China and the world as a total, while the United States, Australia and Canada have higher per capita emissions than Norway. Norway is one of the countries with highest per capita emission and might hold a substantial responsibility of reducing

emissions. However, the emissions from Norway as a total is less than the aforementioned countries' emissions. This is shown in figure 5.

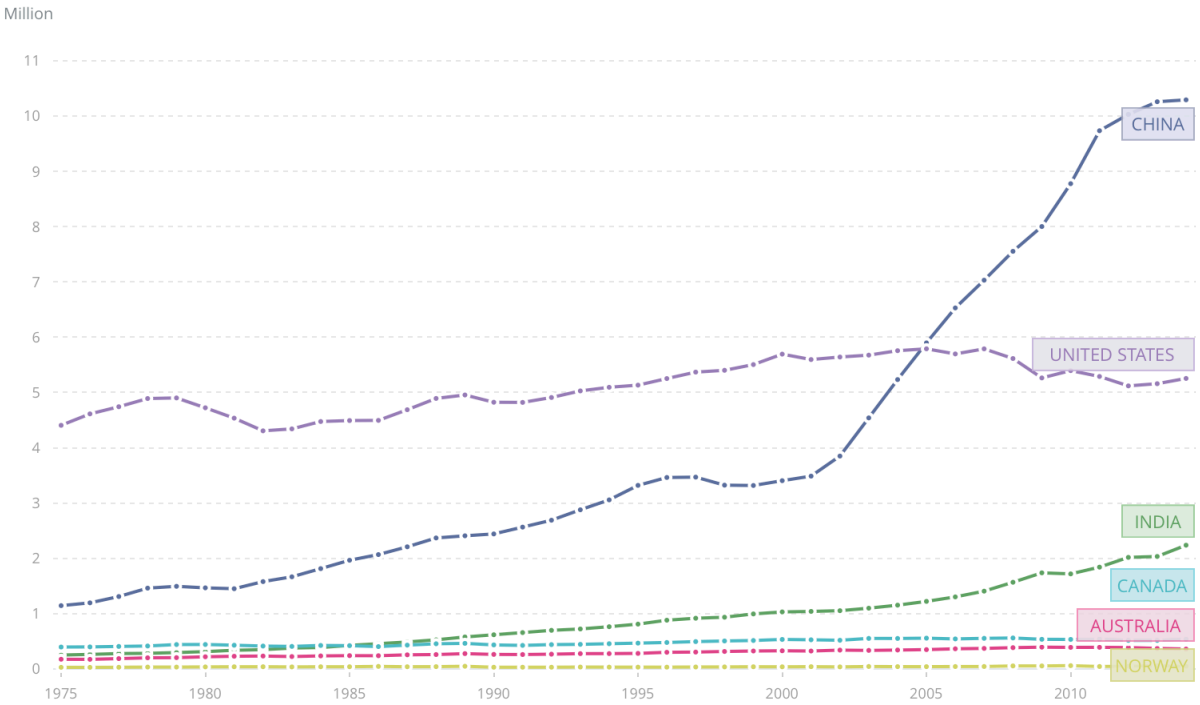

Figure 5. CO2 emissions (kt) - India, China, Australia, Canada, United Stated, Norway. By The World bank, n.d.b (https://data.worldbank.org/indicator/EN.ATM.CO2E.KT?end=2014&locations=USNO-IN-CN-AU-CA-US-NO&start=1975)

From these numbers one can understand that climate mitigation activities in Norway are likely to have less influence on climate change compared to countries with larger emissions. With less power to influence the worlds' total emissions, and hence limit climate change, activities associated with climate change adaptation becomes relevant for Norway.

2.3.2. Climate change adaptation

NASA (n.d.c) defines climate change adaptation as "*adapting to the climate change already in the pipeline*". For human systems, climate change adaptation involves the process of limiting, or in best case avoid, the consequences that come of climate change (Matthews, 2018).

Countries are realizing that climate change adaptation is unavoidable (United Nations Environment Programme, n.d.b). It is especially important considering the longevity of climate change. Decades and possibly centuries after emissions have been reduced to a desired level, the adverse effect on our climate will persist (NASA, n.d.d). The Paris Agreement

followingly includes a global adaptation goal, which specifies the need for continuing research on climate change and the exchange of knowledge between nations (United Nations Environment Programme, n.d.b).

Norway expects more precipitation in the years to come due to climate change (Ministry of Climate and Environment, 2015). This includes both an increasing number of days with precipitation and higher levels of precipitation on these days. Events with this type of heavy rain lead to floods and surface water, which in turn leads to damage on buildings, roads and infrastructure. In order to avoid severe damage from the events of heavy rain, Norway needs to adapt to the projected increase in precipitation.

2.4. Adaptation-strategies to increased precipitation

In this thesis it is relevant to elaborate on how Norwegian municipalities adapt to climate change and briefly introduce some of the measures that have been implemented today. We will limit the presentation of adaptation-strategies to the ones focusing strictly on precipitation and surface water. When talking about surface water, also called pluvial flooding, we refer to runoff water from surfaces such as roofs, roads and other closed surfaces that comes due to rain, storm flood or meltwater (Ministry of Climate and Environment, 2015).

In addition to the obstacle of more precipitation, Norway is facing a trend of more impermeable surfaces in its cities. More buildings are constructed than before and they are built both tighter and with denser surfaces (Brevik et al., 2014). Norway will therefore have a problem with both an increased level of precipitation and the case that the water will not be able to percolate through the soil as easily as before. This leads to more runoff water, and thereby more surface water. Following figure shows how infiltration of water differs between permeable and impermeable surfaces and the amount of runoff water the different scenarios can create.

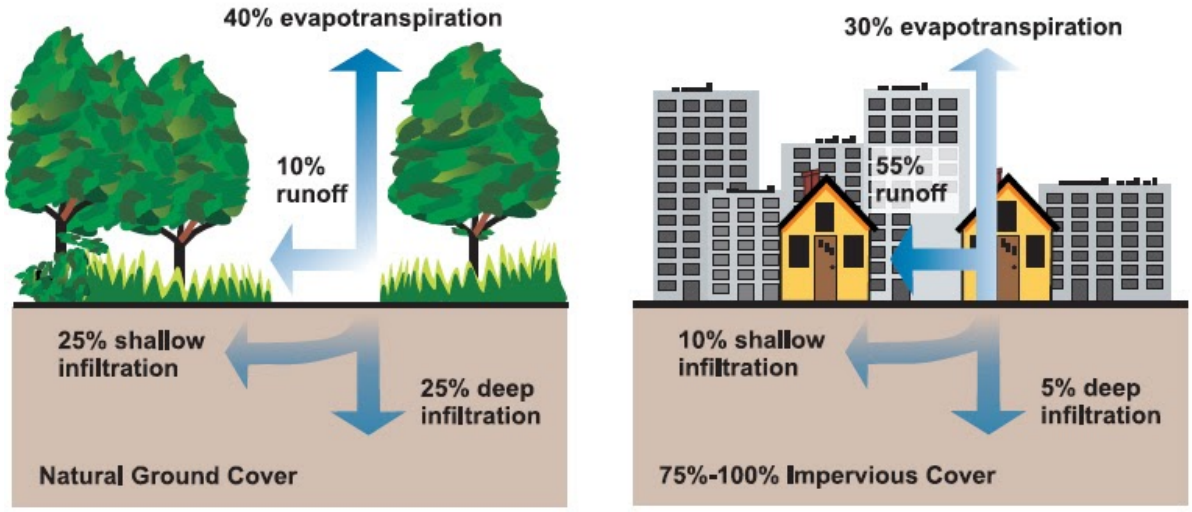

Figure 6. Relationship between impervious cover and surface runoff. From "Protecting water quality from urban runoff" by United States Environmental Protection Agency, 2003 (https://www3.epa.gov/npdes/pubs/nps_urban-facts_final.pdf).

In cities and suburban areas, the river network consists of both open and closed waterways (Aano, Mora, Lawrence & Skaugen, 2019). Open waterways consist of the natural river network that are still open and infrastructure that is made by humans, like roads, buildings or canals. Closed waterways consist of the natural river networks that are put into storm drainage system. A storm drain is a hole or a pipe that takes the water away during heavy rain. Over the years, these drainage systems have become a part of the city's sewerage system (Aano, et al., 2019). The increasing level of precipitation and impermeable surfaces in urban and suburban areas will lead to more surface water that needs to be transported away in the drainage system. However, in Norway almost half of the systems (by pipe length) were built before 1980 (Statistics Norway, 2016). They are thereby not dimensioned to handle this increasing amount of water, which results in the capacity of the drainage systems to become overwhelmed (Aano, et al., 2019). As drainage systems has become a part of the sewerage system, the increasing amount of surface water will reduce the available space for sewerage. This will in turn increase the probability for sewerage pipe backup in basements below ground level (Aano, et al., 2019).

Adaptation to more surface water is mainly done in two different ways, where the traditional method has been to transport the surface water away through storm drainage systems (Ministry of Climate and Environment, 2015). The other adaptation method is to manage surface water locally through *sustainable drainage systems (SUDS)*. SUDS include approaches that infiltrate, attenuate or lead the water into flood streams. The main purpose with SUDS-measures is to reduce the damage from surface water. The measures should manage the surface

water locally, which means as close to the impermeable surfaces as possible (Nordeide, 1996). The surface water is instead to be utilized and seen as a resource which can strengthen the biodiversity in the urban areas. In addition, these measures are considered more environmentally friendly, flexible and cost-effective compared to upgrading the capacity of the storm drainage systems (British Geological Survey, n.d.; Willems et al., 2012). SUDS are often associated with using blue-green (water-nature) infrastructure techniques to manage local surface water disposal (Cettner, 2012). Some examples are: *Green roofs* which may intercept runoff, *vegetated ditches* which may remove pollutants prior to discharge to aquifers, *ponds* which may act as retention basins and delay discharge to watercourses and *infiltration systems* which may allow water to soak into the ground. Municipalities have been encouraged by national authorities to increase the use of SUDS for years, but the SUDS are yet to be fully appreciated (Ashley, Cettner , Walker, Sharp & Westling, 2011; Cettner, 2012).

2.5. Insurances in the meeting with climate change

In order to better understand the driving forces behind the pilot project which this thesis is based upon, it is necessary with a short overview of how insurance related to surface water is carried out in Norway. We will therefore give a short introduction to the Norwegian insurance policies of personal property insurance and home insurance and the damage covered in these insurances. We will also present how damage due to natural perils are insured through the Norwegian Natural Perils insurance.

2.5.1. Personal property insurance and home insurance

Insurance is defined as an agreement in which one party undertakes to provide the other party a guarantee of compensation for a specific loss or damage suffered by the latter, in return for a payment of a specified premium (Døving & Loen, 2018). In 2018, there were registered more than 2.2 million personal property insurances and more than 1.3 million home insurances in Norway (Finance Norway, n.d.). Personal property insurance covers private movable property for theft or damage. The different kinds of damage to the valuables that are covered varies between the issuing insurance companies. Common for all personal property insurances are coverage of damage due to fire, water damage or natural hazards. Home insurance covers damage to buildings and nonremovable objects installed to the building. The exact details on damage also varies between insurance companies. Common

for all home insurances are coverage of damage to the building due to fire, water damage or theft.

2.5.2. Norwegian Natural Perils Pool

In 1980, Norway formed the Norwegian Natural Perils Pool, with a compulsory membership for all insurance companies which offer fire cover in Norway (Norwegian Natural Perils Pool, n.d.a). The pool is an "*equalization mechanism whereby claims and costs are distributed between members in proportion to their share of the pool, which corresponds to their share in the market for fire insurance*" (Norwegian Natural Perils Pool, n.d.a). When a building or movable property is insured against damage from fire, either through a personal property insurance or a home insurance, it will automatically also be insured against natural perils through the Natural Perils Insurance.

2.5.3. The Natural Perils Insurance

The Natural Perils Pool covers damages due to natural perils (Norwegian Natural Perils Pool, n.d.a). Natural perils are by Norwegian law defined as damages that come directly due to landslide, storm, flood, storm surge, earthquake or volcanic eruption (Naturskadeforsikringsloven, 1989, §1). In this definition, *flood* is more precisely defined as streams, rivers or waterways overflowing its banks (Norwegian Natural Perils Pool, n.d.b). Surface water, however, is defined as runoff water from impermeable surfaces (Ministry of Climate and Environment, 2015). Accordingly, surface water is by law not defined as a natural peril. All damages on private buildings or valuables due to surface water will thereby not be covered by the Natural Perils Pool but must be covered by the insurance companies.

2.5.4. Insurance companies covering damage due to suraface water

As insurance companies are bound to cover damage due to surface water, all such damages are consequently reported to these companies. Insurance companies hence inhabit a lot of valuable information associated with surface water damage (Finance Norway, 2018). The increasing amount of precipitation that is projected due to climate change, and the increasing area of impermeable surfaces may lead to more surface water than we have today. Without any preventive measures, this can lead to events causing larger and costlier damages on buildings and movable property (Norwegian Environment Agency, 2016). These

consequences can be seen as insurance companies' driving motivation for entering the pilot project.

2.6. Pilot project

This chapter will give a solid elaboration on the pilot project initiated by Finance Norway, in order to give the reader a thorough understanding of the background of our study. We will also present the main findings of the project and some of the challenges that emerged during the execution of the pilot project and relevant activities which have happened in the aftermath of the pilot project. We will at the end of this chapter briefly present the DSB Knowledge bank.

2.6.1. About the pilot project

In 2013, Norwegian insurance companies shared their insurance loss data with a selection of Norwegian municipalities as part of a pilot project initiated by Finance Norway (Brevik, et al., 2014). The project was conducted from 2013 to 2014 by the Western Norway Research Institute and the Department of Geography at the Norwegian University of Science and Technology (NTNU). Finance Norway and the Ministry of Local Government and Modernisation served as the principals. The insurance loss data was shared with a motive of being implemented into municipal planning, in order to enable municipalities to improve climate preventive measures. The main objective of the pilot project was to determine the potential and preconditions for strengthening preventive measures to climate related natural hazards. This was done by examining the municipalities' utility of having access to the insurance loss data. The pilot project examined problems concerning natural perils such as storms, floods, landslides and storm surges, but had a main focus on problems concerning surface water and sewerage pipe backup.

Ten Norwegian insurance companies participated in the pilot project and shared their insurance loss data with Finance Norway. These insurance companies were Gjensidige, Tryg, If, Eika, Sparebanken 1, Frende, DNB and KLP. In total, these companies represented nearly 90% of the market share in the Norwegian insurance market (Brevik et al., 2014).

The pilot project started out with ten municipalities. It was emphasized to choose municipalities with different sizes, topography, location and variation regarding potential natural hazards. During the course of the project, one of the municipalities withdrew their

participation. Thus, only nine municipalities completed the project. All municipalities received their own separate set of insurance loss data from Finance Norway, which included insurance loss incidents reported in their municipality. The received data sets contained raw data from all the participating insurance companies. The municipalities separately processed the received data with an aim to geolocate the insurance loss incidents on maps. The geolocated data was then used in different analyses within the municipal planning, like land-use planning and water and sanitation planning.

After the completion of the pilot project in June 2014, Finance Norway decided to prolong the project until 2015. The most active municipalities were allowed to continue their trials with the insurance loss data, and the pilot project would also receive more documentation of the municipalities utility of receiving insurance loss data. Two municipalities from the original pilot project accepted the proposal of taking part in the prolongation of the pilot project. These were Stavanger Municipality and Tromsø Municipality. In addition, Oslo Municipality was incorporated in the prolongation of the pilot project.

Oslo Municipality was not a part of the original pilot project but had on their own worked on a similar project as the pilot project. They could thereby be incorporated in the prolongation of the pilot project. As the other municipalities, Oslo Municipality also received a data set from Finance Norway with insurance loss incidents reported in their municipality, which they subsequently had to geolocate in order to use it into analyses within the municipal planning.

2.6.2. Main findings in the pilot project

The main finding in the pilot project was that municipalities found great use of gaining access to insurance loss data (Brevik et al., 2014). It was found that the basis for collaboration within municipalities, between municipalities and between municipalities and insurance companies was improved by participating in the pilot project. In addition, it was found that sharing insurance loss data had the potential of providing new knowledge of previously unknown natural hazard risks, which could potentially strengthen their preventive measures related to natural hazards. This was especially useful within five main areas:

- Land-use planning
- Planning public infrastructure

- Development and maintenance of water and sewerage systems
- Strengthening the quality of risk- and vulnerability analysis
- Emergency preparedness

During the time of research execution, the pilot project encountered and revealed some limitations. These mainly concerned a varying degree of data quality of the insurance loss data the municipalities received. The essential reason for this inadequate data quality was that the data sets consisted of insurance loss data from several different insurance companies, which all had their own unique reporting systems and requirements. This led to data sets consisting of insurance loss data reported in numerous formats. Thereby, the municipalities faced a substantial task when cleaning the data and had to create a uniform standard before they were able to make any use of the data (Brevik et al., 2014).

The inadequate quality of the insurance loss data consisted of three challenges. Firstly, the data lacked a proper dating for when a damage had occurred. The insurance company's reported date of a damage was not necessarily the actual date of when the damage had occurred. The date could instead reflect when the damage was discovered or when the policyholder filled out the damage claim form.

Secondly, the data lacked proper geolocations of the reported incidents. The insurance loss data was not in a sufficient way attached to unique addresses or GPS coordinates. This gave the municipalities a reduced level of capability to geolocate the insurance loss data into maps, and consequently the ability to use it in different analyses. The municipalities had a varying degree of success in their processes of geolocating their data sets. The amount of successful geolocating varied between the municipalities from 31% to 71% of the total insurance loss incidents they had received in their data sets (Brevik et al., 2014).

The third challenge was about the reported information. When damage occurs, the insurance company register the incident with a code for the reason, installation and source of the damage. The reason is the actual reason for how the damage occurred, the installation gives a rough description of where the damage occurred, and the source gives a more detailed description of the damage and how the damage occurred. The municipalities found this information highly inadequate. In addition, the insurance companies registered the reason, installation and source of the damage in different ways. This made it harder for the municipalities to properly

understand what each damage in the data set contained, and their ability to compare the damages. As a result of this, the municipalities could not rely on the insurance loss data. Nevertheless, the municipalities reported that the insurance loss data would potentially be useful, provided that the reason, installation and source of damage are coded in a sufficient way.

A consequence of inadequate data quality can be related to how the municipalities made use their internal resources. All municipalities had a given amount of available resources they could dedicate to the pilot project. Due to the fact that the sorting and cleaning of the raw data required a larger part of these resources, there were less available resources to be used on the actual data set and climate preventive measures (Brevik et al., 2014).

2.6.3. Aftermath of the pilot project

Even though the pilot project was conducted from 2013 to 2014, and the prolongation lasted until 2015, there has been activity in this field the following years. Next, we will mention some of the work that has happened in the years after the pilot project and until today.

In 2017, the Western Norway Research Institute published a report called *Status and possibilities with the use of insurance loss data into the work on climate adaptation,* where they had gathered new experiences on using geolocated insurance loss data from the municipalities (Aall, Husabø & Groven, 2017). This new information came from Oslo, Bærum and Stavanger Municipality. In this report, it was concluded that the insurance loss data had not been used to a large extent. However, the report did present a couple of experiences where the data had been made use of, such as a feasibility study in Stavanger Municipality and hot spot maps in both Stavanger Municipality and Oslo Municipality (Aall et al., 2017).

In 2019, selected municipalities received new data set with insurance loss data (Ministry of Finance, 2020). Several of these selected municipalities are the same as the ones that participated in the original pilot project. Also this time that the municipalities had to geolocate the incidents on their own, before they could use it into different analyses within municipal planning. As the municipalities received the new data set with insurance loss data the spring of 2019, a large share of the participating municipalities has not yet used the shared insurance loss data into any analyses.

2.6.4. DSB Knowledge Bank

It is relevant to shortly mention one important initiative which has happened after the pilot project ended. The Norwegian Directorate for Civil Protection (DSB) has initiated the Knowledge Bank. This is a compound initiative which includes cooperation, coordination, guidance and technological support (Røng, Stuestøl, Rui & Myrestøl, 2018). The objective is to give a broader and more comprehensive foundation within the field of civil protection by gathering and assembling relevant data on a common platform which will enable better analyses, visualization, reporting and export of data. Data from national expert authorities is made available on a common digital platform and facilitated to regional and local risk and vulnerability analyses. This will allow municipalities to get their information from this digital platform instead of collecting data independently. This will in turn reduce the use of resources in order to conduct analyses in municipal work. The DSB Knowledge Bank is expected to be ready and start the operation- and development phase in January 2020 (Røng et al., 2018).

In February 2018 a public-private partnership between Finance Norway and DSB was initiated with the aim of preventing unwanted events and having an effective management of disasters and crises (Norwegian Directorate for Civil Protection [DSB], 2018). The partnership focuses on exchange of insurance loss data and cross-fertilization with DSB Knowledge Bank. The insurance loss data will be used in the Knowledge Bank, which compiles data in the field of social security to support the work of municipalities in preventing disasters (United Nations Office for Disaster Risk Reduction, 2018). The exact role of the Knowledge Bank in the composition with insurance loss data has yet to be experienced.

3. Methodology and Research Design

The purpose of this chapter is to explain our methodological choices for addressing and answering our research question. In chapter 3.1 we explain our research approach, before we in chapter 3.2 explain our research design consisting of research purpose, research method, research strategy and time horizon. Chapter 3.3 is focused around our data collection, whilst chapter 3.4 will elaborate on our data analysis. The data quality of our study will followingly be evaluated in chapter 3.5. We discuss some ethical considerations in 3.6, while we in chapter 3.7 present the limitations of the study. Lastly, we give a short summary of all our methodological choices in chapter 3.8.

3.1. Research philosophy and Research approach

In this research project we find it most appropriate to follow a pragmatic research philosophy. We aim to explore and understand how municipalities can use insurance loss data in order to better manage surface water challenges for a climate in change. This understanding can be used to influence future practice. In accordance to this research philosophy, we make methodological choices which will best enable us to collect relevant data, conduct appropriate analyses and arrive at credible conclusions.

All research questions express a need for theory during the process, and a research approach refers to how the development of the theory is approached (Saunders, Lewis & Thornhill, 2016). How this need for theory emerges, is decided by how the research question is formulated. The theory can be relevant in different ways and at different times during the research process. There are three common ways to approach theory development:

- Inductive
- Deductive
- Abductive

When using a deductive approach, the goal is to test a set of premises based upon existing theory. An inductive approach uses data collection to explore a phenomenon and further identify themes and explain patterns which in turn can be used to develop new theory. An abductive approach involves a back- and forth combination of inductive and deductive approaches (Saunders et al., 2016).

We have chosen to use an inductive research approach. Our research question states that we aim to explore and gain a deep understanding of how two municipalities in Norway have implemented insurance loss data in their municipal work concerning measures on surface water, and what surrounding circumstances might explain this utilization. By collecting and analyzing data, we want to develop a conceptual framework that can shed light on this phenomenon. Additionally, there is a substantial amount of literature on climate preventive measures both nationally and internationally. However, our focus is narrowed down to climate preventive measures where shared insurance loss data have been used. We therefore find ourselves in an academic niche where the existing literature and research is limited. Consequently, we see an inductive approach to be most appropriate in order to contribute to the understanding of the climate preventive work as with the use of shared insurance loss data.

3.2. Research design

Research design is a plan of how we want to address our main research question and the sub-questions. The plan consists of several components which are: research purpose, research method, research strategy and time horizon. All components will be discussed in this chapter.

3.2.1. Research purpose

The purpose of a research project is closely linked to how the research question is formulated and can be defined as either (Saunders et al., 2016):

- Exploratory
- Evaluative
- Descriptive
- Explanatory
- Combination of these

Our research purpose is best assorted into having an exploratory nature, even though it has a slightly degree of evaluative research purpose. Exploratory research aims to gain deeper insights about a topic while evaluative research aims to find out how well something works (Saunders et al., 2016). Our research aims to seek a better understanding of how two municipalities in Norway have implemented insurance loss data in their municipal work concerning measures on surface water, and what surrounding circumstances might explain this

utilization. This must be understood as an exploratory objective. Exploratory studies are especially useful when the aim is to clarify an understanding of a phenomenon, and often consist of a data collection which is characterized by having open-ended questions (Saunders et al., 2016). An exploratory research purpose has advantages such as being flexible and allowing changes in the research directions if new data and new insights appear. Our data collection consists of open-ended questions, with a low degree of structure. This has led our research to change direction during the research process. Consequently, an exploratory research purpose is a good fit for this study.

3.2.2. Research method

Research methods can be divided into three different types (Saunders et al., 2016):

- Quantitative
- Qualitative
- Mixed methods

The methods are often differentiated between the use of numeric and non-numeric data. The qualitative methods use words and open-ended questions while quantitative methods use numbers and close ended questions. The mixed methods research approach often involves collecting both qualitative and quantitative data, with an aim to create a more complete understanding of the research question (Saunders et al., 2016).

We have chosen a qualitative research method, as this method will allow us to gather non-numeric data and ask open-ended questions. A qualitative research method is also well suited for our choice of an exploratory research purpose (Saunders et al., 2016). In addition, the field we want to study has not previously been examined to a large extent. Consequently, there is a lack of understanding of which variables to study as well as little data to base potential hypotheses on. The qualitative research method is a well-suited method in such situations. The qualitative method is commonly used with an inductive research approach, which is well suited for in-depth research of specific phenomena (Saunders et al., 2016).

3.2.3. Research strategy

A research strategy describes a planned approach to answer a research question (Saunders et al., 2016). There are numerous research strategies, which should be consistent with the

research method and throughout the whole research design. The choice of research strategy will be guided by the formulation of the research question and objective, and how these link to the chosen philosophy and research approach, design and method. In addition, practical considerations such as existing knowledge, available time, available resources and access to potential participants will also affect the choice of research strategy. For a qualitative research method, research strategies such as case studies, grounded theory, ethnography and narrative inquiry are suitable research strategies. Case studies are appropriate for both inductive and deductive research approaches, in quantitative and qualitative research methods, and with descriptive, explanatory and exploratory research purposes (Saunders et al., 2016; Yin, 2014)

To answer our research question, we find a case study to be appropriate. This will allow us to explore the phenomenon in-depth in the real-life setting, where we can gain rich data, as well as approach the phenomenon inductively with a qualitative research method.

Yin (2014) distinguishes and defines four different case study strategies, based upon two dimensions. The two dimensions are:

- Single case or multiple case
- Holistic case or embedded case

A single case is used in situations where one studies a unique case and allows the researcher to examine a population which few people have examined before. A case study strategy can also be a multiple case. The objective for using a multiple case strategy is to test whether the findings can be replicated across cases. The cases are selected on the basis that similar results are predicted, or different results are predicted. For a multiple case study, the research is often deductive aiming to test hypotheses based upon existing theory.

In this thesis we examine Stavanger Municipality and Oslo Municipality as one single case. Even though it is two different municipalities with their own unique characteristics we do not have the empirical and theoretical foundation to examine the two municipalities as a multiple case study. Instead, our research question is formulated with an exploratory purpose rather than explanatory or descriptive purpose, where we aim to gain rich in-depth data for the sake of understanding the phenomenon, instead of aiming to replicate the analysis across the two cases. With this research purpose, the two municipalities are therefore most suitable for being

treated as one single case study. Furthermore, we make use of an inductive research approach where we hope to gain new insights rather than testing existing theory on the two cases.

Yin (2014) also presents a dimension of holistic versus embedded cases. This refers to the unit of analysis. The holistic approach evaluates the case as one unit, whilst the embedded approach allows the researcher to examine smaller units within a case. Our research method involves evaluating the two municipalities as one case, where we look at the municipalities as one unit. This qualifies as one holistic case study.

3.2.4. Time horizon

The time horizon in a research project can be sorted into two categories:

- Longitudinal
- Cross-sectional

A longitudinal study includes data collection over a given time span, often several years, with the aim to study the development of a given population over this time span. A cross-sectional study is characterized as a study of a phenomenon at a specific moment in time. Our research project is a cross-sectional study. We have collected our data over a short period of time, in October and November 2019. Our findings therefore represent the phenomenon as it appeared at this time. It should also be stated that due to the time restrictions of this master project, a cross-sectional study was found to be the only appropriate time horizon.

3.3. Data collection

Research data can be divided into primary or secondary data (Saunders et al., 2016). Primary data is collected firsthand in this project with the aim to answer our research question. Secondary data has been gathered at a previous point by other researchers for a different research question but is found to be relevant for this research as well (Saunders et al., 2016). In this chapter, we will first present our primary data collection and the methodological choices following this. After, we will present our secondary data.

3.3.1. Primary data: Semi-structured interviews

We have chosen to use semi-structured, in-depth interviews to gather our primary data. This method is fairly flexible and allows us to collect rich descriptions. It is also suitable with our exploratory research purpose. The interviews were conducted face-to-face with one interviewee at a time, consisting of semi-structured questions. The interviewees were allowed to answer the questions in the way they found appropriate. They were also allowed to spin off and talk about other subjects they found relevant. As we have an inductive research approach it was of importance to not delineate the interviewees in their information sharing but allow them to lead the conversation. Our objective was to attain as rich data as possible. Additionally, as we in our pragmatic research philosophy view our participants as the experts, we wanted to avoid constraining the interview more than necessary. However, we aimed to identify patterns across the municipalities and within a municipality's agencies. A minimum of questions was therefore necessary, in order to encourage the participants to talk about somewhat the same themes.

One disadvantage with this data collection method is the fact that it is a time-consuming and demanding interview process. Furthermore, there are data quality issues associated with semi-structured and in-depth interviews. The data-quality issues will be explained more in detail in chapter 3.5.

3.3.1.1. Choice of Stavanger Municipality and Oslo Municipality as single case

The decision of including Stavanger Municipality and Oslo Municipality in this research project was based upon the sample from the pilot project and the prolonged pilot project. As mentioned in the theory chapter, Stavanger Municipality and Oslo Municipality were two of the three municipalities that participated in the prolonged pilot project. In addition, these two municipalities represented the municipalities that had made use of the insurance loss data to the largest extent. Some of the reason for this, was due to the amount of adequate and available resources the municipalities had in order to make use of the insurance loss data (Brevik et al., 2014). This is explained more thoroughly in the report *Pilot project about testing insurance loss data from the insurance industry when considering climate vulnerability and prevention of climate related natural hazards in selected municipalities*. In order to attain rich information about the climate preventive work conducted in the aftermath of the pilot project, we decided

to include both Stavanger Municipality and Oslo Municipality. There are potential weaknesses attached to this choice, which will be discussed in chapter 3.5.

3.3.1.2. Respondents

Our study sample consists of six participants, two women and four men, where three of the participants come from Oslo Municipality and three from Stavanger Municipality. All participants are working in different agencies within the two municipalities. Besides information about which agency they are employed in, and parts of what their work consists of, no other personal information was considered relevant for the analysis and therefore not collected.

We required that all participants had good insights or experiences from the pilot project, as well as good knowledge of climate preventive work in their municipality in the aftermath of this project. We also attempted to find respondents who worked in somewhat similar and relevant agencies across the two municipalities, concerning their climate preventive work on surface water. This was of importance in order to hopefully identify general patterns across the two municipalities. We also made contact with five other potential candidates. As participation in the research was voluntary, these candidates either rejected our request for participation or were not found relevant during the recruitment process.

3.3.1.3. The sampling process

Sampling techniques can be divided into two categories (Saunders et al., 2016):

- Probability sampling
- Non-probability sampling

In probability sampling, the probability of being selected from the target population is equal for all individuals in the target population. This technique is often associated with surveys and experiment research strategies and is therefore not relevant in our research project. For non-probability samples, the probability of being selected from the target population is not known (Saunders et al., 2016). This technique is more suitable for exploratory research purposes, and hence we have made use of a non-probability sampling technique.

There are numerous non-probability sampling techniques (Saunders et al., 2016). In this study the respondents are recruited by a non-probability sampling technique called snowball

sampling. This technique is commonly used when participants are difficult to identify and is based on primary information sources who nominate other primary information sources, which forms a chain of referrals (Dudovskiy, 2018). There are several reasons for choosing this sampling method. From a methodological perspective, the reason is rooted in the research purpose of our study. We want to study a unique phenomenon, and consequently there is no need for statistical inferences from the sample. For the same reason, there is also no need to have a sample that represents a population of municipalities proportionally. Furthermore, gaining access to appropriate respondents was not an easy task, as we were looking for individuals with a high level of insight in the pilot project and its prolonging conducted from 2013 until 2015. The number of individuals with this level of insight was expected to be limited. In addition to this, the initial pilot project took place for more than four years ago, and we faced a situation where potential participants could be individuals who since the pilot project might have retired, quit or switched jobs. Individuals who no longer worked in the two municipalities were decided to be unsuitable as participants as they no longer represent the municipality or are involved in the daily municipal work.

By reaching out to one individual who worked on the pilot project and also knew other relevant individuals, we were able to get references to other relevant participants. Hence the snowball sampling method was an effective sampling technique.

3.3.1.4. Recruitment process

The recruitment process started by contacting two professors at Norwegian School of Economics who gave us helpful guidance on who to contact next in order to find relevant participants on this subject. We reached out to these individuals, who further recommended us to initiate contact with Finance Norway. Finance Norway is the initiator of the pilot project (Brevik et al., 2014). The relevant employee in Finance Norway gave us contact details to individuals who were thought to be appropriate in the two different municipalities. From here, we got in touch with several relevant individuals from Stavanger Municipality and Oslo Municipality. We ended up with three relevant respondents from each municipality, making a total of six respondents.

Contact with the different participants was initiated by sending out emails containing a short presentation of the researchers and the research project we planned to conduct. The emails also included a request for a phone call with the participant, if they found this research project

to be relevant. The phone call allowed us to more properly evaluate whether the participants would be a good fit for our research project, based upon the aforementioned requirements. The participants who accepted a phone call, and who also were considered a good fit for our research project were later interviewed in person.

3.3.1.5. Interview guide

We developed an interview guide which we used prior and during all interviews, and which functioned as a supporting element in order to gain data of high quality. Developing the interview guide also helped us prepare for all the interviews. The interview guide was developed early in the project period and was partly based on relevant research literature, relevant public information as well as information we had received during the process of recruiting our participants. The aim of the interviews was to gain a deep understanding of the climate preventive work with a basis in insurance loss data. We intended to gather rich data and wanted the participants to talk freely. This way, the participants had the opportunity to talk about potential projects, initiatives and other interesting thoughts, experiences and opinions that we potentially were not aware of. We therefore developed a very flexible interview guide, consisting of a majority of open-ended questions. The interview guide allowed the respondents to deviate from the premade pattern and talk freely. Even so, in order to structure the conversation slightly, as well as make sure that we would obtain information that could help us answer our research question, we included five main themes all participants were asked about. These were: About the interviewee and its agency, Pilot project 2013-2015, After the pilot project, Relevant measures and Advantages. The interview guide had between two and four questions in each of these main themes which was made with the aim to cover our research question adequately. We made sure to ask all interviewees these same questions, in order to ensure data quality. The questions, however, could come in the order that best suited the particular interview.

Prior to the interview, all participants received a copy of the consent form, information letter and also our planned interview questions, all attached in the Appendix (A-C). The interview questions were a comprised version of our interview guide where we included all the planned questions in a consistent order. We chose to send the questions to all participants in advance, in order to let them prepare before the interview. The information letter let the participants better understand our aim of the research, the process of the interview and their rights as participants. In this way, the participants could also be more relaxed during the interview

situation. We noticed that a majority of our participants had printed out and brought with them these documents. We consider this as a sign that our participants were well prepared for the interviews.

3.3.1.6. Conducting the interview

In order to obtain as much relevant information as possible, it was crucial that we were well prepared for the interviews. We prepared for each interview by going through all documents the participant had sent us or mentioned prior to the interviews. We also prepared by going properly through the report of the pilot project. This allowed us to better understand what the participants were working on, as well as let us ask meaningful follow-up questions. The interviews took place October 14-15th, October 22nd and November 1st, 2019.

All interviews were carried out in person and took place in the municipality of the participant. The interviews were conducted in meeting rooms or private offices, which allowed the participants to speak privately and without disturbance from the surroundings. The interviews lasted from 45 to 120 minutes and were conducted in Norwegian. Five participants were Norwegian, and one was not native Norwegian. This respondent did however speak Norwegian at a proficient level which was considered not to represent any data quality challenge.

All interviews started with general questions about the agency's responsibilities and everyday work tasks. There were two reasons for starting the interview like this. Firstly, it allowed us to get a better understanding of what the participants are working on as well as function as a natural way to introduce relevant terminology. Secondly, it lets the participants start off with a question they can easily answer and let them get comfortable in the interview setting. This builds trust amongst the interview objects. Following, we asked open-ended questions where we tried not to ask leading questions. This aimed to not affect the participants' answers. We also asked follow-up questions related to what the participants had elaborated on.

During five of the interviews both researchers were present, while one interview was carried out with only one researcher present. When both researchers were present, one researcher focused on the conversation whilst the other noted observations during the interview and made sure that all questions were covered. The goal of having both researchers present during the interviews was to ensure data quality by asking additional follow-up questions and ensure all ambiguity was cleared.

After each interview, both researchers did a short debriefing of the interview. Personal reflections were shared, and possible ambiguity was discussed. How the interview had been conducted and potential problems towards data quality were discussed and noted.

3.3.1.7. Processing the data

As our interviews were audio-recorded, this is by Norwegian Centre for Research Data (NSD) evaluated to be gathering personal information. The collected data consequently had to be handled and processed according to their standards. This is elaborated more thoroughly in chapter 3.6, concerning ethical considerations.

3.3.2. Secondary data: Reports from Western Norway Research Institute

The secondary data was gathered from two reports carried out by the Western Norway Research Institute. The two reports were *Pilot project about testing insurance loss data from the insurance industry when considering climate vulnerability and prevention of climate related natural hazards in selected municipalities* (2014) and *Status and possibilities with the use of insurance loss data into the work on climate adaptation* (2017). The first report is a final report of the pilot project, with a focus on how the sharing of insurance loss data had been seen through, as well as the different municipalities' experiences from using this data. The second report is a review of which databases in Norway that can be relevant in evaluating natural hazards and climate change. The report also contains newer experiences from municipalities about the use of insurance loss data. We used these two reports to get an understanding of how the pilot project had been conducted, as well as what results had been found. This provided a foundation for our research project.

3.4. Data analysis

3.4.1. Transcription

As soon as an interview was conducted, we started transcribing the audio-recording of the interview. This was done in order to remember as much as possible from the interviews and thereby reduce the loss of insights. The interviews were divided equally between the two researchers, making a total of three transcribed interviews each. After an interview was

transcribed, the other researcher read through the transcript while listening to the audio recording. This process was done in such an extensive way for two reasons. It facilitated a reduction of possible misinterpretations and also allowed the researcher who had not transcribed the interview to gain a better knowledge of the data.

The transcripts were aimed to be transcribed as accurately as possible in order to minimize the chance for subjective interpretations. However, the interviewees made use of an informal language including words like “uhm” and “ehh”. We decided to not include these words in order to make the transcripts more comprehensible and easier to analyze further. All interviews were transcribed in Norwegian.

3.4.2. Coding and Analysis

When all interviews were transcribed, we started to code and analyze the data. When analyzing qualitative data, the process focuses on summarizing, coding and categorizing the data (Saunders et al., 2016). During our thematic analysis, we took inspiration from Gioia, Corley and Hamilton’s (2012) recommended systematic approach for analyzing qualitative data.

The coding process started by dividing the six transcripts between the two researchers, who worked individually during this first part of the coding. The first step consisted of extracting quotes from the transcripts that described different phenomena. We then aimed to concretize and comprehensively describe the phenomenon with a short sentence. After this first step, we double-checked the other researchers’ extracted quotes. This was done in order to make sure all phenomena from the transcripts were included. This resulted in 461 different quotes. The rest of the coding and analysis was done in cooperation with both researchers present. All the unique phenomena were imported into one excel-sheet. This created a common ground for which we used to create 1st order Concepts. We here agreed upon the concept of the phenomenon while trying to stay faithful to the interviewee’s terms. No attempt of making joint categories for the concepts were made. This resulted in 398 different 1st order Concepts. These were further divided into 25 more general 2nd order Themes. The 2nd order Themes consisted of between three and thirty-eight 1st order Concepts, depending on how much the participants had said about the different themes. We here focused on gathering the concepts that had somewhat the same theme. Lastly, the 2nd order Themes were divided into four Aggregate Dimensions of Themes, where the four Aggregate Dimensions of Themes represent each of the four sub-research questions in our research project. We here contracted the themes

and put them in aggregate themes. The findings were contracted from the 25 themes after being sorted into the Aggregate Dimensions of Themes and gave us a total of 12 findings. The findings represent conclusions we could draw from our data set which helps us answer the research sub-questions and main research question. All coding and analyses were done in Norwegian.

3.5. Research quality

When evaluating the quality of a research project, one must evaluate the methodological choices. We can use certain criteria to assess the methodological choices in a case study (Yin, 2014). These are reliability, construct validity, internal validity and external validity. However, as this research project has an exploratory research purpose, internal validity is found to be not relevant and will therefore not be elaborated any further (Yin, 2014). We will further discuss the three other criteria.

3.5.1. Reliability

Reliability refers to replication and consistency in the findings of a study. If the study is replicated and the findings are the same, the findings are reliable (Saunders et al., 2016). As there is a lack of standardization in semi-structured interviews, this can result in issues concerning reliability (Saunders et al., 2016). These issues would appear from different biases. Threats to reliability when using semi-structured interviews are participant bias, participant error, researcher bias and researcher error.

3.5.1.1. Participant bias

Participant bias is any factor that will cause a false response from the participant (Saunders et al., 2016). Interviewer bias is a version of participant bias and is associated with the behavior of the interviewer during the interview, which can impact the responses of the interviewees (Saunders et al., 2016). This bias could appear when the interviewer responds to the different responses, or if the interviewer seems to lack credibility by the interviewee. By engaging in proper preparations before all interviews we aimed to overcome this bias. When contacting the participants, we aimed to be serious and well-informed. Our interview-techniques were also practiced in order to hold a neutral tone in the interview-situation. By doing this, we believe that we have avoided the interviewer bias.

Response bias is another version of participant bias and can be associated to the interviewee's reaction to the interview setting (Saunders et al., 2016). This could happen if the interviewee finds the interview intrusive and therefore restricts what they say. In our study, we have made use of audio-recordings of all interviews. This can appear intrusive for the participants. Response bias can also occur if the participant wants to appear more socially desirable, either for the researchers or other potential listeners (Saunders et al., 2016). In our research we are aware that we were interviewing the participants about a pilot project which the interviewees could have incentives on speaking overly positively about. The pilot project represents many opportunities concerning adapting to climate challenges, and it could be socially desirable to show a positive attitude towards such initiatives.

We aimed to overcome the risk for response biases with several measures. By sending the interview questions to the interviewee prior to the interview, the participants could prepare for the interview and the interview situation could appear less intrusive. We focused on appearing neutral but friendly during the interviews, in order to make the interview situation less intrusive. Furthermore, by arranging all interviews in closed meeting rooms and offices, the interviewees were free to speak without worrying about listeners. In the beginning of each interview, we reminded all participants that their answers were confidential and anonymous as well as say that there were no "textbook"-answers, and that they were allowed to answer all questions in their own will and way. Lastly, after all interviews we evaluated our impressions of the interview concerning whether the interviewees seemed relaxed and without restrictions during the interview-setting. By discussing this together we had the opportunity to take out potential data that seemed to be of poor quality. However, there was no need to remove any data as all interviewees seemed to be relaxed and spoke without restrictions.

3.5.1.2. Participant error

Participant error is any factors that can impact the way a participant performs (Saunders et al., 2016). Participant error could occur if the interview is conducted at times when it is not appropriate for the interviewee which might impact their performance (Saunders et al., 2016). By arranging all interviews in the agencies of the participants, as well as allowing the participants to choose the appropriate time slot for their interview, we believe the risk of participant error is reduced. After each interview, we evaluated whether the participants

seemed to be in a hurry and whether this impacted their answers. This did not appear to be a challenge as they had scheduled the interview to fit their schedule.

Additionally, there is a significant amount of issues concerning biases associated with snowball sampling. There is a lack of control over who is recruited to the sample, and the method cannot show representativeness. Respondents are likely to identify other potential respondents who are similar to themselves, resulting in a homogeneous sample (Saunders et al., 2016). This could impact our findings, in which we could get similar answers which are not representative for the whole population. However, we believe this can be justified by our exploratory research purpose. We aim to gain a richer understanding of the climate preventive work within municipalities with the use of insurance loss data. In order to obtain sufficient information about this, we must accept and acknowledge that we do not aim to achieve representativeness in this study.

3.5.1.3. Researcher bias

Researcher bias consists of factors that can impact the researchers' recordings of the responses (Saunders et al., 2016). This could happen if the researchers let their subjective opinions impact the recordings of the responses. Throughout the whole research process, we have aimed to stay objective, and have communicated and discussed all thoughts and interpretations of the responses. In addition, we made use of audio-recordings of all interviews, and we believe that researcher bias has little impact on our study.

3.5.1.4. Researcher error

Researcher error is factors that can impact the researcher's interpretations of the participants answers (Saunders et al., 2016). This could happen if the researchers are not sufficiently prepared and misunderstand the responses. We were well prepared for every interview. Furthermore, we believe that both researchers being in present in all but one interview and debriefing after all interviews, allowed us to discuss and settle on a precise understanding of the participants' answers.

3.5.1.5. Dependability and Transferability

In some cross-sectional qualitative studies, the concepts of reliability and validity is applied in such a rigid way which could become inappropriate (Saunders et al., 2016). Lincoln and

Guba (1985) have developed an alternative set of criteria which can be used in such studies. They formulated dependability for reliability. Dependability in this context is associated with the accounting of the emerging research focus. By thoroughly elaborating all our methodological choices, we enable that other researchers can evaluate the dependability of our study.

3.5.2. Validity

Validity refers to the appropriateness of the measures used in a study (Saunders et al., 2016). In a case study, the relevant criteria to evaluate are construct validity and external validity.

3.5.2.1. Construct validity

Construct validity focus on whether the set of questions in the study actually measure the construct they are intended to measure (Saunders et al., 2016). In preparations for the interviews we developed an interview guide, consisting of the interview questions. The interview questions were carefully formulated aiming for clarity yet maintaining open-ended questions. By this, we mean that we wanted the questions to allow the participants to answer in any way they found relevant. The interview guide was evaluated by external individuals, who focused on how they understood the questions. This way, we made sure the formulation of the questions was formulated in a way which less likely would be misunderstood. When preparing for each interview we also focused on the individuals' agency, what they had brought up in the prior phone call and hence made sure we used relevant terminology. By taking these measures, we believe that we ensured construct validity.

3.5.2.2. External validity

External validity focus on whether the findings in our study can be generalized to other relevant contexts (Saunders et al., 2016). We have a sample size which is not representative, and we cannot achieve generalizability in our study. However, we make use of the alternative criteria transferability as developed by Lincoln and Guba (1985). Transferability in this study can be achieved by providing elaborations on research questions, design, context, findings and interpretations in the study (Lincoln & Guba, 1985). By elaborating all our methodological choices, we believe that we facilitate for an evaluation of the transferability in the study.

3.5.2.3. Language barriers

The interviews in this research project have been conducted in Norwegian, and the thesis is written in English. This might cause a challenge where some meaningful insights might be lost in translation (Nes, Abma, Jonsson & Deeg, 2010). We have faced this challenge by several measures. Firstly, we transcribed and conducted all analyses in Norwegian, in order to maintain the meaning of all data. As translation is an interpretive action, translating the information as late as possible would allow us to better conserve the original meaning of the data (Nes et al., 2010). Secondly, we have during this process always cross-checked and double checked all quotes, by both the researchers in this study as well as with external help from friends and family who have been asked about the meaning of each quote.

When producing chapter 4, Empirical findings and Discussion, numerous quotes are included in English. These were translated for the purpose of being presented to the reader in this thesis. As the interviews were conducted using informal language, the quotes have a rather informal tone, which cannot be directly translated into English. Consequently, the translation focused on abstracting the meaning of the quote. We take full responsibility for any mistakes or mistranslations that might have emerged during this process.

3.6. Ethical considerations

Ethical considerations refer to the standards of behavior that guide the conduct in relation to the rights of the interviewees or others who are affected by our work (Saunders et al., 2016). In regard to formal ethical guidelines, the study has been approved from the Norwegian Centre for Research Data. The study therefore follows their standards for secure storage of personal information. All interviewees gave their informed consent on being audio-recorded, by signing an informed consent form (see Appendix C). These audio-recordings were stored in encrypted files and locked lap-tops and deleted as soon as the transcription-process was finished.

The study additionally follows a set of ethical guidelines presented by Saunders et al. (2016). All participants were informed that their participation is voluntary, and that their participation at all times can be withdrawn without giving a reason for this. All participants were told that there were no obligations to answer any question. The participants received an information letter about the study, a consent form as well as the interview questions a couple of days prior to their interview (see Appendix A-C) so that they had the opportunity to properly

go through all relevant information, and consequently have the ability to give their informed consent. All information is handled confidential and all participants shall remain anonymous throughout the research process and in the master thesis.

Lastly, we aim to maintain objective and act with integrity, in which we will be truthful and promote accuracy in our work. We want to show respect to all affected parts, in which we follow our obligations to recognize and respect the rights of all participants. We will work in a way that shall not harm any participants, which is done by not including any intrusive or sensitive questions or behavior as well as not break the promise of confidentiality.

3.7. Limitations of the study

This master thesis is written within the time limit of one semester at Norwegian School of Economics. We acknowledge that this time limit of the research period comes with some limitations.

We identify some limitations associated with our methodological choices. We chose to conduct a single case study as our research strategy. Although case studies give the opportunity to conduct in-depth inquiry into a subject within its real-life setting, case studies also have some disadvantages as it is both resource-demanding and time-demanding. In addition, the ability to achieve replication and providing a statistical generalizability will be reduced. Compared to multiple case studies, our choice of single case study will also contribute to less robust evidence from our study.

The use of interviews as our primary data source can be seen as a weakness to our study. It was a limited number of municipalities that originally gained access to insurance loss data through their participation in the pilot project and the prolonged pilot project. This led to a limited sample of which municipalities to include in our study. Additionally, both of the participating municipalities are considered large municipalities, with big academic communities and a substantial amount of resources. They represent large Norwegian cities and will have a “big-city” perspective on all of their work. As Norway consists of numerous municipalities where an absolute majority represent smaller cities and towns, we must acknowledge that our study is likely to not be representative for all municipalities in Norway.

In addition, interviews were conducted with only six respondents, which is a limited sample size. We were in touch with other potential respondents who chose not to participate in the study due to a lack of appropriate knowledge or were not found relevant. All interviewed respondents on the other hand had thorough knowledge about the pilot project. The characteristics and the size of this sample can thereby have resulted in an erroneous picture concerning the use and possibilities of the insurance loss data and consequently reduced the generalizability of our study.

One final weakness might have occurred during the phone calls we had with the interviewees in advance of the interviews. During the calls, some respondents mentioned projects and measures where insurance loss data already was implemented. Specific questions concerning these measures and projects was addressed in the interviews. As a result of this, these projects and measures might have received stronger attention compared to projects and measures which was mentioned solely in the interviews.

3.8. Summary of methodological choices

Table 1. Summary of methodological choices

Dimension	**Methodological choice**
Epistemology	Pragmatic
Research Approach	Inductive
Research Purpose	Exploratory
Research Method	Qualitative
Research Strategy	Case study
Multiple/Single	Single case
Holistic/Embedded	Holistic
Time Horizon	Cross-sectional
Data Collection	Semi-structured Interviews
Data Analysis	Thematic Analysis

4. Empirical findings and Discussion

We will in this chapter present and discuss our empirical findings, with an aim to answer our research question. Chapter 4.1 will present the main themes that appeared from our analysis in a graphic model. The next chapters will then present our empirical findings and its following discussion, sorted by how they answer our four sub-research questions. All findings will be presented objectively, before we discuss implications of this. In chapter 4.2 we will start by looking at the municipal factors that seem to have an effect on the work concerned with implementing surface water measures in municipalities, answering the first sub-research question. Thereafter, chapter 4.3 will answer the second sub-research question, on which factors the municipalities find challenging when implementing insurance loss data in their projects. The third sub-research question, how the two municipalities can implement insurance loss data in their municipal work, will then be discussed in 4.4. We will here focus on the projects where insurance loss data already have been incorporated in addition to potential projects where insurance loss data can be implemented. Chapter 4.5 will then look at the solutions that the municipalities see to several identified challenges attached to using insurance loss data, answering our last sub-research question. Chapter 4.6 presents two tables, one which summarizes our findings and one that summarizes our recommendations.

4.1. Conceptualization of our findings

Based on the findings in our thematic analysis, we have created a conceptual framework. This framework should be understood as an illustration which serves as a simple way for the reader to interpret our findings. It should not be understood as a model which explains causal relationships.

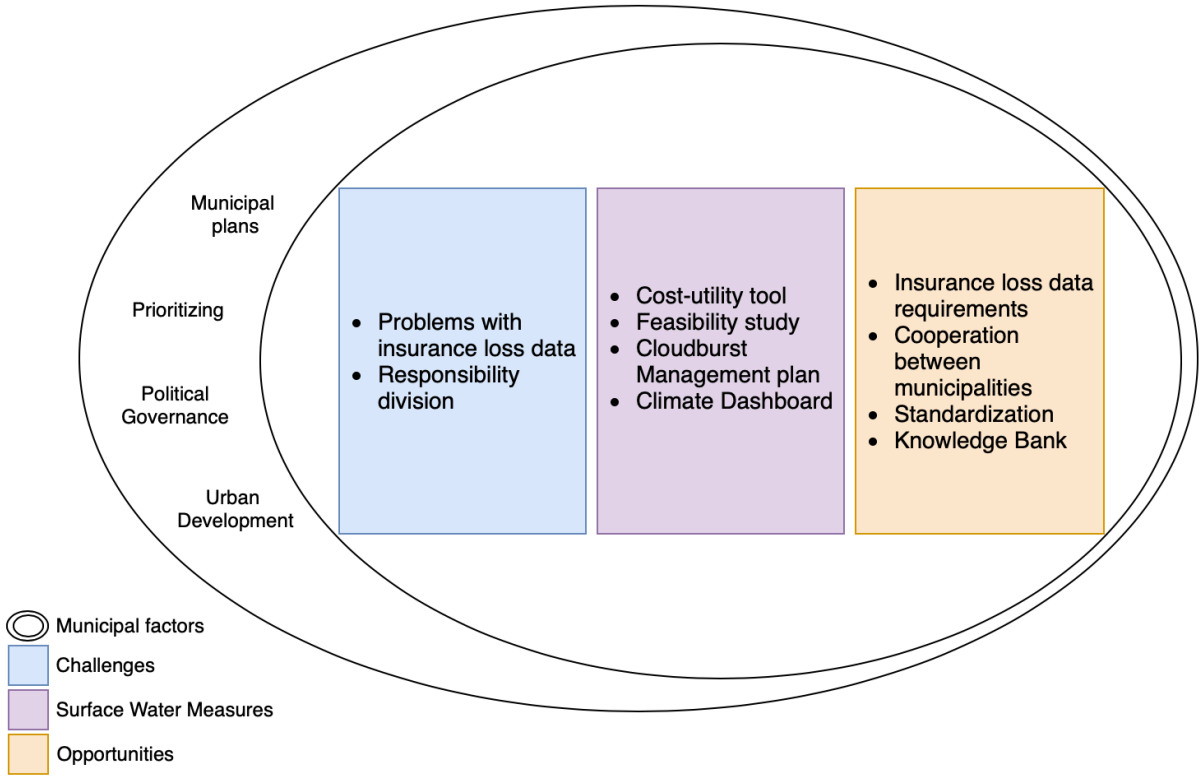

Figure 7 Conceptual framework for the use of insurance loss data in a municipality

The conceptual framework represents four themes, which conforms with our four sub-research questions. The frame in the model represents one theme which we have named municipal factors. The second theme consists of a blue box, and represent challenges attached to the use of insurance loss data. The third theme is represented by a purple box that contains surface water measures where insurance loss data can be or already is incorporated. The fourth theme, illustrated by an orange box, represent opportunities and possible solutions to challenges concerning the use of insurance loss data.

4.2. Theme 1: Municipal factors

Table 2. Findings in Theme 1

Finding	
Finding 1.1.	Municipal plans influence the use of insurance loss data.
Finding 1.2	The use of insurance loss data is affected by how municipalities prioritize and evaluate alternative costs.
Finding 1.3	Political governance seems to influence municipal activity on climate preventive measures.
Finding 1.4	Urban development happens in a long-time perspective with the private sector as the main decision maker.

During our interviews we focused on the agency the respondent represented, and the implementation of insurance loss data in this agency's work tasks. However, when discussing the implementation of insurance loss data, all respondents mentioned different municipal factors that form and impact the general work in their agency. We thereby found these municipal factors relevant to include in our analysis, and in which these factors later became the first theme in our conceptual framework. We will next discuss how these municipal factors impact the implementation of insurance loss data in surface water measures.

We find that there are four municipal factors which sets the frames for the activities and processes in an agency, and indirectly also the work with insurance loss data. In figure 7, we have therefore made this theme, *municipal factors*, the frame of the model. The four most important factors will be presented below.

Finding 1.1. Municipal plans

Finding: Municipal plans influence the use of insurance loss data.

Municipal plans emerged as a subject during all interviews and play an important role when dealing with projects related to surface water measures. The relevant municipal plans consist of the master plan, land-use plans and municipal master plans. In this project we have

comprised them into one definition, called *municipal plans*. The municipal plans function as municipal laws and guidelines that aims to preserve municipal, regional and national objectives and interests. The plans include the municipality's most important objectives and tasks (Ministry of Local Government and Modernisation, 2009).

Most statements about municipal plans in our dataset were focused around provisions concerning surface water measures. One respondent from Oslo Municipality stated how important municipal plans are when trying to implement surface water measures using insurance loss data as a standard for future projects:

> I think that if one shall properly get something done, it must be incorporated in the municipal master plan. The municipal master plan is the place to make the big changes. The municipal master plan is a juridical binding thing. And if you have mapped something, and it is attached to a legal provision, and you want to deviate from this, you need a very good reason.

We see that the legal aspect of the municipal master plan emerges as an important element on why the municipal plans seem to play a substantial role in the implementation of measures. It also plays a substantial role on which standards measures and investments must follow in the upcoming years.

All employees use and follow municipal plans in their work as the general standard for decision making. However, if municipal plans do not include provisions with a goal of improving the surface water situation, there is no guarantee that work on surface water measures will be taken. There will also be no standard which all employees follow, and no legally binding requirements to construction work or other activities that might affect how surface water are handled. The need for implementing stricter provisions on climate change adaptation and thereunder surface water measures in the municipal plans is found to be important. The same respondent from Oslo Municipality stated that their upcoming municipal plans are expected to have provisions with stricter phrasing concerning surface water *"The last municipal master plan was adopted in 2015 and now it is revised again, probably starting next year. And then we see that surface water will be one of the subjects that must be emphasized more heavily"*.

A motivation for the stricter phrasing, can be understood from a climate perspective. As presented in chapter 2, Norway has faced an increasing amount of precipitation the last century and are predicted to experience even more until the end of this century (Hanssen-Bauer et al., 2017). Oslo Municipality and Stavanger Municipality have yet to experience severe incidents due to heavy rain and cloudburst. Nonetheless, nearby areas such have suffered from incidents like this. One respondent talked about such severe incidents as *granting rainfall.* Granting rainfall is best defined by the respondent from Oslo Municipality:

> We call it granting rainfall in our industry, because often it has to happen a big, serious incident in order to wake up the politicians. Then, in a sort of way, they will throw money after you (…) Well, I hope we can work in a way so that we do not need to face these catastrophes to achieve our goals.

Even though Stavanger Municipality and Oslo Municipality have yet to experience granting rainfall, we believe that the events in nearby areas are close enough to have some degree of a granting rainfall effect, and hence "wake up" the politicians. One way the politicians can act is then to implement stricter provisions and emphasis on climate change adaptation and hence surface water management in municipal plans.

Finding 1.2. Prioritizing and alternative costs

Finding: The use of insurance loss data is affected by how municipalities prioritize and evaluate alternative costs.

We find that in a municipality's attempt to meet all the needs and interests, they have to make priorities between different projects and measures. In the municipality's process of prioritizing, the municipality has to evaluate alternative costs. Surface water measures with incorporated insurance loss data are also subject to these prioritizing processes, and we see that these processes impact the use of insurance loss data.

One respondent stated that even though municipalities aim to achieve and follow through all their projects, this will not always be the case. Situations where the municipality does not have the opportunity to follow all projects through will occur. Following quote explains how municipalities have to plan and prioritize with this in mind when defining flood streams:

> We have to see what areas are the most important when it comes to getting the safe flood streams in place, in case we do not have time for all of them. Of course, we hope we have time for all of them. If we do not have the time for all of them, at least we have to have the time for the most important ones.

When it comes to implementing projects and measures, the municipalities have to prioritize to make sure the most crucial ones will be conducted. One respondent enlightened us on how a list of priorities concerning drainage systems looks like:

> We prioritize pipes that are old and in bad condition, to put it like that. And then we prioritize the strategically important pipes considering water supply. Critically important water pipes shall not break (…). On sewerage pipes we prioritize pipes that can handle surface water from the main sewerage system, so that we do not have to pump and clean the water. (…) And we prioritize pipes that are important in order to release capacity (…). If we see that a lack of capacity on sewerage pipes leads to problem for the inhabitants during heavy precipitation this always becomes a priority.

A respondent from Oslo Municipality talked about the importance of alternative costs in their prioritizing of surface water measures:

> If we are leading the water to pass through here, instead of there, it is like, it might cost 200 million kroner (NOK). And every basement-flooding might cost 40 000 to 50 000 kroner (NOK). There has to be quite a lot of basement-flooding incidents before this will pay off.

This respondent enlightened us on how the municipality is faced with alternative costs, which applies for all the work they control. In this situation the alternative costs represent money the municipality must spend in the best possible way. The process of prioritizing can also function as a hindrance for the work on surface water measures, as one of the respondents told us:

> And there are some projects that like, the purpose and objective is so good. Even though it means that you lose a lot of retention, well, the purpose is so important that we just have to approve the project. And what do you do then?

Again, we see that the municipalities have to see and represent all the public interests as a part of their responsibility as a governing body. There will be situations where projects are

beneficial for one interest group, at the expense of other projects and interest groups. The municipality is then forced to evaluate its alternative costs and prioritize between the different projects. The municipality must then aim to decide upon which project will be most beneficial or least costly for the society as a whole. We see that these priorities also apply for the work concerning surface water measures, and the use of insurance loss data into these measures.

Finding 1.3. Political governance

Finding: Political governance seems to influence municipal activity on climate preventive measures.

Three of our respondents pointed out that which political parties the City Council consist of, will influence how easy it is to get support, money and approval for work concerning climate change adaptation. Less resistance was experienced when the City Council included representatives from more environmentally friendly parties in contrast to not. During the interviews, respondents from both Stavanger Municipality and Oslo Municipality explained how the political governance in the municipality can affect the municipal work on climate change adaptation. The relevant municipal bodies include the City Government and the City Council which consists of elected political representatives. The City Government is the executive body which answers to the City Council in the municipality (Oslo Municipality, n.d.).

Two out of the three respondents from Oslo Municipality stated that their area of responsibility receive a higher level of support as the current City Government has a large focus on the environment and climate change. As one respondent stated, "*In Oslo, we kind of have the right politicians now, and we are experiencing a lot of support*". A respondent in Stavanger Municipality expressed an expectation of change in support from the City Council after a switch in the political govern in the municipality in 2019 "*After many decades of right-wing dominated political govern, it is now on the completely opposite side (...), it will be pretty interesting to see what they will be able to achieve*".

Our finding is thereby that which political parties the City Government and City Council in a municipality consists of, influence how a municipality works with climate change adaptation, and thereby surface water measures. With favorable political parties, in a climate preventive

view, this can indirectly result in a higher use of insurance loss data in surface water measures, due to the higher willingness to invest in climate preventive measures.

Finding 1.4. Urban development in a municipal perspective

Finding: Urban development happens in a long-time perspective with the private sector as the main decision maker.

We find that urban development operates and happens within a long-time perspective. This long-time perspective involves a scenario where it might take 10 to 30 years before municipalities can evaluate the actual effects of measures which are implemented today. One respondent had following statement when talking about construction work and urban development "*All urban development is long-term (...) in a 10-20-30 years perspective one can start to see the effect of measures".*

When talking about challenges concerning management of surface water and sewerage system, the same respondent stated that "*We spent 100 years on creating the problems we have today, and I believe we are going to have to spend, maybe not 100, but at least 50 years before we get to see this being properly solved*". The problems that the respondent is talking about concerns surface water incidents in Oslo Municipality. As presented in chapter 2, Norway face a situation of an increased level of precipitation along with a drainage system that partly has a too low dimension criterion. In addition, the drainage system has become a part of the sewerage system (Aano, et al., 2019). This has led to even more surface water. An important observation is that maintenance of the sewerage system is a long-term activity. Both of the aforementioned quotes teach us something about the time perspective in municipalities. We presume that when insurance loss data is to be implemented in municipal work, also this implementation will fall under this long-time perspective. We must therefore assume that concluding on results from municipality's implemented insurance loss data in surface water measures will take time.

One factor that was pointed out to explain some of the reason to why urban development takes time, was that municipalities do not have as much money as they would want to have. A respondent told following quote which we believe is also applicable for urban development:

> It is not like we identify a problem, and then the municipality has a lot of money so that they can enter the area, fix the problem and solve everything. Even though one would want this to be the case.

It was also reported that municipalities experience that the majority of construction work is initiated and developed by private constructors. This might lead to a lack of control on the urban development for the municipalities. One respondent mentioned that:

> That is what is so hard, because urban development is mainly not controlled by the municipality. Because the municipality does not have a lot of money. And it happens to be that, it is the private sector that owns the largest part of this country. And it is also they who build the most. So, urban development is largely driven by private investors.

The municipalities find themselves in a situation where they have limited tools and power to affect the urban development. Consequently, surface water measures and the use of insurance loss data might suffer. However, the same respondent also talks about what the municipality does in situations where one of the agencies are expected to intervene in an area:

> And this is how much of the urban development happens. One identifies a problem area, and then you know that in this area the municipality has the responsibility for something. Maybe we have the responsibility for the road, or maybe the sewerage system. So, when the municipality enters the area to do something, the municipality can do it in a favorable way.

Through different guidelines, information and projects with the constructors, the municipalities aim to control the urban development in a favorable way. This includes how the constructors manage surface water.

We find that municipalities operate with long time frames. The consequence for our understanding on how municipalities can implement insurance loss data in surface water measures is that we must accept that this implementation falls under this same time frame and must thereby be expected to take several years. Municipalities lack of control on urban development also affects the ability to implement surface water measures. We think that this can lead to a problem where the municipality might have to wait years before they can properly evaluate the result of the utilization of using insurance loss data in their projects and measures.

4.3. Theme 2. Factors that the municipalities find challenging with insurance loss data

One of our sub-research questions was to identify challenges the municipalities face when incorporating insurance loss data in their work on surface water measures. The interview questions regarding the challenges were answered in a broad scope. We have in our analysis identified two findings.

Table 3. Findings in Theme 2

Finding	
Finding 2.1.	Low quality on the insurance loss data and uncertainty concerning the use of sensitive data are challenging for municipalities.
Finding 2.2.	Allocation of responsibility for managing surface water is unclear, making it harder to work on surface water measures.

Finding 2.1. Problems with insurance loss data

Finding: Low quality on the insurance loss data and uncertainty concerning the use of sensitive data are challenging for municipalities.

All respondents stated that there were several challenges with the quality of the insurance loss data. One respondent stated that one of the problems was that the insurance loss data they received was highly unstructured:

> We received a large share of data that was very unstructured. It was everything from paper copies to, what can I say, ASK file or text files, to map files, to very, very, spaghetti data as we call it.

Another respondent mentioned a problem with the insurance loss data concerning the localization of incidents, "*The addresses are written in terribly many different, weird ways"*. Further, one respondent enlightened us about a challenge concerning the reporting of incidents at wrong times, "*But often, they report the incident two weeks after it has happened. And then the timing will be wrong. And then we will not be able to tie it to anything".* Yet another problem that was mentioned repeatedly during the interviews was that the details about the

reasons for damage were not registered in a fulfilling way. One respondent explained that the causes of the incidents are not properly divided into enough different categories by the insurance companies. This way, some of the incidents will be registered with a cause that is not completely correct. This makes it difficult for municipalities to fathom all relevant surrounding circumstances and use the insurance loss data in a sufficient way. One respondent suggested that pictures of the damage could be a tool that would help the municipalities to get enough information.

All of the aforementioned problems concerning data quality of the insurance loss data, were also described in the report *Pilot project about testing insurance loss data from the insurance industry when considering climate vulnerability and prevention of climate related natural hazards in selected municipalities*. However, we find that how the insurance companies have reported the reason, installation and source of a damage seem to be more important than previously documented. Following quotes from two different respondents substantiates this "*I cannot understand how another agency can relate to not knowing whether the water comes from the road or not" and "I think it is relevant regardless of what it is going to be used for. I cannot understand anything else".*

As explained in chapter 2, selected municipalities received a new data set with insurance loss data during the spring of 2019 (Ministry of Finance, 2020). Some of the respondents in our sample had received this data set and explored the new reported insurance losses. Even though we did not ask about their experience on the new data sets, the respondents informed that several of the issues they had reported earlier were still present. In other words, the respondents did not observe much improvement in the data quality.

Our analysis also identified a challenge with the use of insurance loss data that have not earlier been mentioned. One respondent expressed uncertainty concerning to which degree sensitive data, like insurance loss data, could be used. It was stated that "*We used the data a little bit, but we did not really dare to, because of the restrictions that were attached to the data*". The respondent also mentioned that after the pilot project was conducted, several restrictions regarding data protection and privacy have been enforced, making this even more challenging now.

We find that municipalities face several challenges with the use of insurance loss data due to its low quality. Even though specific problems were reported already in 2014, they are still

present in the data set the municipalities received in 2019. We also find that municipalities expect restrictions regarding data protection and privacy to make it even more challenging to process the insurance loss data.

Finding 2.2. Allocation of responsibility

Finding: Allocation of responsibility for managing surface water is unclear, making it harder to work on surface water measures.

Unrequested, all respondents focused parts of their interviews on how responsibility is allocated within a municipality. When asked specifically about the responsibility for surface water measures, three of the respondents explained how this can fall under the responsibility of different agencies. One respondent exemplified how a given responsibility is assigned the agency "*When the municipality open streams, it is our agency's responsibility to open them. Because we put them into pipes once in the past. But everything concerning the esthetics around, the park area, is another agency's responsibility*". Another respondent could inform that the challenge concerning the responsibility for surface water measures between the different agencies, was to be highlighted in the upcoming municipal master plan. The respondent also stated that clarifying the allocation of responsibility is a resource demanding process.

Management of surface water also includes challenges where the responsibility between a municipality and its inhabitants are unclear. One of these challenges is associated with the dimension criterion for the drainage systems. The dimension criterion involves information about how much water the pipes must have capacity to divert. Different municipalities might have different dimension criterion for their drainage systems, but a norm for how large the dimension criterion is established. From time to time, new dimension criterion becomes the new norm. One respondent explains the challenge of this:

> We have 1000 kilometers with sewerage pipes in the municipality. We cannot, just because someone changes the dimension criterion, upgrade all the sewerage pipes. Theoretically, this is a 20 billion kroner (NOK) investment. So, this is actually an unimaginable way to work.

Since it is impossible for municipalities to upgrade the whole drainage system when a new dimension criterion becomes the new norm, the same respondent also told us that "*We have a*

responsibility for everything that goes up to the dimension *criterion for the drainage system which it was originally built for".* This means that the municipalities are only responsible for water up until the dimension criterion of the pipes in its given area. Water levels exceeding this, are not within the responsibility of the municipalities. The respondent also stated that this disclaiming of responsibility, is legally enforced by a court case called the Stavanger-verdict.

Additionally, the allocation of responsibility between the municipality and constructors can be a challenge. Some municipal master plans include provisions stating that constructors are responsible to manage surface water locally and are not allowed to put the surface water into drains in order to lead it away in the sewerage system. The constructors are thereby forced to use SUDS-measures. Following quote was said by one of the respondents regarding surface water "*We reject to take anything, almost, as long as it is possible to make SUDS-measures, we refuse to take any surface water into our drainage systems*". However, the municipal master plans are often rather unclear on how much of the surface water that should be managed at the property through SUDS-measures. As a consequence, events with a high level of precipitation, might result in much surface water and following damage, even though the constructor has implemented SUDS-measures. Disagreements on who is to be responsible for such damage can then occur as the constructors have followed the provisions of the municipal master plan, and the municipality is only to be responsible up to the dimension criterion of the pipes in the given area.

Our finding is that allocation of responsibility for managing surface water is unclear. This includes the allocation of responsibility within a municipality, between a municipality and its inhabitants, and lastly, between a municipality and private constructors. This uncertainty makes it harder for municipalities to work on surface water measures and can also lead to disagreements concerning the responsibility of damage due to surface water.

4.4. Theme 3. Possibilities with insurance loss data

The third theme answers the third sub-question about how the municipalities can implement insurance loss data in their municipal work. From the interviews it was disclosed that in the aftermath of the pilot project and the prolongation of the pilot project, the municipalities had used the insurance loss data in two projects as well as some smaller case-studies. Nevertheless, all respondents identified several projects and measures where insurance loss data potentially could be implemented, as well as the advantages of such implementations. Two projects where

insurance loss data have already been implemented will first be presented. Then potential projects and measures that can utilize an implementation of insurance loss data will be presented.

Table 4. Findings in Theme 3

Finding	
Finding 3.1.	Insurance loss data has been used into two individual projects and some case studies.
Finding 3.2.	Insurance loss data has the potential of being used in several projects.

Finding 3.1. Conducted projects including insurance loss data

Finding: Insurance loss data has been used into two individual projects and some case studies.

Based on the interviews we found that Stavanger Municipality has used insurance loss data in a project called Feasibility study on surface water management in Sørmarka. In Oslo Municipality, insurance loss data has been implemented into a cost-utility tool developed by the municipality. In addition, we found that the insurance loss data had an impact when areas for case studies about surface water projects were chosen in Oslo Municipality. Insurance loss data has not been used in other projects.

To get a thorough understanding of how insurance loss data has been included in the two aforementioned projects, an overview of these projects will follow. As the case studies represent studies in minor areas within Oslo Municipality, and also focus on gaining a better understanding instead of being a measure, we will not specify or discuss these case studies any further.

4.4.1. Feasibility study on surface water management in Sørmarka

Through the Feasibility study on surface water management in Sørmarka, Stavanger Municipality wanted to locate where the waterways in Sørmarka would flow and thus where surface water would arise. A drone with a laser sending pulse signals to the ground was used

in order to examine the surface in Sørmarka. With the information from the laser it was possible to describe the terrain and draw a map of it. Onto the map, different levels of precipitation were simulated, and analyses made concerning where the waterways would flow. Based on these analyses, problem areas due to the waterways and surface water were identified. The insurance loss data were included in the feasibility study as a layer onto the map that was drawn. As the damage in the data set with insurance loss data includes incidents that has arisen due to different reasons, all incidents were reviewed and only the relevant damage, which concerned waterways and surface water, were included onto the map. As a result of including these damages, a relationship between the identified problem areas and damage from the insurance loss data was observed.

By including insurance loss data in a project like this we believe that the user will easily notice if the identified problem areas are consistent with the areas of insurance loss incidents. We also think a comparison like this will give the defined waterways more substantiation. We presume that use of insurance loss data into this feasibility study will bring extra value and emphasis to the results.

4.4.2. Cost-utility tool

With the basis in a cost-utility tool for non-urban areas from The Norwegian Water Resources and Energy Directorate (NVE), Oslo Municipality has developed a cost-utility tool to be applicable in suburban and urban areas. In order to adjust the cost-utility tool to be suitable in urban areas, the sources used to calculate the cost and utility of a measure were modified to apply for Oslo Municipality. Among the sources to calculate the costs, insurance loss data was included.

Concerning the goal of the cost-utility tool, one respondent tells that "*We hope that this kind of cost-utility tools will take the whole lifetime of a project into consideration. So, one also takes into consideration whether the building is meant to last for 20 years, 50 years or 100 years*". Hence, the goal of the cost-utility tool concerning surface water measures, is that it will be resilient enough to take the predicted increasing level of precipitation into consideration over the whole lifetime of the measure. In such a case, the results from the cost-utility tool would be a solid element into the foundation of decision making. We were made aware that in the time period when the interviews were conducted, the developed cost-utility tool was being tested by workers within the municipality. Thereby, no feedback about how the

cost-utility tool worked in practice and what potential changes needed to be made, were yet received.

Deciding on which measures to implement in a municipality often ends up being a consideration of the costs of a measure, accordingly, deciding with a basis in numbers. The benefit of the cost-utility tool was described in this way:

> But to get numbers, very black on white, is very useful. Because it often is concretized down to numbers in the other agencies when they are prioritizing between everything that they have to do. That we can show that it is beneficial to work preventive and not just fix afterwards.

By getting exact numbers from the cost-utility tool, the workers within a municipality will be able to prioritize and choose between measures in exactly the same way as they do when only costs are included. In addition, both costs and utility of a measure is being taken into consideration. We thereby believe that costly measures which would never have been chosen based only on its costs, can be considered if they have a high level of utility. The comparison of costs and utility that you get through a cost-utility tool, will also have the potential of showing the workers within the municipality that preventive measures, which will have a high level of utility, pays off in the long run instead of always repairing in the aftermath of an incident.

Finding 3.2. Thoughts and possibilities with receiving insurance loss data

Finding: Insurance loss data has the potential of being used in several projects.

Despite not having used the insurance loss data to a larger extent, we find that all six respondents were positive to the sharing of insurance loss data with municipalities. From the interview questions regarding receiving insurance loss data, the respondents answered "*It is very useful to receive this information, and I am glad to receive them*", "*The fact that the data can be used all the way down to address level, that is really rare with this type of data*" and "*The best part with the insurance loss data is that it gives you insanely much data.*"

During the interviews we asked the respondents questions in which they answered with a basis in their agency, and thereby with a consideration to the responsibilities in their associated

agency. As none of the respondents from the same municipality worked in the same agency, all respondents from one municipality had different areas of responsibilities and daily work tasks. The possible areas of using insurance loss data would consequently differ between the respondents. Still, we were able to observe similarities between the answers from the respondents, which indicates that there are several areas within a municipality where insurance loss data can be implemented. The most frequent answer from the respondents was a desire to implement insurance loss data into the foundation of decision making. It was expressed that "*Insurance loss data is good supplementary information*". We believe that this implementation of insurance loss data will strengthen the foundation and have a significant impact on the decision making.

Three concrete projects and measures where it would be beneficial to include insurance loss data were mentioned during the interviews. This was in a cloudburst management plan, a climate dashboard and into maps. These projects will be presented next.

4.4.3. Cloudburst management plan

A cloudburst management plan was mentioned as a concrete project where it could be beneficial to include insurance loss data. This is a plan for how to manage surface water in the event of heavy rainfall. An important part of a cloudburst management plan is to define the flood streams. As the trends in Norwegian cities are to build more buildings, even more compact than before, it implies that roads and streets need to be used as the flood streams. Different analyses must then be conducted in order for the municipality to find out whether there are any problem areas with its defined flood streams.

Based on the information we received about the cloudburst management plan during the interviews, we think the use of insurance loss data into this project would be beneficial. By exploring the insurance loss data and the flood streams it is possible to identify relationships. In this way, the municipality will be able to see problem areas that potentially has arisen due to the defined flood streams and implement measures to handle this.

4.4.4. Climate dashboard

Another project where insurance loss data could be implemented is into a climate dashboard in Stavanger Municipality. The technical parts of such dashboards are already made and settled

within the municipality. A respondent informed that they have started to look into what factors that should be included in the climate dashboard, but at the time the interview was conducted this was yet to be decided. Concerning which factors to include, the respondent informed "*For the climate dashboard we visualize a dashboard with a lot of information boxes, as well as a visual presentation of the municipality*". Examples of what to include could be short and long-time weather forecasts, different statistics and analyses, and results from different projects the municipality have conducted regarding climate measures. Further, the respondent stated that "*So it might be that with a climate dashboard, you get to connect the dots and get a proper overview*".

By including insurance loss data in a climate dashboard, we believe that the visual presentation of the municipality will display a more comprehensive picture compared to when insurance loss data is not included. In addition, we believe that an inclusion of insurance loss data in the climate dashboard, eventually will form a routine for how the municipality use insurance loss data in their municipal work.

4.4.5. Incorporating insurance loss data into maps

Several of the respondents mentioned that an implementation of insurance loss data could make prioritizing easier and function as an element to make more accurate decisions. Maps were often suggested as a tool where insurance loss data could be implemented and help to prioritize between different measures and projects. One of the respondents stated this about maps, "*I think that if it comes in any other format it will be much harder for the municipality to use it*". As documented in the report *Status and possibilities with the use of insurance loss data into the work on climate adaptation* both Stavanger Municipality and Oslo Municipality have made hotspot maps of the insurance loss data. One respondent suggested to use hotspot maps that included an overview of different water pipe's dimension criterion, in order to help prioritize where to conduct maintenance on the drainage system. As municipalities strives to manage water up to the national norm, water pipes with low dimension criterion will be prioritized. Through the suggested map, it would be possible to locate the pipes that has both a low dimension criterion and might cause problems for the inhabitants of the municipality. These pipes should of course be prioritized.

We believe that by incorporating insurance loss data into maps, this will become a tool that let workers within the municipalities easily visualize their identified problem areas. We also think

maps containing insurance loss data can function as a tool used to cross-check problem areas which have only been defined through mathematical analysis.

4.5. Theme 4. How municipalities can face challenges concerning the use of insurance loss data

In this theme we address the findings that covers how municipalities can face the challenges concerning the recording and application of insurance loss data. We will also present which circumstances that are viewed as necessary in order to improve the use of insurance loss data in climate preventive measures, and hereunder surface water measures in the future. Some of these findings answer to the challenges we found earlier in our analysis. Others represent ideas and thoughts which the respondents believe will be valuable for an improvement in the future. In this theme we will also add our recommendations concerning future work with insurance loss data.

Table 5. Findings in Theme 4

Finding	
Finding 4.1.	There are specific requirements in order to improve the quality of the insurance loss data.
Finding 4.2.	Improved cooperation between municipalities will be beneficial for municipalities.
Finding 4.3.	Standardization will ensure a long-time perspective on the use of insurance loss data.
Finding 4.4.	The Knowledge Bank has the potential of contributing to the process of standardizing the insurance loss data.

Finding 4.1. Insurance loss data requirements

Finding: There are specific requirements in order to improve the quality of the insurance loss data.

Our analysis uncovered specific requirements the insurance loss data must fulfill in order to maximize the user utility in the municipalities' work on surface water measures. As mentioned in finding 2.1, we find that the respondents report many of the same requirements as they did in the report *Pilot project about testing insurance loss data from the insurance industry when considering climate vulnerability and prevention of climate related natural hazards in selected municipalities*. We understand that the freshest data sets, which the municipalities received during the spring of 2019 still have the same weaknesses. However, we have no insights on what the actual insurance loss data sets consists of, or the work on this data from the perspective of Finance Norway or the insurance companies. We can therefore not make any conclusions concerning how the data sets have developed since the beginning of the pilot project. We can, however, conclude that there are reported issues concerning the freshest data sets. Below we will present requirements to the insurance loss data and possible solutions to meet these requirements.

One of the most repeated requirements about the insurance loss data, was the need to know the type and the reason for an incident. In a considerable amount of cases, the damage reported in the data set did not include a good enough documentation. Two respondents reported that they wanted pictures and measurements of the water levels with basement flooding, in order to properly uncover the reason for the incident. One respondent reported that they needed to be able to separate the reported incidents based on the reason for the incident. Thereby they could more easily identify which incidents were relevant for their agency:

> We are very dependent on knowing, when we prioritize measures on the sewerage system. Whether the water damage occurred due to sewerage pipe backup from a drain in the main sewerage pipe, which indicates an issue concerning capacity on this pipeline. Whether the water damage occurred due to water from surrounding terrain that has poured down a basement staircase. Or, whether the water penetrated a house foundation or those types of things, which concerns surface water and drainage from roads, which can be due to sandfang and the routines concerning that, or it could concern issues and flaws indoors and be water damage due to indoor factors.

Another requirement from the respondents concerning the data sets, is that all incidents should be reported in the same format. A standard for all the insurance companies for how to report their incidents should be made. This way, the insurance loss data can easily and directly be

implemented into the municipalities mapping software, such Geographic Information Systems (GIS).

One respondent wanted to receive new data sets with insurance loss data yearly, whilst other respondents wanted the data as close to real time as possible. Respondents from one municipality stated that they need the freshest data, and it needs to have the correct dating of what time the incident happened. Two respondents requested more data, and believed they got too little insurance loss data compared to what they believed was the real number of incidents. However, one respondent stated that this would come naturally as time goes on and more incidents are reported. Several times during the interviews, respondents pointed out that the incidents in the data set needed better geo-locations, as it was a resource demanding job for them to identify the correct geo-locations.

We find that all respondents are positive to the sharing of insurance loss data, but the requirements for better data quality is an absolute need. The respondents see a greater potential with the insurance loss data once the data quality is up to standards.

Our recommendations:

- All incidents must be reported on the day of the incident, meaning the day of the rainfall.
- All incidents must contain more information on the reason for the incident. Including water levels and information about where the water comes from.
- Pictures could help enlighten the reason for incidents.
- All incidents must be reported in the same format, preferably one that is easily imported into mapping programs such as GIS.
- All incidents must have better geolocations, such as for example GPS-coordinates.

Finding 4.2. Sharing synergies between municipalities

Finding: Improved cooperation between municipalities will be beneficial for municipalities.

An interesting finding from our analysis is how municipalities share synergies. By sharing synergies, we mean that the municipalities by looking at each other and learning from each other's experiences get a greater effect than they would gain if they operated independently. In our interviews, four out of six respondents talked about this phenomenon, and we therefore find it relevant to present this as one unique finding. The sharing of synergies can appear in different situations and with different objectives. We will next present some of the points that the respondents emphasized.

All four respondents talked about how they inspire and take inspiration from other municipalities. Municipalities look at other municipalities and evaluate which of their measures that work and do not work. These evaluations are taken into account when the municipality is making its own choices of what measure to implement, and how the implementation should be conducted. During the interviews, one respondent gave a concrete example of a measure in another municipality that they would look at the next time they were to build a new road *"Drammen. There the Norwegian Public Roads Administration has built a new road. (...) It is built in the new way, using SUDS-methods. (...) It also turned out to be cheaper than the traditional way of building roads"*.

In this concrete example, the road was built with a new design that aimed to better handle surface water. Information and experiences from this project can then be shared across different municipalities concerning how the road handles regular weather, extreme weather and cloudbursts, as well as regular wear and tear. When sharing these experiences, other municipalities can attain valuable information without having to invest money into a measure without knowing its effects.

One respondent could also tell us that when a municipality revise their municipal plans, they look to other municipalities and examine what they have included in their municipal plans and the experiences attached to this: "*When we see something that works, we make provisions based on this experience"*. A respondent from Stavanger Municipality came with an example where they had looked at what Oslo Municipality had included in their master municipal plans:

> We have, not provisions, but guidelines in the master municipal plan about the blue-green factor. It was a system that Framtidens Byer [Cities of the Future] and especially Bærum and Oslo developed. (…) We included this in our master municipal plan.

Another aspect of how synergies are shared between municipalities, is that smaller municipalities can look at what larger municipalities do and the tools they are using in their municipal work. During the interviews, two of the respondents stated that small municipalities have fewer resources and employees compared to larger municipalities. In addition, they also have a smaller academic community which they can utilize when evaluating and implementing different measures. Concerning development of measures and tools, two of the respondents expressed that larger municipalities should develop these on behalf of smaller municipalities *"It is only reasonable that the large municipalities contributes to a greater extent than smaller municipalities"* and *"The tools should not only be for our municipality."*

Based on these statements we can assume that municipalities have a great advantage of sharing synergies with each other. This can lead to more investments in project and measures with higher accuracy and utilization. Even though a sharing of experiences will be beneficial for all municipalities, we assume that smaller municipalities are the ones that will have the greatest advantage of sharing synergies.

Our recommendations:

- All municipalities must openly share their experiences with each other.
- Tools and measures must be developed by larger municipalities.
- Finalized tools and measures must be shared with smaller municipalities.

Finding 4.3. Standardization

Finding: Standardization will ensure a long-time perspective on the use of insurance loss data.

In this finding we will refer to standardization as standardizing the use of insurance loss data in routines and work within municipalities. Several of the respondents pointed at standardization as a possible solution to ensure use of insurance loss data in a long-time perspective.

Half of our respondents discussed how standardizing the incorporation of insurance loss data in routines and work, was necessary in order to ensure a long-time perspective on measures and municipal work. One respondent requested better guidelines from Finance Norway regarding how the insurance loss data could be used concerning the sensitivity of the data. Another respondent waited for a standard to be developed in order to cement the use of insurance loss data in their municipal work, but expected this to take time: "*The process of going from pilot project or a one time-measure into making it business as usual will take more time*". A third respondent stated that in order to cement the use of insurance loss data, resources must be allocated in order to develop stable routines and procedures.

We see that the use of insurance loss data is not widespread. The municipalities need the use of insurance loss data to be standardized. We also notice that there is uncertainty attached to the sensitivity in the data, and that a standardization process would reduce this uncertainty. The municipalities also need to standardize their routines concerning the use of the data, which will ensure a long-time perspective of the use of insurance loss data.

Our recommendations:

- Better guidelines from Finance Norway concerning the sensitivity-issues when using the insurance loss data.
- Municipalities must incorporate the use of insurance loss data in their work. Incorporating insurance loss data in important tools such as the climate dashboard and cost-utility tools will cement the use of the insurance loss data in a long-time perspective.
- Incorporating insurance loss data in municipal plans will ensure a long-time perspective of the use of the data.

Finding 4.4. DSB Knowledge Bank

Finding: The Knowledge Bank has the potential of contributing to the process of standardizing the insurance loss data.

As mentioned in chapter 2, DSB and Finance Norway have signed a partnership in order to achieve an effective management of disasters. A part of this partnership involves an incorporation of insurance loss data in the Knowledge Bank, aiming to let the redistribution of this data go through the digital platform (DSB, 2018). In our last finding we will discuss

the possibilities that are believed to emerge from making use of this digital platform, as well as the challenges that can emerge. Based on this, the finding will end with our recommendations to what the Knowledge Bank should fulfill in order to improve the municipalities' use of insurance loss data.

Possibilities with the Knowledge Bank

There are several factors that the Knowledge Bank has potential to improve. First, the Knowledge Bank can help solve the challenges concerning insurance loss data not being reported in the same data format from the different insurance companies. The Knowledge Bank is planned to be a platform containing different sorts of information, which can be relevant for all sorts of public work (Røng et al., 2018). The Knowledge Bank must therefore collect, clean and sort different kinds of data in order to make it accessible and useful for other institutions and municipalities. As mentioned, both previously in chapter 2, as well as in finding 2.1, a problem with the insurance loss data is that the data is not reported in the same format. The Knowledge Bank is in a position where it must collect data and present the data in a useful way, and they should therefore also clean and format the data. This will be highly beneficial for the municipalities which then can use this platform to collect insurance loss data which is already converted into one format.

Secondly, the Knowledge Bank can reduce the municipalities use of resources. In addition to insurance loss data, the bank will contain other types of data from national expert authorities (Røng et al., 2018). The DSB Knowledge Bank will thereby represent a database where municipalities easily can extract data and use it in their analyses, instead of collecting the data independently. As one respondent stated:

> We spend a lot of time in all our projects to collect the data we need. For example, insurance loss data. If we had systems for that. Because this says something about the scope of things, but also something about the costs.

The possibility of extracting data directly from the Knowledge Bank is particularly helpful for smaller municipalities. As mentioned in finding 4.2, smaller municipalities have fewer resources and employees, in addition to a smaller academic community which they can utilize when evaluating and implementing different measures. The DSB Knowledge Bank will

thereby make it more accessible and easier for smaller municipalities to make use of insurance loss data in their municipal work.

Challenges with the Knowledge Bank

However, the respondents showed some skepticism to the Knowledge Bank. This skepticism can be sorted into two categories. The first category represents the Knowledge Bank's location in the organizational chart over Norwegian municipalities and Norwegian govern. The second category concerns the inadequate quality of the insurance loss data.

One respondent stated that a challenge was that communication between the Knowledge Bank and employees who work on projects and use the insurance loss data has to go through county governors:

> DSB has a problem, I think. And that is that they have country governors under them. And it is not so easy to make contact then, to go through the county governors and down to the municipalities and contact. (…) and we have so much more competence in our small agency than the county governors have concerning Civil protection, really.

The communication flow is slowed down by going through an additional hierarchical level and not directly between the ones who create the data sets and the ones who use the data. This is particularly problematic as this middle part does not have the same level of expertise or academic competence as the employees that the county governor redistributes the information to.

On the other side, as presented in the theory chapter, the objective of the Knowledge Bank is to become a digital platform where municipal employees have access (Røng et al., 2018). The goal is that employees can collect whatever data and analyses the employee might need and tailor this to their work. On the other side, in order to make sure the Knowledge Bank works in an optimal way, a direct line of communication between the users of the platform and the developers of the platform should be in place.

The second category of skepticism concerns the quality of the insurance loss data. One respondent stated that the main reason to the challenges of using insurance loss data was attached to the data quality. This respondent could not see that this problem would be solved

with a Knowledge Bank instead of being redistributed with the help from Finance Norway. The main issue would still remain, which was that the data does not contain enough details such as the type and the reason for why a damage has occurred. The issue here lies with the fact that the surveyor, while examining for instance a water damage, does not collect enough information from the location. In this situation we see that the Knowledge Bank is not really the main problem.

When taking this last category of skepticism into consideration, we can assume that the DSB Knowledge Bank represents an improvement in data sharing between institutions. Even so, the Knowledge Bank cannot reach its full potential in the work on climate preventive measures before the insurance loss data quality is improved and contains more information about every incident.

Our recommendations:

- Heavy focus on standardizing the format of the insurance loss data.
- Focus on reducing the need for resources especially for smaller and resource-scarce municipalities.
- Make routines and standards attached to the sharing of insurance loss data. The data must be shared regularly, or ideally real-time.
- Ensure a direct line of communication between the users and the developers of the Knowledge Bank.

4.6. Summary of findings and recommendations

Table 6. Summary of findings

Finding	
Theme 1	
Finding 1.1	Municipal plans affect the use of insurance loss data.
Finding 1.2	The use of insurance loss data is affected by how municipalities prioritize and evaluate alternative costs.
Finding 1.3	Political governance seems to influence municipal activity on climate preventive measures.
Finding 1.4	Urban development happens in a long-time perspective with the private sector as the main decision maker.
Theme 2	
Finding 2.1	Low quality on the insurance loss data and uncertainty concerning the use of sensitive data are challenging for municipalities.
Finding 2.2	Allocation of responsibility for managing surface water is unclear, making it harder to work on surface water measures.
Theme 3	
Finding 3.1	Insurance loss data has been used into two individual projects and some case studies.
Finding 3.2	Insurance loss data has the potential of being used in several projects.
Theme 4	
Finding 4.1	There are specific requirements in order to improve the quality of the insurance loss data.
Finding 4.2	Improved cooperation between municipalities will be beneficial for municipalities.
Finding 4.3	Standardization will ensure a long-time perspective on the use of insurance loss data.
Finding 4.4	The Knowledge Bank has the potential of contributing to the process of standardizing the insurance loss data.

Table 7. Summary of recommendations

Finding	Recommendations
Insurance loss data requirements	
	All incidents must be reported on the day of the incident, meaning the day of the rainfall.
	All incidents must contain more information on the reason for the incident. Including water levels and information about where the water comes from.
	Pictures could help enlighten the reason for incidents
	All incidents must be reported in the same format, preferably one that is easily imported into mapping programs such as GIS.
	All incidents must have better geolocations, such as for example GPS-coordinates.
Synergy sharing	
	All municipalities must openly share their experiences with each other.
	Tools and measures must be developed by larger municipalities.
	Finalized tools and measures must be shared with smaller municipalities.
Standardization	
	Better guidelines from Finance Norway concerning the sensitivity-issues when using the insurance loss data
	Municipalities must incorporate the use of insurance loss data in their work. Incorporating insurance loss data in important tools such as the climate dashboard and cost-utility tools will cement the use of the insurance loss data in a long-time perspective.
	Incorporating insurance loss data in municipal plans will ensure a long-time perspective of the use of the data.
DSB Knowledge Bank	Heavy focus on standardizing the format of the insurance loss data.
	Focus on reducing the need for resources especially for smaller and resource-scarce municipalities.
	Make routines and standards attached to the sharing of insurance loss data. The data must be shared regularly, or ideally real-time.
	Focus on reducing the need for resources especially for smaller and resource-scarce municipalities.
	Ensure a direct line of communication between the users and the developers of the Knowledge Bank.

5. Summary and Conclusions

5.1. Summary

The summary is organized based on the four sub-research questions, which conforms with the four themes presented in the previous chapter, Empirical findings and discussion.

(i) *Which municipal factors can have an effect on how surface water measures are implemented?*

- Municipal plans. Function as municipal laws and guidelines and include the municipality's most important objectives and tasks. This impacts how agencies conduct their work on surface water measures.
- Prioritizing and alternative costs. The municipality must prioritize projects and measures with an aim of optimizing the social welfare in the municipality based on alternative cost. Use of insurance loss data falls under this process of prioritizing.
- Political governance. How much focus on environment the political governance has, affects the monetary support and experienced resistance when implementing surface water measures using insurance loss data.
- Urban development in a municipal perspective. Operates within the timeframes of 10 to 30 years, which means that one might have to wait years before one can properly evaluate the results of the utilization of insurance loss data.

(ii) *What do the municipalities find challenging concerning implementing the insurance loss data in their municipal work?*

- Low data quality and uncertainty concerning the use of sensitive data. Low data quality is especially related to insufficient reporting of localization, timing and identified reasons of damage. Insurance loss data being sensitive data, makes it more uncertain for municipalities to know how they are allowed to use the data.
- Allocation of responsibility. This is unclear concerning management of surface water, making it harder for municipalities to work on such measures. It can also lead to disagreements concerning the responsibility of damage due to surface water.

(iii) *How can the municipalities implement insurance loss data in their municipal work?*

- Feasibility study on surface water management in Sørmarka. Relevant parts of the insurance loss data were included as a layer onto the map describing the terrain. We presume that use of insurance loss data brings extra value and emphasis to this study.
- Cost-Utility tool. Insurance loss data has been included as one of the costs used to calculate the cost side in the cost-utility tool. We believe that through the use of this tool both costs and utility of a measure will be taken into consideration when choosing which measures to implement.
- Cloudburst management plan. By including insurance loss data we assume it will be possible to identify relationships between the identified problem areas and the experienced problem areas from the insurance loss data.
- Climate Dashboard. We think that when including insurance loss data, the information from the climate dashboard will give a more comprehensive picture of the situation in the municipality.
- Maps. An incorporation of insurance loss data will make it easier for the workers within the municipality to visualize their identified problem areas as well as function as a tool that can be used to cross-check problem areas which have only been defined through mathematical analysis.

(iv) *How can challenges concerning the recording and application of insurance loss data be faced?*

- Specific requirements in order to improve data quality. Insurance losses must be reported on the day of the incident, contain more information about the reason of the incident and be reported in the same format.
- Sharing synergies between municipalities. Great advantage for all municipalities. Larger municipalities must lay the groundwork on the insurance loss data, as the smaller municipalities do not have the resources to do this on their own.
- Standardization. A standardization of the use of insurance loss data in the work within a municipality is needed to ensure a long-time perspective on the use of this data.
- DSB Knowledge Bank. Can represent an improvement in data sharing between institutions. Through the DSB Knowledge Bank the insurance loss data can be more accessible and easier for smaller municipalities to make use of.

5.2. Conclusions

We will here conclude upon our main research question "*How have two municipalities in Norway implemented insurance loss data in their municipal work concerning measures on surface water, and what surrounding circumstances might explain this utilization?*".

If we compare the two municipalities we find that both have conducted few projects on surface water where insurance loss data has been incorporated. After the finalization of the pilot project and its prolonging, Stavanger Municipality has used insurance loss data in one project, namely the Feasibility study on surface water management in Sørmarka. Also Oslo Municipality has only incorporated insurance loss data in one concrete project, a cost-utility tool developed by the municipality.

We find that there are a number of surrounding circumstances affecting the two municipalities use of insurance loss data. First, there are several municipal factors which are setting the frames for the activities and processes within a municipality. These municipal factors also apply for surface water measures and indirectly the use of insurance loss data. Municipalities have an ambition and goal of optimizing the public welfare and has to prioritize its activities thereafter. As of today municipal plans do not include any hard provisions concerning surface water measures. These measures, and the use of insurance loss data, thereby falls under the same degree of prioritizing as other measures.

Another circumstance that is affecting the municipalities use of insurance loss data is the unclear allocation of responsibility connected to management of surface water. Depending on the setting, surface water can fall under the responsibility of different agencies. Both municipalities reported that the uncertainty of who is responsible for the surface water makes it harder to work on surface water measures, and indirectly also the use of insurance loss data.

Still, the main reason why the two municipalities have not used insurance loss data in any greater extent seems to be due to the low data quality of the insurance loss data. Oslo and Stavanger Municipality report that the lack of proper localization and dating, together with the reason for damage not being registered in a fulfilling way, makes it hard to fully utilize this data.

Even though Oslo and Stavanger Municipality are facing the same challenges to fully utilize the incorporation of insurance loss data in surface water measures, we can conclude that all six interviewees are positive and see possibilities with this incorporation. We hope that the ongoing project with the Knowledge Bank can help overcome some of these obstacles, making municipalities take use of the insurance loss data in a greater extent.

5.3. Implications with the findings

Through this research project we aim to give a further understanding of how insurance loss data can be implemented in municipalities' measures and projects concerning management of surface water. We also want to contribute in the understanding of what municipalities need in order to maximize their utility of receiving insurance loss data. In the long run we hope that smaller as well as larger municipalities will benefit from the use of insurance loss data in their management of surface water.

With this master thesis insurance companies will receive a feedback on how useful the insurance loss data they share today are and how useful it can be in a long-time perspective. The insurance companies are able to get a better understanding on how municipalities adapt to an already increased level of precipitation as well as the estimated increase of precipitation. This understanding can in turn help the insurance sector to better adapt to climate change.

With this research project, we desire to help municipalities communicate their requirements concerning the data quality and the use of this data. Ideally, this will improve the cooperation between municipalities and the insurance sector.

5.4. Proposals for further research

Neither the pilot project and its prolonging conducted from 2013 to 2015 or the following municipal projects and measures using insurance loss data have been evaluated in a socio-economic perspective. This is a perspective we encourage future research projects to focus on. Quantifiable data and analyses would allow Finance Norway, as well as other public and private institutions in Norway, to better understand the actual value of the initiated pilot project and use of insurance loss data into surface water measures.

Another proposal for further research is to re-evaluate how insurance loss data has been implemented in municipal work concerning measures on surface water. Hopefully the identified projects and measures from this study, which was yet to have insurance loss data implemented will now be conducted. This study could thereby contribute to the further understanding of the utilization of implementing insurance loss data.

A third recommendation for further research is to evaluate the insurance loss data in the perspective of insurance companies. This could help both municipalities, insurance companies and Finance Norway to understand how insurance loss data should be reported. And hopefully contribute to a higher utilization for municipalities use of insurance loss data in municipal measures and projects to manage surface water.

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7. Appendix

APPENDIX A: Interview Guide

Part 1: Introduction

About us and the project

1. Short presentation of Hanne and Lina: Education & Background.
2. Short introduction to our research.
    1. Project objective and background.
    2. Thesis on sharing insurance loss data with municipalities.

General information

1. Participants rights to anonymity and confidentiality. Inform about how the storing of personal information will be conducted.
2. Present the participant with consent form and information letter. Empathize voluntary participation and right to withdraw at any time.
3. Request to audio-record the interview.

Part 2: Interview start, and audio recorder is switched on

About the interviewee/agency

1. What are the responsibilities of the agency you are working in and what does the everyday work in this agency consist of? → We ask about this in order to get a thorough understanding of how the agency works and how interaction within/between agencies work
2. How are the budgets in this agency organized? → This to get an understanding of how saved costs will be budgeted.

Pilot project 2013-2015

1. Did you/your agency participate in the pilot project initiated by Finance Norway in 2013-2015?
    1. What is your professional opinion and reflection of the pilot project in retrospect?
2. How was this project relevant for your agency/ your municipality?

After the pilot project

1. Concerning the pilot project, what has been useful for your agency in the aftermath (from 2015 until today)?
2. After the pilot project, have your agency taken any considerations to insurance loss data when planning/working on projects, measures or everyday tasks? → We are interested in all sorts of work where the insurance data has been used, in any way.
    1. Can you give any examples of measures/projects/everyday tasks related to surface water where this data has been used?
    2. Can you give any examples of measures/projects/everyday tasks related to surface water where this data is planned to be used?

Relevant measures

1. Can you elaborate on what these measures/projects/everyday tasks are? (the aim, functions, how they are/are planned to be implemented)
2. What was used as the foundation for decision making when the agency decided to implement these measures/projects/everyday tasks.
    1. Was the cost-utility evaluated? If yes, how?
    2. What other elements was evaluated?
3. What is/do you expect the results of these measures to be?

Advantages

1. What advantages has the measures (implemented and planned) had?
    1. What is your professional opinion about this measure/projects/everyday tasks?

    2. What advantages and disadvantages are related to this measure/projects/everyday tasks?
2. Have the measure/projects/everyday tasks given better accuracy regarding where climate change causes most/biggest damage.
    1. Can the agency see any saved cost related to this?

Part 3: Closing part

1. Short summary, focusing particularly on what we found to be most interesting in the interview**?**
2. Anything you want to add? (They can at all times contact us in case they come up with more information they would like to add)
3. Do you have any questions for us?

Part 4: Interview ends, and the audio recorder is switched off

1. The respondents often keep on talking and says relevant things → Pay attention to this.

General

1. Start the interview calm and create a pleasant atmosphere for the interviewee
2. Researcher should have an open and friendly body language
3. Be a good listener, only ask general questions
4. Let the respondent speak freely and not controlled by the interview guide.
5. Make small notes during the interview, these notes should be cleaned and debriefed as soon as possible.

Three types of notes for the researcher:

i. Actual happenings
ii. Personal reflections
iii. Execution of interview (did the interview guide work, personal skills, methodological issues etc.)

APPENDIX B: Information letter

Dear participant,

Project objective and background

This research project is part of a master thesis by two students from NHH Norwegian School of Economics. The thesis aims to contribute to the understanding on how insurance loss data can improve the climate preventive measures in Norwegian municipalities, and whether this can be economically beneficial. The study is limited to measures for surface water. The research project is supervised by Professor Stein Ivar Steinshamn and financially supported by Finance Norway.

What information we are gathering

In the interview we want to learn about your agency's work and responsibilities in general, and climate preventive work. We also want to study if and how insurance loss data has been considered when carrying out the tasks of the agency. Lastly, whether the access to insurance loss data has led to higher accuracy or reduced costs in your municipality.

About the research design

In order to gather this information, we wish to conduct interviews with employees in relevant agencies in the municipalities of Oslo and Stavanger. All interviewees have worked either with the pilot project or with climate preventive measures in the aftermath of the pilot project. Consequently, all participants have valuable insights which can enlighten this research project. To attain this information, the interview will be semi-structured with a majority of open-ended questions.

The duration of the interview is estimated to be around 45-75 minutes.

Audio-recording and storing of personal information

To ensure that all relevant information is captured correctly, we wish to audio-record the interview. All personal information will be handled confidentially, and only the two master students will have access to the personal information. The audio-recording will be stored on an external hard drive. Notes and transcripts with pseudonyms will be stored on an encrypted USB and all personal information on a second encrypted USB. All personal information will

be securely deleted after the conclusion of this research project. In the final report, all participants will be anonymized, and all referrals will be solely to the agency you represent.

Voluntary participation

Participation in this research project is voluntary, and you are free to withdraw from the project throughout the whole research period. All personal information will then be deleted in a secure way and no questions will be asked.

After the interview you will have the opportunity to receive a transcription of the interview, in which you are free to correct any mistakes. As long as you can be identified by the collected data, you have the right to access the personal data that is being processed about you and receive a copy of your personal data. You also have the right to send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data.

If you have any questions or want to exercise your rights, you can contact either of the students via email or phone. You can also contact the Data Protection Officer at NHH at personvernombud@nhh.no.

If you want to participate in this research project, please sign the consent form attached.

We will be most grateful for your participation. Thank you in advance for your help.

Kind regards,

Hanne Haavik and Lina Bratten Due

Supervisor: Stein Ivar Steinshamn

APPENDIX C: Consent from

About the research

This research project is a part of our master's degree at NHH Norwegian School of Economics. The thesis aims to contribute to the understanding on how insurance loss data can improve the climate preventive measures in Norwegian municipalities, and whether this can be economically beneficial. The study is limited to measures for surface water. The research project is supervised by Professor Stein Ivar Steinshamn and financially supported by Finance Norway.

I volunteer to participate in a research project by Ms. Lina Bratten Due and Ms. Hanne Haavik from the Norwegian School of Economics. I understand that the research design of the project aims to gather information about climate preventive measures in Norwegian municipalities with a basis in insurance loss data.

1. My participation in this project is voluntary. I have the right to withdraw and discontinue participation at any time.
2. I have the right to decline to answer any questions or to end the interview at all times.
3. Participation involves being interviewed by researchers from NHH Norwegian School of Economics. The interview will last approximately 45-75 minutes. Notes will be written during the interview.
4. I understand that the interview may be audio-recorded.
5. I understand that the researchers will not identify me by name in any reports using information from the interviews, and that my confidentiality as a participant will remain secure. Subsequent uses of records and data will be subject to standard data use policies.
6. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction.
7. I have been given a copy of this consent form.

My name (in block letters):

_____

My signature: Date:

_____ _____

Signature of the researchers: Date:

_____ _____