SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

ASSESSING THE CURRENT NATIONAL FLOOD EARLY WARNING SYSTEM IN NORWAY AND MAKING RECOMMENDATIONS ON CHALLENGES RELATED TO PREDICTIVE UNCERTAINTY

By Grant Reagon Son

Supervised by
Dr. Salvatore Fava PhD

A DISSERTATION

Presented to the Department of
Natural Science
program at Selinus University

Faculty of Life & Earth Science
in fulfillment of the requirements
for the degree of Doctor of Philosophy
in Natural Science

2022

Abstract

In the first chapter of this dissertation the research problem and background has been identified. The aim of this research paper has been created so that the proper purpose of the research paper can be developed. In this research paper, proper hypotheses about the research topic have been generated so that the finding of this research paper is able to meet the demand of the people of Norway. In the second chapter literature review has been conducted, the most vital chapter in this research topic, in this research paper all the data that are associated with this topic are collected. Furthermore, the opinion of different researchers has been collected and studied in a proper manner so that all the gaps and measures against the gaps can be analysed in a proper way. In the third chapter researcher has focused on adopting different steps to complete the research paper in much effective manners.

Acknowledgement

The research study has provided me with a positive experience in my life. I would also thank my family members, without whose encouragement, it would have not been possible for me to acquire motivation and financial support. The moral support I acquired from them encouraged me to complete the research accurately.

Declaration

By submitting this research electronically, I, Grant Reagon Son, declare that the entirety of the work contained therein is my own, original work. I also confirm that this work has not been submitted to any other institution for qualification.

…….

Grant Reagon Son **27 Jan 2022**

Electronically signed

Table of Contents

List of Figures

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Riverine floods have huge social consequences across the globe, which includes crops destruction, loss of lives, property damage and increase in waterborne diseases. It results in huge economic loss, which requires proper management for stimulating the economic progress in the country. Organisation involved in economic development and cooperation plays a key role in managing flood risk and increasing public awareness (OECD, 2018). It is seen that floods disrupt the drainage system of the flooded area and overwhelm the sewer system. In addition to this, it is found that severe flood in the country is the result of destruction of huge buildings. The building destruction releases array of several toxic materials, such as gasoline, paints in the atmosphere, thereby degrading the quality of air.

An extensive Literature Review investigated that flood causes destruction of agricultural lands as the crop gets submerged into the water, resulting in huge economic loss for farmers. Local people too suffer from the loss of agricultural land as they face difficulty in getting food for their survival. Flood also reduces the biodiversity level, food, habitat potential in ecosystem. It is noticed that flood stands as the reason for sedimentation and riverbank erosion (Krøgli et al., 2018). Turbidity and sedimentation result in growth of phytoplankton and algae, which jeopardize the quality of water. Hence, the local people also face difficulty in getting safe drinking water for satisfying their thirst. Not only this, the research further explores negative impact of flood on businesses and transport infrastructure.

Norway is currently under spotlight as highlighted by the need of EWS for reducing the impact of flood. The flood forecasting is considered as the integral and important part of flood warning, which is beneficial for providing timely and accurate warning. According to Pappenberger et al., (2015), the system of flood forecasting helps provide vital early information flood to international and national authorities of civil protection. The information gathered from early warning system is used by the authorities of civil protection to make decision for avoiding upcoming floods. It is considered as the important part for the management of flood risk for protecting property, citizens and infrastructure. The actions for flood precautions include closing or evacuation of floodgate. Krøgli et al., (2018) added that EWS (Early Warning System) comprises of four different elements, which includes warming and monitoring services, risk knowledge, communication and dissemination. It is important to mention that effective forecasting

is done through different types of EWS, which includes Alarm, Warning and Forecasting. The prediction of Alarm EWS accuracy is high, which helps in detecting the parameters of hazard event to initiate the alarm automatically. Warning EWS helps in detecting significant changes that would occur in environment due to riverine flood. Experts use Forecasting EWS for analysing sensor data for forecasting danger level of regions that are communicated in bulletin. Therefore, it can be said that the goal of effective forecasting of riverine flood is to reduce economic as well as human losses.

The earlier researchers have highlighted the negative impacts that are caused due to riverine floods but have failed to show the need for EWS. The current study sheds light on the importance of EWS for reducing the risk of riverine flood in Norway. The research would make use of both primary and secondary source for providing deep insight into the research topic. The participants selected in the research were the local people of Norway and 3 meteorologists. The present research further outlines the framework for meteorologist for enhancing safety procedures for controlling flood in Norway.

The effects of natural disasters are sudden as well as terrible, therefore knowing about the probability of occurrence of the flood is significantly important. Natural calamities usually result in severe damage to the environment; however, the effects of most of them cannot be predicted. Therefore, damages are even greater in the case of natural disasters. Flood is one of the most common natural calamities and they have a substantial number of consequences for the environment (Dyrrdal et al. 2015). Flood affects both the individuals and the communities. On the other hand, riverine flooding has economic social as well as environmental consequences. The effects of riverine flood, both negative and positive, change immensely depending on the extent and location of the flood. In addition to this, it can be said that the value and vulnerability of the natural environment around the area of flood has significantly different effects.

There are mainly three kinds of floods, among which riverine flood is significantly important. Riverine flooding is also called fluvial flood. This flood refers to the incidence of excessive rainfall for a longer period, which causes a river to exceed the capacity of it. Riverine flooding can happen as a result of ice jams and heavy snow. Knighton et al. (2018) suggested that the damage caused by a riverine flood can be considered as widespread as the overflow affects smaller downstream of rivers. It is often seen that the dams and dykes are broken by riverine floods

and they tend to swamp the nearby areas. There are two primary types of a riverine flood, such as overbank flooding and flash flooding. In the case of Overbank flooding, water increases overflow through the sides of the stream. This is a fairly common kind of flood in the case of a riverine flood.

On the other hand, flash flooding can be intense and they are generally associated with streams of higher velocity. In the case of an existing river, flash flooding is considered to be detrimental due to the high force of water (Li et al. 2016). It is often noticed that debris being hurt for the flow. There are certain adverse effects of the riverine flood which can be felt in any part of the globe. The most important consequence of riverine flood can be the loss or lives as well as property. On the other hand, another significant impact of floods can be the loss of lives. Similarly, another detrimental effect of a flood can be the financial loss for a country. Therefore, the reduction in production and purchasing power can be seen. In Columbia, flooding has accounted for more than 40% of all the destroyed dwelling (Oecd.org, 2016). On the other hand, riverine flooding can have a severe impact on the minds of the individuals; their psychological stability is disrupted by the destructive effects of floods.

In addition to this, it can be also added that the occurrence of flood hinders development and economic growth in an economy. It is also important to consider that the political implications of floods are not favourable due to the fact that inadequate relief operations can create resentment among the flood-affected people (Westerberg et al. 2016). It can be further added that flooding causes long term as well as short term losses. The most significant loss includes the loss of lives, in the US, approximately 100 people died annually for floods (Nrdc.org, 2019). It can be further added that flood can have destructive effects on property. It can be further added that property damage include bridges, roads, bridges, utilities. Repair of public assets and infrastructure cost has contributed to an estimation of $48.6 million from 1998 to 2014 (Nrdc.org, 2019).

It can be added that between 2007 and 2017, the NFIP or the National Flood Insurance Program paid an amount of 42.9 billion per year for covering losses related to flood (Nrdc.org, 2019). It can be further added that, in some of the individual years, the cost is even higher than the average. Another significant aspect of flooding can be that it increases disease and contamination. The water of flood can help in the contamination of several diseases as they carry toxic chemicals,

raw sewage and wastes from factory farms (Liu et al. 2018). In the season of a flood, drinking water can be highly contaminated with pollutants and can cause infections in the eye, skin and ear. Furthermore, it can be added that the worst affected in the case of a flood can be people from the lower-income group, people from minority and elderly.

It is also important to consider that a lot of people do not have flood insurance which can be a significant issue in the times of flood. Floods can create issues in transportation, reallocation and financial issues.

Floods can be regarded as one of the most familiar kinds of natural hazards that are faced by the entire world. Therefore, it is imperative for a country to know about the probability of a flood in order to avoid the consequences of it. It can be further added that the development of flood is not instant in every situation (Torgersen et al. 2017). In some cases, riverine floods can develop slowly however; flash floods are more frequent and rapid. Therefore, it can be said that flood forecasting can be considered as one of the most significant needs in the present era. Alfieri et al. (2018) suggested that the process of forecasting floods comprises the estimation and prediction of the magnitude, duration and timing of flood. The forecast is primarily done with the knowledge of the characteristics of a river basin. The need for flood forecast is also essential for preventing destruction to human life, environment and properties. The consequences of riverine floods are destructive and widespread, therefore, the prediction of floods can help countries to know about the potential risks that the country can face.

Norway is a country with increasing chances of riverine flood and the country is quite susceptible to floods. The torrential rains and an increased temperature in the country can contribute to the rapid snow melting in the western parts of Norway. Flash flooding is quite common in the country, therefore people are forced to evacuate and floods in the country causes a significant amount of damage, especially in valley areas. In 2018, a barn was completely swept off from its foundation and moved up to 50 meters (Newsinenglish.no, 2018). Therefore, it can be said that the effective forecasting of a riverine flood can significantly reduce the effects of a riverine flood. It can be added further that predicting floods from earlier also enables people to decide their action accordingly. It can also help the Government of Norway to plan their respective steps that can be taken for better flood management.

It is also important to consider that a successful prediction of the flood can increase the chances that the damages will be less. However, an ineffective prediction of the flood can create issues for people of the country as well as the Government. The current research aims at assessing the present early flood warning system in Norway and it also attempts to suggest remedies for the challenges of predictive uncertainty. The most significant challenge of predictive uncertainty can be the ineffectiveness. An ineffective prediction can create a lot of challenges for the Government. Assessing the early warning system for a flood can increase the effectiveness of the prediction; therefore, the research can shed light on that aspect.

1.2 Problem Statement/Thesis Statement

Norway can be considered as a vulnerable country for floods. Therefore the implementation of an early detection program can be significantly important. The current research attempts to evaluate the early warning system in Norway and it also attempts to suggest recommendations for the challenges of predictive uncertainty. The most important aspect related to predictive uncertainty can be the issue of ineffectiveness. On the other hand, it can be added that the challenges such as increased cost, psychological aspects are also there. The current research tries to find out solutions to the challenges of predictive uncertainty. It also tries to evaluate the early warning system for flood in Norway and tries to suggest recommendations. Assessing the early warning system in Norway can be challenging due to the fact that, the aspect is fairly new and it is problematic to assess. On the other hand, the challenges of predictive uncertainty are not easy to assess, therefore, suggesting recommendations can be challenging. The current research attempts to evaluate the early warning system for flood and the shortcomings of predictive uncertainty for Norway in order to suggest areas of improvement.

1.3 Aim & Objectives

The current research aims at evaluating the national flood early warning system present in Norway and also attempts to find out the shortcomings of predictive uncertainty.

Following four objectives have been set for the research,

- To evaluate the effectiveness of flood early warning system in Norway

- To point out the factors that affect the early warning system
- To find out the challenges of predictive uncertainty
- To recommend methods that can reduce the shortcomings of predictive uncertainty

1.4 Research Questions

In the current research, there are a few research questions, such as,

1. How effective is the flood early warning system in Norway?
2. What are the factors that affect the flood early warning system in Norway?
3. What are the challenges faced by predictive uncertainty?
4. What are the ways to reduce the shortcomings of predictive uncertainty?

1.5 Research Hypotheses

H_0: The national flood early warning system of Norway is not significantly effective.

H_1: The national flood early warning system of Norway is significantly effective.

1.6 Significance and Scope of Study

Norway is a country that experiences a significant amount of rainfall in almost all parts of the country. In the coastal areas of the country, most of the amount of rainfall can be seen. In Norway, there are certain disadvantages of heavy and unpredictable rainfall. One of the most crucial effects of rainfall can be the power blackouts in a vast area of the country. Heavy rains in most times are accompanied by lightning which causes power blackouts (Graziella et al. 2015). In addition to this, it can be added that with persistent, the probability of flood increases and this, in turn, increases the chances of a power blackout. Therefore, power blackouts in times of flood worsen the situation in the country. On the other hand, floods in Norway also cause the streets, sewerage and houses to be clocked.

Owing to this situation, the sewage systems are overwhelmed with the excessive amount of water and also increase difficulties for the normal people. In this case, mission manhole covers can create a lot of issues. Additionally, flooding causes transport-related difficulties. In Norway, excessively heavy rainfall washes off the roads as well as the bridges which in turn cause transportation problems. Piciullo et al. (2017) stated that most vehicles are stuck on the roads and they require mechanical help due to the wet weather in the country. Additionally, floods are also

detrimental to the production of farms. In the case of flat farmlands, excessive rainfall can cause flooding of fields and homes. It can be further added that excessive rain can be immensely harmful to crops. In Norway, the incidence of excessive rains can be seen in almost all areas of the country, therefore, they introduced a flood early warning system that can be helpful for the people to know about the potentiality of flood in the near future.

The service was introduced in 1989 by NVE or Norwegian Water Resources and Energy Directorate (Thiebes & Glade, 2016). In 2009, the directorate also introduced a national warning service in order to help the people from rainfall-induced areas. The initiative of the government to announce a forecasting service was taken in order to reduce the risk of landslide and to improve flood situations as well. The main goal of the service was to reduce the financial and economic losses caused by the flood. The program was introduced in 2013 and it was a joint venture by different government departments of the country (Devoli et al. 2018). The service attempted to perform a hazard assessment in every day of the week and it also depicts the expected probability of a flood in regional areas. In addition to this, it can be further added that the service stays operative in all seven days of the week through the course of one year.

The evaluation and updates about potential flood are published in their warning portal. The service attempts to analyse the effects of potential flood in the coming three days by which they are able to create awareness among the population of the country. In Norway, the service attempt to deliver continuous updates about the present situation as well as the situation that can be expected in the near future. It can be further added that the national flood early warning system is conducted with the help of Flood Forecasting service. Kalsnes et al. (2017) stated that the service provided by the system depends on five basic attributes, which are, flood and landslide historical database, forecasting models of hydro-meteorology, automatic meteorological and hydrological stations, an efficient group of forecasters and return periods. In the current research, the early warning system related to flood in Norway has been tried to be evaluated.

In order to know about the effectiveness of an early warning system, it is significantly important to have knowledge about the effectiveness of the system. On the other hand, an effective warning system can help the people of the country with a substantial amount of benefits. An effective early warning system in Norway can help people to be aware of the potential flood. An

efficient warning system can also help the people of the country to receive a clear picture of the effects of the flood. Additionally, it can be said that these kinds of warning systems help the country to know about the potential costs that the country can face in the occurrence of a flood. It can be further added that an effective warning system can also enable people to find out effective strategies to cope up with the adverse effects of the flood.

Therefore, it can be added that a forecasting system needs to be effective in order to help the citizens of a country. On the other hand, an inefficient warning system can create a lot of issues in forecasting the potentiality of a flood. An incorrect forecast by the system creates tension in the minds of the citizens. It can be further added that an incorrect forecast can induce people to take unnecessary steps which can increase financial costs. Additionally, it can be said that an incorrect forecast can compel the Governments of the country to take steps that are not required currently. It can be further than weather forecasts cannot be effective in most of the cases, therefore, there is always a chance to experience incorrect forecasts. Therefore, in order to have a better understanding of the national flood early warning system in Norway, it has been assessed in the present research.

The effectiveness of the assessment also has succeeding effects; therefore, an evaluation of the system is significantly important. On the other hand, in the case of predictive uncertainty, there are certain aspects that should be taken into consideration. Predictive uncertainty can be described as the possibility of occurrence of an observed variable of interest dependent on al the available data and information (Oppikofer et al. 2016). An early warning system for a flood can increase the chances of uncertainty in prediction. It can be further added that predictive uncertainty can be significant in the case of weather forecast due to the fact that weather forecasts cannot be accurate in most of the times. In the case of predictive uncertainty, the most vital aspect of the concept can be the fact that it is uncertain. The surety of a prediction cannot be assumed in this case, therefore there are potential risks in predictive uncertainty.

It can be further added that due to the aspect of inaccuracy is related to the aspect of predictive uncertainty, it can create unnecessary stress and anxiety among the people of the country. It can be further added that people can have unnecessary expectations about future outcomes which cannot occur. A weather forecasting system can predict that there will be no

rainfall however it can be inaccurate. This can cause a lot of difficulties in everyday life. However, there are certain challenges that impact the aspect of predictive uncertainty. Additionally, it can be said that uncertainty in prediction can incur a substantial amount of cost which can be inessential (Sättele, Bründl & Straub, 2015). In order to know about the challenges of the concept, it is significantly important to know about the disadvantages of the concept. In the present research, the challenges of the concept of predictive uncertainty have been attempted to be addressed.

In the current research, the concept of predictive uncertainty has been discussed based on the challenges faced by the concept. In order to employ an effective weather warning system, a significant level of cautiousness is needed. Additionally, it can be said that the challenges of predictive uncertainty and actions related to their mitigation can have a significant impact on the aspect of weather warning systems. An efficient flood warning system can have positive impacts on the economic, environmental as well as social aspects of the society. Therefore, the effectiveness of the warning system needs to be evaluated. In the current research, the factors affecting the early warning system for flood has been attempted to be discussed. Therefore, it can be significantly important for the people related to weather forecasting as well as the general people. On the other hand, the research attempts to recommend a few ways by which the warning system for flood in Norway can be improved.

Norway is a country which faces a substantial amount of issue due to its excessive levels of rainfall in all parts of the country. Therefore, in order to reduce the harmful effects of floods, and efficient flood forecasting system has been designed. The effectiveness of the existing warning system in Norway is dependent on a few factors. On the other hand, there are certain areas in which the warning system can be improved. On the other hand, it can be further added that an efficient weather system ensures that the prediction will be correct, therefore, it can be helpful for the people of the country to experience better outcomes. Additionally, it can be said that flood forecasting can be regarded as a significant aspect for Norway. Therefore, it can be useful for predicting the potentiality of flood in the coming future. Therefore, it is also significant to assess the early flood warning system in Norway.

Therefore, it can be stated that the present research can be substantially important for assessing the current warning system for flood in Norway. It can also help the governments of the

country to find ways for improving the warning system. On the other hand, it can be further added that the research attempts to find out the challenges that are prevalent for predictive uncertainty. Prediction in any fields help people to assume the outcomes in the coming future however, there is always a factor of uncertainty related to it. Therefore, it can be said that the current research can be significantly important for further research in the same field and it can also act as an important source of information for further research. The research can help to assess the flood warning system in Norway and challenges related to predictive uncertainty which can be helpful for conducting further research related to the field of forecasting.

1.7 Chapter Plan

The current research paper has been divided into the following chapters.

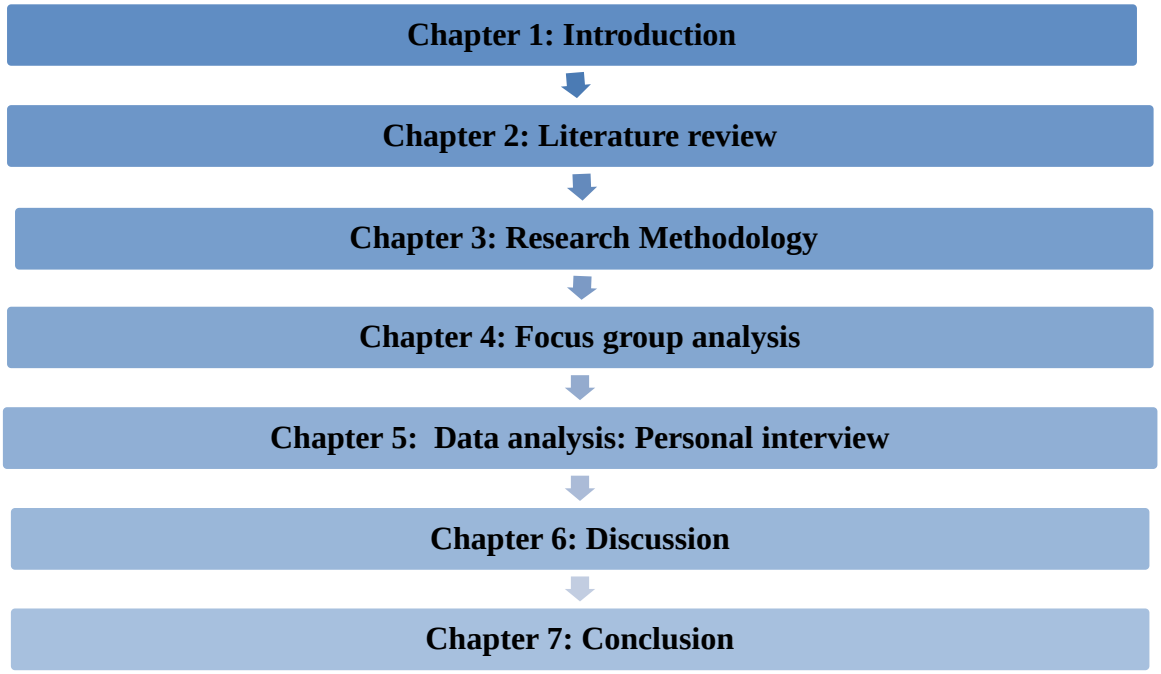

Figure 1.1: Chapter Plan

In the first chapter, the section of the introduction has been discussed in which the background of the research as well as the research questions and objectives have been described.

The second chapter contains the literature that has been reviewed for the research. The chapter includes trends and causes of flood in Norway and early flood management initiatives in

the country. This chapter also entails the challenges that are faced by the forecasting system in the country.

The third chapter entails the research methodology and discusses the process of data collection and analysis with respect to the context of the research. The chapter has been summarized by the section of summary.

The fourth chapter of the research has attempted to carry out a focus group analysis based on qualitative findings.

The fifth chapter attempted to analyze the qualitative findings and also performed a personal interview.

The sixth chapter aims at discussing the findings of the research effectively.

The seventh chapter has attempted to conclude the entire research with answering research questions and also suggesting recommendations. The section has also pointed out the limitations of the research as well as the future scope.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A flood can be considered as one of the most harmful experiences of natural calamities. Escalated level of flood in any country can significantly impact the lives in the country. In Norway, there is a significant potential for flood throughout the year. In spring, there is a chance of snowmelt flood. The country experiences a tendency of occasional flood in autumn depending on the frequency of rainfall. Therefore, the country has introduced the National Flood Early Warning System in order to avoid the risks of floods. The system of the early warning is a form of predictive analysis. The system attempts to predict the potential for the occurrence of a flood. The current section of the dissertation attempts to analyse the different aspects related to the early flood warning system as well as predictive uncertainty in Norway. The section attempts to analyse the trends and scenario of floods in Norway.

Furthermore, this section also attempts to discuss the causes of a flood as well as techniques of Early Flood Management in Norway. In addition, government initiatives regarding flood management have also been discussed. Requisites of early warning systems and challenges of Norway's early warning plan has also been attempted to evaluate. In addition, the relevant techniques for the early warning system for ensuring accuracy have also been discussed.

2.2 Trends and Scenario of Floods in Norway: Emphasis on the frequency of floods and major incidents

The occurrence of the flood can be considered as a frequent phenomenon in Norway. The country has experienced a significant number of floods over the years. River floods or riverside floods are considered to be one of the most common types of river floods predominant in Norway. The risk of river floods in Norway is not uniform; however, the country has experienced several instances of river floods over the years. Owing to the regional variations in landscapes as well as the climates in Norway, incidence of river floods cannot be predicted for a particular period of time (Yan *et al.,* 2019). Riverside floods mainly have the characteristic that it can happen at any point of time of the year. In addition, the floods happening in spring is most of the times depending on the snowmelt in the country. However, the intensity of riverine flood is mostly felt in all parts of the country.

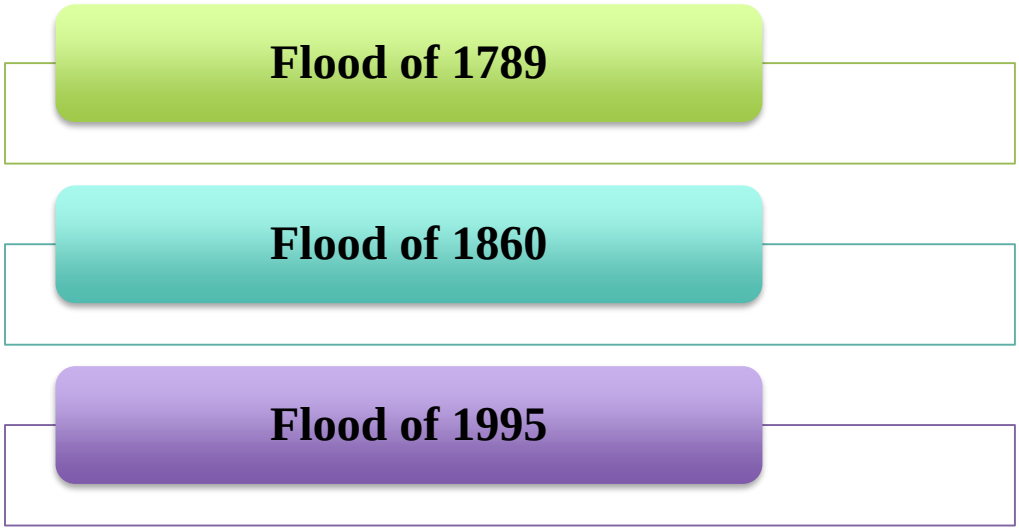

Figure 2.1: Major floods in Norway

(Source: Yan *et al.*, 2019)

The country has experienced that the floods from spring melts have also shown that in Northern and Southern parts of Norway, it happens at different times. However, there are a few areas that are prone to river floods in Norway (Hailegeorgis & Alfredsen, 2017). The western, as well as eastern sides of the country are regarded as prone to riverine flood rather than the other areas. In addition, the mountainous areas are considered to have a lesser amount of risks of the riverine flood. Norway also has a wide area having low lying lands which have a long river running through them. In addition, there is also a substantial amount of coastal lands in the country which has which are 800 to 1300 meters above the sea level (Romanowicz *et al.*, 2016). The trends in flood for Norway show some intriguing facts about the incidence of flood in the country. Historically, there have been a significant number of floods that have happened in the eastern part of Norway.

Among these floods, most of them were intensive and devastating. Large quantities of snowmelt water caused the situation of flood in these areas. The snow melting has also been accompanied by the rapid process of melting as well as high temperature which can be considered as the main reason behind the incidence of floods. It was seen that major floods in eastern Norway happened in 1789, 1860 as well as 1995 (Matti *et al.*, 2017). These floods are considered as some of the major floods that happened in Norway as well as Europe. Emmer (2018) suggested that the

flood of 1789 was regarded as the most devastating flood of all time in the history of floods in Norway. Autumn floods are also common which are prevalent due to the high precipitation and increased temperature. In September of 1962, Norway experienced a detrimental flood which caused the damage of NOK 1 Million at that point of time (Kvisvik, Paasche & Dahl, 2015).

In the Western part of Norway, it is seen that depression in polar front from the Atlantic accompanies with the mountains which lead to an increased level of precipitation rather than the eastern parts of the country. Rivers existing in the western parts of Norway also have flooded in spring. The most intense flood of spring mainly occurs from the late autumn until January which is due to the freeze periods at that time. This climate is followed by a season of high temperature which induces heavy rain in Norway. Engeland *et al.*, (2017) suggested that the most significant flood at this part of the country was the flood of 1743 which resulted in rock falls and landslides which damaged more than 500 farms in the country. The impact of riverside floods can be considered as less intensive in Norway compared to the other floods. However, river floods tend to cause substantial damage to livelihoods and infrastructure.

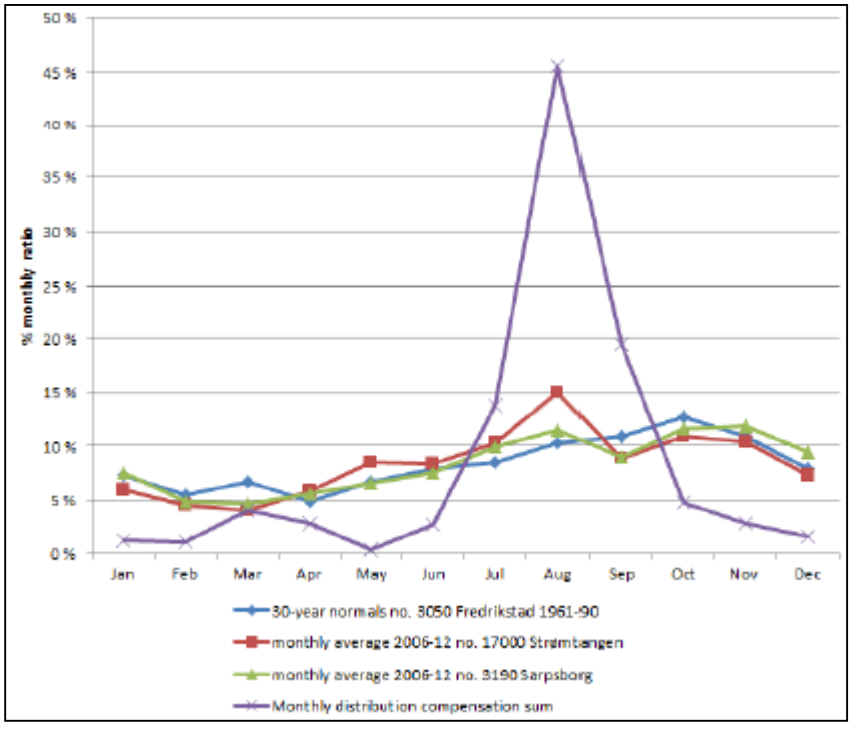

Figure 2.2: Distribution of precipitation in Norway

(Source: Torgersen *et al*., 2015)

The country has experienced more than 600 major river floods over the years and the number of deaths has ranged from 1 to 75 for river floods (Kundzewicz, 2019). The low death rates in the case of riverside floods can be due to the fact that most of the river floods develop slowly and they take a significant amount of time after raining or melting of snow. It generally gives people enough time to evacuate and prepare for the upcoming situation. Furthermore, the less population and few numbers of towns in the floodplains also contribute towards the avoidance of intensive fatalities related to the flood. Over the last century, especially at the end of the 1970s, there has been a significant change in the climate of Norway. The rate of precipitation has increased in all parts of the country by 18% (Fouinat *et al.*, 2017). In addition, the intensity, as well as the frequency of the events related to heavy precipitation, also increased substantially.

These events have been seen in all parts of the country; however, the intensity of the events has been largely seen in Western and Southern parts of the country. In addition, the entire amount of snow in the winter, which is named as SD or Snow Depth as well as SWE or Snow Water Equivalent, has substantially increased over the last few years in specific areas such as colder areas and northern regions (Blöschl et al., 2017). This increase has been regarded as the contribution of Global warming which is a matter of grave concern in the current era. A few inland and areas with high altitude can still accumulate more amount of snow in the winter season until the end of 2050 (Sauquet & Lang, 2017). On the other hand, other parts of the country are mainly regarded as having a warmer climate than the northern parts. These areas are expected to have a long term trend in SWE and SD. This suggests that in the near future, the country is expected to have intensive floods in regions of higher altitudes and larger areas.

The analysis of peak flow discharge suggested that the country has experienced a significant increase in the frequency of flood for the future. Since 1962, the western and southern parts of Norway were expected to have more frequency of rainfall due to peak flow discharge. In these areas, events related to rainfall have caused a significant increase in the frequency of rainfalls. In addition, the incidence of rainfall in other parts of the country has also decreased significantly such as the northern part. In this region, a major reason behind the decrease in the

frequency of flood can be considered as a reduced level of snowmelt in the respective region. In the present era, the frequency of rainfall in Norway is considered to be the main contributory factor to the frequency of floods. Increased levels of rainfall in the country also increase the level of flood in the country.

The contribution of snowmelt water has significantly reduced for frequent floods. In addition, in the case of Norway, the timing of rainfall has also changed significantly. These various changes in the climate of Norway have been considered as contributed by climate change. In addition, the country also experienced a substantial level of importance of rains in the case of floods (Berghuijs *et al.,* 2019). Over the years, snowmelt has been regarded as one of the most important factors behind the floods in the country. However, in the current era, the focus has shifted towards rainfall as the main reason behind rainfall. In areas of catchments with high altitude, precipitation is likely to cause the most amounts of snow melts as well as floods in these areas. In addition, trends in the peak flow analysis are considered to be more methodical and pronounced rather than the range of peak flow events.

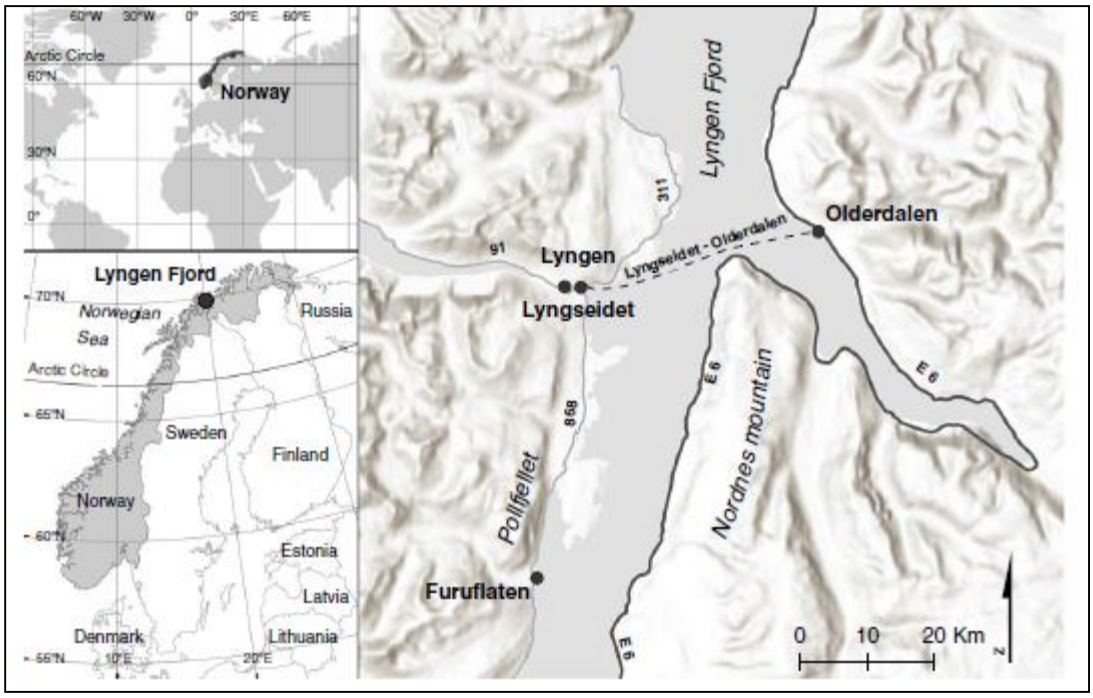

Figure 2.3: Location of the fjord Lyngen

(Source: Goeldner-Gianella *et al.,* 2017)

On the other hand, in the case of rainfall related floods, changes in the level of precipitation are stronger than the changes in the intensity of precipitation in Norway. In the country, there are also some instances of flash floods and these floods also cause damages to the lives of the people in the country. In May 2013, the country experienced a devastating flood which was considered to be the most intensive one from the last 50 years. This flood was largely contributed by the substantial frequency of rainfall in the country. Romanowicz *et al.*, (2016) stated that in this flood, more than 300 people in different parts of Norway were forced to evacuate. Railway lines were worst affected in the flood and they were also obstacles in the roads of the country. In some parts of the country, there were natural landslides. In August of 2014, Norway also experienced a series of flash floods in different parts of the country.

In some places, the height of floodwater was more than 1 metre. The main incidence of the flood focused on the south-west parts of Norway. Pall, Tallaksen & Stordal (2019) stated that the town named Vigrestad was the most affected area in the floods of 2014. The advent of climate change can be considered as the major contributing factor to the incidence of flood in 2019 (Chen, Bruland & Li, 2018). Coastal areas of Norway were always prone to flooding, however, in the present era, the chances of compound flooding in the Northern parts of the country.

2.3 Causes of Floods in Norway

Norway can be considered as a country which is prone to have a significant number of floods over the years. All parts of the country are not susceptible to floods all the time, however, due to the seasonal change, some part of the country is considered to be more prone to experience floods in some times. There are several kinds of floods that are more frequent in Norway such as floods due to rainfall, flash floods, floods due to snow melting (Carrivick & Tweed, 2016). Therefore, it can be suggested that there are several causes and factors that can be considered to be the reason behind extensive floods in all parts of the country. In Norway, there are several reasons behind the incidence of floods such as rain cyclones, ice melting and increased precipitation and climate.

2.3.1 Rain Cyclones

Rain cyclones can be considered as the most significant causes behind the extensive level of flood in Norway. There is a substantial level of incidence of rain cyclones in the country which

is considered as the most significant reason behind the frequent incidence of floods in the country. Rain cyclones are regarded as one of the most important contributors to the level of floods in the country. Cyclone can be regarded as an area with low pressure in which the direction of wind flow is counter-clockwise (Ntajal *et al.*, 2017). Cyclones bring precipitation and clouds which in turn increases the potential for rain in an area. Cyclonic rainfall is also caused by activities of the cyclone and it often happens along the fronts of the cyclone. The climate of Norway can be regarded as much milder than neighbouring countries in the area. The western part of the country is considered to be wilder than the other parts.

However, there is a significant level of rainfall in all parts of Norway which causes most of the floods. The average level of rainfall is 774m which is significantly higher (Forecast.weather.gov, 2019). Therefore, the frequency of floods related to rainfall can be regarded as one of the most significant climate issues in the country. In May 2013, Norway experienced a devastating flood and it was caused by heavy rainfall in the country (Hodgkins *et al.*, 2017). Flood warnings were issued earlier; however, there was not a significant level of awareness among people. The rise in floodwaters was assumed to be the highest in the last 50 years. The issue of heavy rainfall was also accompanied by a substantial level of snowmelt in the country. In addition, the floods in August 2014, was also contributed by the increased level of rainfall in south-western Norway (Zhang et al., 2015). All the connections had to be cut off in some parts of the cities and in or out access roads were blocked for hours by the floodwater.

Railway services were also significantly affected in Vigrestad and Ogna. In addition, the municipality of Hå was considered to experience 60mm of rainfall in a day which is significantly higher. In October 2014, Norway again experienced a chance of heavy rainfall and warnings were issued for the projected floods. A prolonged period of thunderstorms and rainfall was regarded as a contributory factor to the rainfall in the country. In the presence of rain cyclone, air converges to a centre of low pressure. In addition, this increasing motion tends to generate precipitation and clouds. Gundersen, Kaltenborn & Williams (2016) suggested that the various types of precipitation cause different types of climatic activities such as thunderstorm and rain. Mainly the incidence of rain is considered to be more prevalent in summers and thunderstorms are more common in winters.

2.3.2 Ice Melting

Melting of ice can be considered as another significant cause behind the high levels of rainfall in all the parts of Norway frequently. Snowmelt can be considered as the water as well as runoff as the result of the melting of snow. Increased temperature melts snow and ice. This creates a situation of excess water and it appears rapidly. This, in turn, causes flooding and this is quite prevalent in all parts of Norway. In the time of spring, most of the floods happen due to thawing of snow as well as heavy rains. The climate of Norway is strictly determined by the seasons of the country. In Norway, there is a substantial trend of timing-based floods has been identified. Floods in Norway at the time of spring are generally caused by the melting of snow. In the current era, there is a significantly large percentage of annual precipitation that falls as snow.

Snowmelt is largely a climate-controlled factor which regulates the state of hydrology in almost all the countries. Rapid snowmelt can cause severe flooding due to its incidence of frozen soil. Higher levels of snowmelt also cause erosion in some areas (Torgersen *et al.*, 2015). In addition, freezing of soil can drastically reduce the infiltration capacity of the soil. Ice tends to block the soil pores which results in an increased level of runoff events rather than insignificant snowmelt events. Increased level of climate change can be considered as another significant factor behind the frequent events of snow melts in the country.

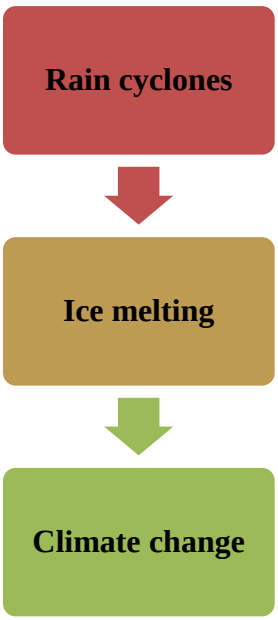

Figure 2.4: Main causes of floods in Norway

(Source: Influenced by Gundersen, Kaltenborn & Williams, 2016)

2.3.3 Climate change

Climate change can be regarded as a reason behind several problems related to climate and it is a matter of great concern in the current era. Climate change can be also called as global warming and it is considered as one of the most effective reasons behind climate change. The situation of climate change refers to the increase in temperature on earth. Climate change is said to be the consequence of different human activities. Increased use of fossil fuels releases high levels of carbon dioxide as well as other gases in the climate which in turn increases the temperature of the surface of the earth. The gases released by fossil fuels seem to be increasing the heat with the atmosphere which adversely affects the ecosystem (Torgersen *et al.,* 2017). This also contributes to the increasing sea levels and further contributes to the severe weather issues such as floods and droughts.

For the weather in Norway, it is expected that the climate of the country can be significantly impacted by the issue of climate change. Therefore, the intensity and frequency of rainfall due to snowmelt can further increase. It should be also considered that climate change not only causes heavy rainfall (Goeldner-Gianella *et al.*, 2017). It also causes an increased amount of warmer rain which induces the process of snowmelt. Therefore, it can be further added that due to climate change, there can be different issues in the climate. Over the years, Norway has experienced several significant floods, however, climate change has not been considered as the reason behind the aspect of climate change. However, it can be suggested that there are several issues that are related to climate change and must be considered in order to know about the climate. In addition, most of the countries are currently facing the issue of climate change as it is a serious matter of concern. There is not enough evidence to prove that climate change has caused floods in Norway over the years. However, frequent flash floods and events of snowmelt can be regarded as one of the most significant consequences of climate change. Floods in Norway and other parts of Europe have become quite prevalent for years. Climate change can be considered as a significant reason behind this issue.

2.3.4 Other conditions related to the floods in Norway

Norway has a tendency of getting occasional flood due to autumn, the National Flood Early warning system is focused on providing a good back up to the country. Providing early analysis can help the Norway government to take some quick measures against the flood. The country has

a major coastal area of about 800 to 1300 metres the long river that is lying within the country. Norway had experiences 600 major river floods and this statistic highlights that the death range in the country varies from 1 to 75 per flood. At the end of the 20 th century, the climate of Norway has been changing and in modern entrance the precipitation level in the country has increased.

Figure 2.5: Catchment areas in Norway with gauging stations

(Source: Chen, Bruland & Li, 2018)

An increasing trend in the streamline and the magnitude of timing creates an annual flow whereas the near natural catchment, 30 % of the Norway precipitation is occurred due to snow. Irrespective of these Engeland *et al.*, (2017) commented that the continuous change in climate will create an issue as this increases the rate of contribution in increasing the level of participation. Furthermore a post published by the Climate Department of Norway highlights that the Scandanian River has no statistical flow and the peak often discharge due to natural catchments. The precipitation level in the Scandanian River has been changing a continuous level whereas in the winter the level of precipitation increases up to 14.6%. This short duration of precipitation increases the level of precipitation. This increased number of precipitation often results in flash flood.

Rise in level of precipitation in the county increases the rate of rainfall, It has been often found out that the rate of flood occur most in the eastern region compared to other regions. On contrary to this, a flood warning has been issued in the southern region of Norway highlighting that this flood will break the records of both flood in ten years (Norwaypost.no, 2017). Sagabekken the river located in Norway has broken its banks due to high rain. Irrespective of this the landslides and damages of the roads has been creating an issue for the Fire and Police Department of Norway. Irrespective of this the increasing number of ice melting due to high rain often increases the

tendency of flood in the Norway. This high flood river in the banks of Sagabekken is about to 20-30 millimetres if rain that has been raised in a very short time. From this information it can be stated that that water level in the Norway Domestic River are quite high, and for this reason less number of precipitation often tends to create flood. The Norway flood has been occurring usually in the autumn season, due to high precipitation level in winter the water freezes into snow. In the summer season the snow melts into water, therefore in the autumn season people of Norway can experiences various natural calamities such as floods.

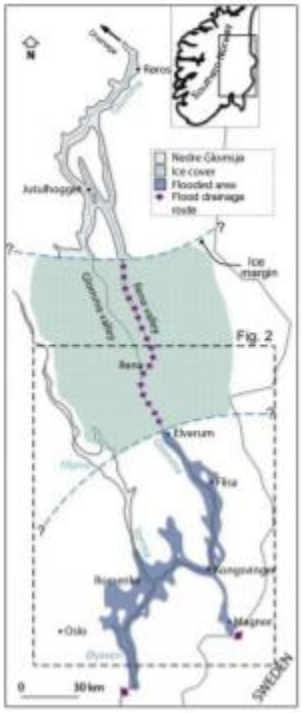

Figure 2.6: the flood split into two branches of the glacier Edge Glosmsja

(Source: Høgaas & Longva, 2016)

Over the years it has been found out that snow melt has a major contribution in the flood of Norway, irrespective of this, the increasing number of the flash flood due to high precipitation often results in increasing the number of floods in the Norway regions. The Norway flood has been based on two major things one is melting of the snow and the other is increasing of level of precipitations. In the year 2013, Norway had experienced a devastating flood and this flood prime reason lies in increasing precipitation level and melting of snow. Due to this massive flood in the year 2013 in Norway it has been approximated that about 300 people have been reported out of the house. Some of the geologist has provided an expert opinion on this flood by stating that the snow melt in the higher region is the primary reason (Floodlist, 2015). Irrespective of this drainage

system could not handle the level of precipitate water as this increases the level of water and this result into a massive rainfall.

Erosive features and mega deposit often outburst the level of flood, as this affects the south-eastern region of Norway. Høgaas & Longva (2016) commented that kettle holes and ice block obstacles are the primary reason that leads to quite flood in the Norway regions. The catastrophic drainage system in Norway cannot able to handle the pressure of the water as this increases the level of water in the country. The streamline beds that are evolved in the flood bars often results in drake whereas this bedrocks knot leads to flow of the river. The post glacial sea level is about 200 to 205 m, this indicator highlights that the level of the sea is quite high and due to excessive rainfall the raining system are not able to cart flow the water. On the contrary, Hailegiorgis & Alfredsen (2017) commented that precipitation in the catchment occurs due to snow melt whereas lack of proper regimes the Norway industries cannot able to handle the rainfall situations.

In Norway most outburst snow melt occurs in the higher region, the hill shade and the geographical information system helps in reducing the level of stress that has been related to the flood. The erosion feature of the flood level highlights that the catastrophic flood swept all the erosive flood levels. This morphological flood level highlights that the government should take quick action to minimise the rate of damages that can happen from this flood. One of the major truncated situations that notably highlight the level that are close to flood is inner bend of the mountains. The typical length of the stream flow records highlights that the evaluation of floods depends on the of the stream line infrastructures flows.

2.4 Early Flood Management and Forecasting Techniques in Norway

In the year 2001 and in the year 2013, two major floods have been occurred In Norway, these two major floods had not affected the life of the local Norway citizen. On contrary to his information, these two floods affect high property. In the year 2011, due to the Flood in Gudbrandsdalslågen, the whole place has been brought down irrespective of this the telecommunication system had also been affected. Establishing proper coordination with the public is nearly impossible in the year 2011 Flood in Norway. Preventing a natural disaster i s highly impossible but taking precaution of the flood can be done by the Government and for this reason the Government had initiated a HYDRA phase. The main intention of this unit is to protect flood and take proper measures to minimise the level of flood in the areas. According to Pall

Tallaksen & Stordal, (2019) visual tools are often focused on creating and enacting a good model of performances, using of DEM can increase the use of getting proper visualisation. This visualisation can help in finding a way of resolutions whereas the faster and higher accuracy provides a good resolution. Due to increase of urbanisation in the local areas it has been often found out that the use of DEM tool can be a risk to the geological department of a country. Actual data can be provided with help of DEM tools, if proper and accurate attention provides to them.

2.4.1 HYDRA

This is one of the research programmes that had been interconnected with the floods. The aim of the study is to analyse all the factors and influence the risk that was associated with the flood. This Hydra project risk was highlighting about the economic loss that had been associated with the Flood. The Hydra research had been focused on providing a good level of knowledge about different factors of risk that are associated with the flood (Uni.no, 2016). The Hydra research project had been focused on providing a perfect knowledge about environmental consequences that are associated with the floods. Irrespective of this Hydra programme had been focusing on flood reduction and flood protection process. The main task of the Hydra is identifying flooding zone and the main task of HYDRA is to improve the regional flood frequency analysis. Irrespective of this, Hydra had been focused on establishing standard report that can help in reducing the cost and improves the flood frequency analysis in a proper way. Hydra was considered as the research programme that can help in establishing proper decision making process related to flood. The analysis of the peak flow in the Norway region highlights that the country had been experiencing various flow flood stream. Irrespective of this, the Global warming creates a concept era as this became an issue for the government to handle the flood issues. The report published by the Hydra highlights that in some of the region the population is quite low and evacuation in proper time often decreases the overall mortality in flood.

2.4.2 River Basin Management Plans

Joint water Management system has been adopted by the Norway Government this step can help the Norway government to reduce the stress that has been arises due to flood. This joint water management system has been focused on maintaining the condition of the river basin that has been situated in Finland and Norway regions. Maintaining the basin properly can help the Norway region to increases the flow of the waters, as this probability reduce the risk that are

associated with the floods. This River Basin Management system is an important tool that has been helping the country to improve the condition of the river basin.

Water Category		Rivers		Lakes		Coastal waterbodies		Groundwater	
		Amount	Length (km)	Amount	Area (km^2)	Amount	Area (km^2)	Amount	Area (km^2)
Norway	Tana	506	14 193	156	248	20	1072	31	231
	Pasvik	116	2677	89	186	10	1884	7	18
	Neiden	85	2764	55	73	7	107	2	8
Finland	Tana	39	967	46	63	-	-	397	304
	Pasvik	66	1 475	184	1 550	-	-		
	Neiden	18	234	76	176	-	-		
Total		830	22 310	606	2 296	37	3063	437	561

Figure 2.7: different River that are covered under the River basin Management Systems

(Source: Ec.europa.eu, 2015)

Maintaining this river basin in proper way can reduce the rate of the risk, whereas the ecological standards are also measured. The hydropower production in Finland and nickel production in Norway has been affecting the quality of the river. Maintaining the condition of the basic help in reducing the environmental waste whereas the level of precipitation by which flood occurs will also rise. Maintaining this flood basin will increase the depth of the flood basin as a result the chance of flash flood reduces.

2.4.3 River Defences

River flood defence system is a series of flood defence system as this reduces the risk that is available to the systems. Dupuits *et al. (*2016) commented that economical optimization in Norway will help the Government to use the tools to reduce the risk of the Flood. In Norway the southern river of Norway has been flooded; The Government OF Norway had used the river defence system as this can help in reducing the rate of damage in the areas. On contrary to this, Lendering, Jonkman & Kok (2016) during flood events it has been often found out that the critical infrastructure that are related to flood defences are not reinforced properly to handle the situation it has been often found out that use of sandbag is appropriates. The Government of Norway had invested on building river defences in the Saga Beeken River that has been situated in the northern side of Norway. This river side defence has been helping the local citizens as the landslide in the southern region has affected the roads whereas this river defence system removes the permanent flood defence systems. According to newspaper of Norway it has been highlighted that the infrastructure of the country is not upto mark as this decreases the overall flood management

system (Politico.eu, 2015). Furthermore the People of Norway are not aware of flood management system as this creates an issue for the government.

2.4.4 Coastal Defences

Coastal Defences has been focused on building defences and sea beach in the island to get protected against the flood. Producing scientific knowledge on the risk highlights that the Government OF Norway are focusing more on reducing the economic threat from the floods. This coastal defence is an important situation that helps in reducing the future development. According to Dupuits, Diermanse & Kok (2017) commented that flood defences is considered as the multiple line of defence configuring this in a proper way helps in minimising all the economic cost. A computational integration has been achieved as this increases the complex flood defence system; this not only interdependent but provides a varied line of defences. This economic optimization helps in reducing the stress and minimise the level of issue that has been associated with the coastal defences. Nepal *et al.* (2015) commented that flood defence system is focus on ageing the level of deteriorations, as this provides an effective flood management strategy. Flood alleviation programming helps in reducing the probabilistic performances and this life cycle helps in reducing the rate of the flood defence system. Due to tight economic and political situation the Norway government cannot able to tackle the coastal defence in proper way. Managing the coastal defence in the proper way can help the Norway government to reduce the rate of economic crisis by flood management.

2.4.5 Flood Forecasting Techniques

The purpose of the flood management system is to analyse all the instances in effective manners. Providing a proper forecasting and warning will not only help the Government to take countermeasures but also helps the local people to get ready for the situations. The most useful output of the FFWS is to have a proper outlook at the extraction points. The Flood forecasting system has been focus on hydrological condition as this helps in providing a perfect opinion about the techniques. According to Emerton *et al.* (2016) highest frequency of occurrence of natural disaster has been focused on displacement of the Sendai Framework. Global hydrological modelling is a complex geographical variation, this variation not only helps in predicting the regimes but due to technological advancement the meteorological uncertainty has also been forecasted. Norwegian flood forecasting system has been implemented in 145 basins

(Ui.adsabs.harvard.edu, 2016). Probabilistic decision making sis often decreases on the flood forecasting systems. The flood forecasting system has been depends on various regimes one is both hydrological regime and the other one is size inhibit regime. Deterministic metrological forecast helps improvising probabilistic forecast as this improves the overall performance.

Flood forecasting is mostly depends on meteorological forecast as this is an autoregressive procedures this helps in achieving probabilistic forecast. The stream flow ensembles post-processed process this improves the overall sharpness and generally calibrate a perfect result. Resemblance of the precipitation helps in conducting the forecast whereas the hydrological ensembles are focused on precipitation and temperatures. The flood forecasting system has been focused on analysing the temperature and precipitation level in the callibeative and streamline flows. On supporting this information Givati et al. (2016) commented that advanced warning system helps in reducing the risk that are associated with the floods whereas quick response team can help personnel to reduce the level of mortality. Advance warning system is very much beneficial as this reduces the risk that is associated with the flood where's the emergency personnel can help in mitigating all the damages. The semblance of the forecast models have been focused on analysing all the matters as much effective way. Temperate resemblances are calibrated using the Gaussian distribution and altitude corrected by the constant gradients. Flood forecasting has been based on the meteorological forecast and this auto regressive procedure helps in achieving probabilistic forecast.

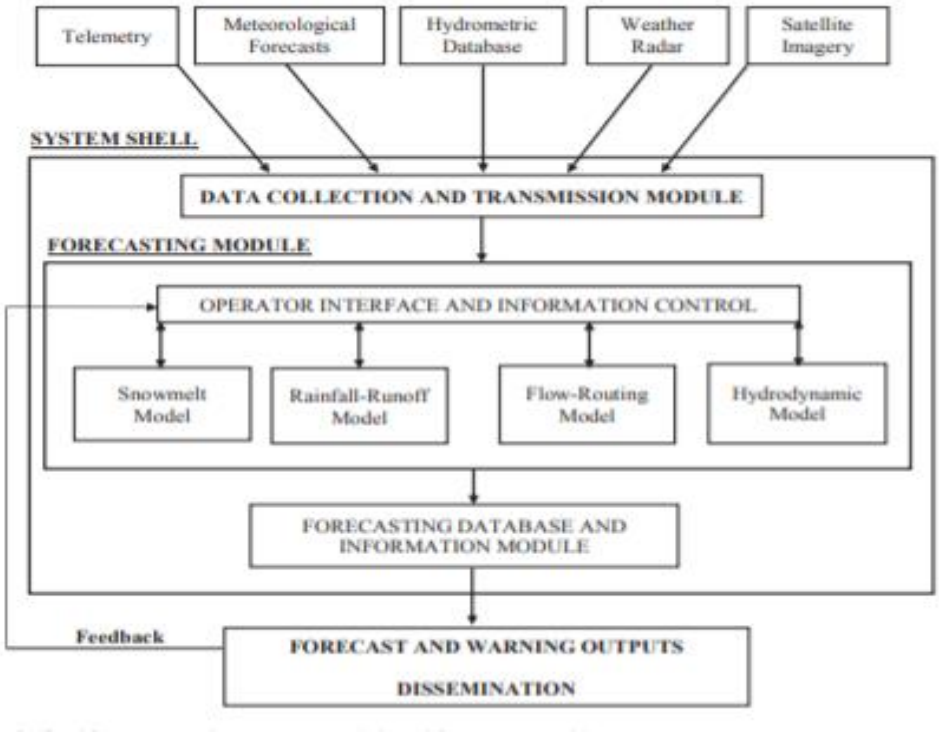

Figure 2.8: Flood forecasting system

(Source: Ui.adsabs.harvard.edu, 2016)

2.5 Current Flood Management Projects under Government Initiatives

2.5.1 Institutional Structure and Relationship

The Norway government had adopted centralised situation to minimise the level of institutional structures as this helps in managing the flood in much effective way. Norway government had implemented institutional framework, this framework helps in reducing the rate of policies. The institutional framework for the flood management has been focused on enhancing the level of collaborations (Science Policy.colorado.edu, 2017). The Norgenian Water and resource department is the main actor of this institutional relationship and structures, the main function of this structure has been focus on degrading the quality of the environment. The Government of Norway has passed a Building Act in and the area planning will be done to minimise the rate of issue that are created by the flood. At the regional level, the Governor of Norway's 'regionalized state'; the main function of the governor is to implicate the regulation that doesn't affect the emergency planning system. Social learning programmes have been focused on reducing the damage to the property, as preparing for a sudden adversity is often considered the crisis. Government capacities are focused on minimising all the issue in effective manners,

irrespective of it implication of the Government helps in reducing the stress that is associated with the government policies. The Norway flood comprises of severe poor weather condition whereas this step also highlights two massive evacuation processes. Norwegian politics has been focusing on different capacity that can improve the overall performance rates to minimise the damages that can happen during flood.

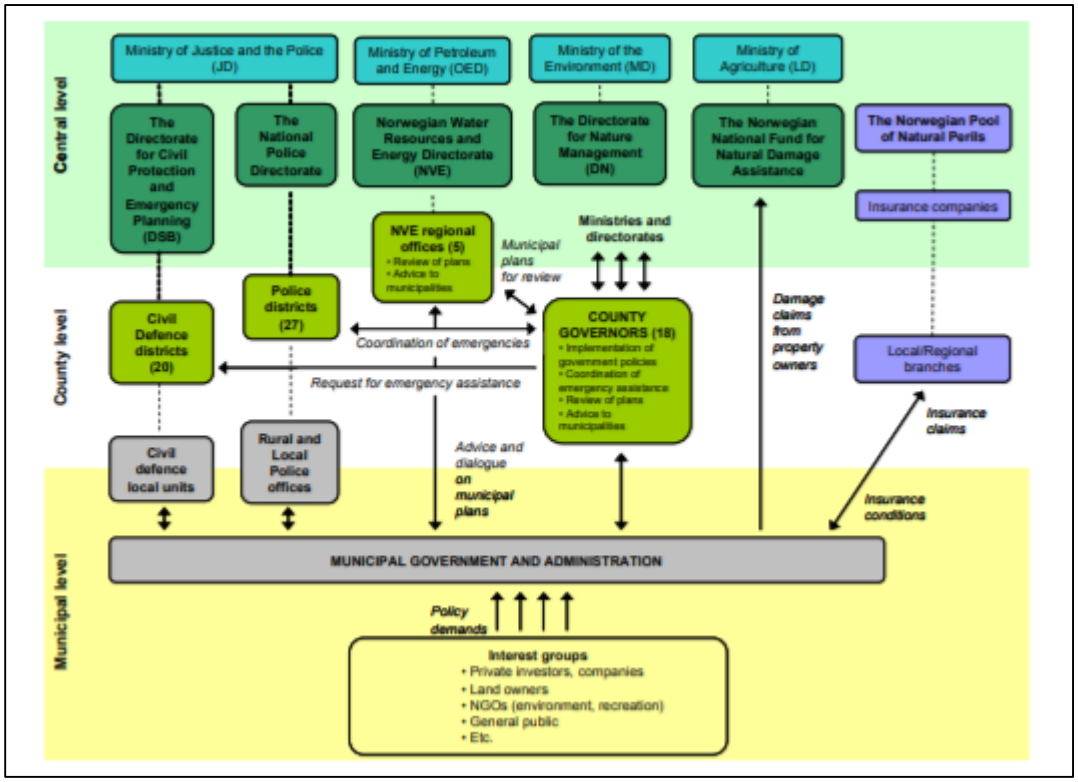

Figure 2.9: Institutional Framework of Norway

(Source: Science Policy.colorado.edu, 2017)

Floods are considered as the major situation that can create intensive and devastating situations in the areas. In Norway the flood has been occurring due to snow melting in higher places. On the other hand another vital reason is constant changes in climate. This constant change in climate affects the snow melting process, as this affects the detrimental flood process. The western part of Norway has a higher depression as compared with eastern part and this increased level of participation affects the overall flow and the flooded part gets affected. The impact of riverine floods can be considered as less intensive in Norway compared to the other floods. However, river floods tend to cause substantial damage to livelihoods and infrastructure.

2.5.2 Local Power Structure

Structural disincentives help in establishing a proactive flood management services. The Norway flood and water management department had developed a flood zone map as this helps the country to take preventive measures against the flood. Irrespective of this, the government had set up policies and under this policy no proper guidelines and building standards were issued. These local power structures help in establishing proactive flood management systems as this decreases the level of perception that has been associated with the project. The flood management system has been focused on minimising all the negative impacts that has been associated with the flood management (SciencePolicy.colorado.edu, 2017). A flood can create momentum and adoption of proper step helps in reducing the level of issues that are associated with the project. A good unique decision making can help the local people to adapt some suitable strategy against the flood. Unique decision making strategy by the government helps in adapting good measures whereas this step not only helps in minimising all the ideologies but also helps in balancing the flood management phase.

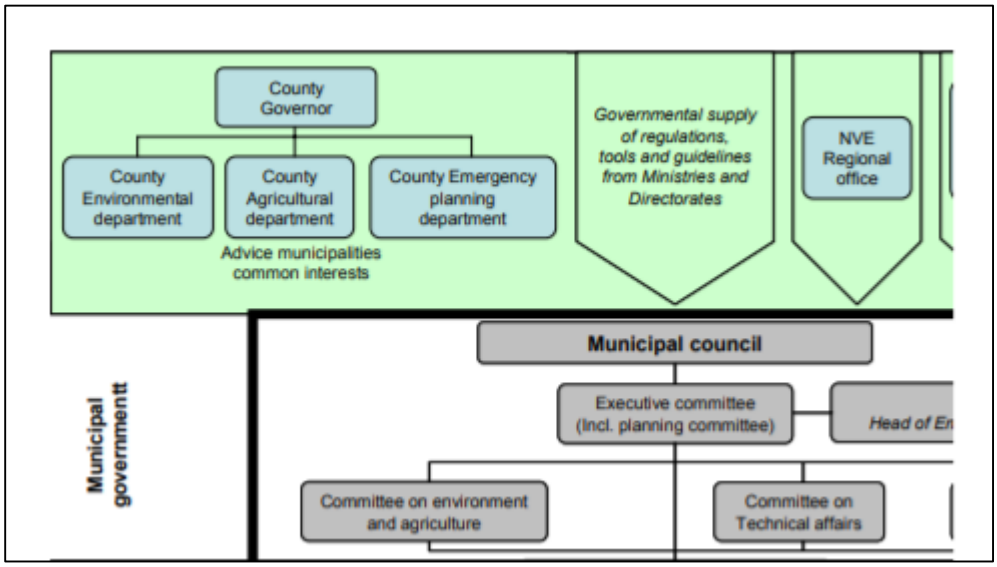

Figure 2.10: Structural decisiveness in flood management.

(Source: Science Policy.colorado.edu, 2017)

2.5.2 Different Flood Forecasting Models

Flood forecasting models are used to forecast precipitation and the streamline that has been associated with rainfall and the flow. Flood forecasting is an important component that produces flood warning; this flood warning helps in forecast all the issues that are related to the

flood. Real-time flood forecasting helps in taking preventive measure so that the mortality rate can be decreased.

Correlation Diagrams: This flood generation condition helps in reducing the stress whereas; flood estimation can help in creating awareness among affected citizens. The main purpose of the correlation diagram is to construct a hydrological model and this hydrological model incorporate human activities. Flood estimation and flood design are depends on coaxial diagrams, the main purpose of the coaxial diagram is to have a perfect understanding about two adjusted methods. The analysis of peak flow in the Correlation diagram highlights that the country will experience a peak flow as this will increase the level of rainfall. The frequency of flood in Norway is high, as the main contributory factors that creates flood is for snow melting and high level of precipitation.

The Rainfall runoff model: The rainfall runoff model is a mathematical model focus on understanding the level of precipitation. The drainage basin is focused on understanding the practice of the linear reservoir where the non-linear reservoir is far more applicable for providing useful catchments. Modelling runoff has been focused on monetary control and the quality of the precipitation that has been occurring. Norway has received 600 majors flood and out of it the number of deaths ranges also increased. Adopting this model can help in understanding the river depth, irrespective of this, the model has been also focused on conducting statistical data. This statistical data analysis can help in improving the level of performances against flood. The intensity of the events varied from Western to Southern part of the country. Due to high step in the southern part of the country has been focused on getting maximum snow in the southern sides. On contrary to Blöschl et al.(2017)commented that the country has been experiencing warmer climate and this intensive mixed climatic condition affecting the overall climate conditions.

The rainfall-runoff model plays a pivotal role within the hydrological cycle since it helps to return excessive precipitation towards the direction of the ocean along with the provision of controlling system upon the quantity of water that tends to flow through a stream. Detection of the quantity and quality of water resources is the significant activity of this model. The relation between rainfall and runoff is identified through the usage of this model and this model can be helpful in detecting the overall amount of rainfall and the flow of the falling rain under the rain falling catchment area. Responding to the rain falling events, the mentioned model attempts to produce a hydrograph to calculate the conversion process from rain falling to runoff. The model

with respect to runoff is possessed with the implication of non-lining reservoir and that can be applied in the catchment areas whose surface level is confined under a situation that rain falling might be regarded to be distributed in the entire area uniformly. Depending on the characteristics with respect to rainfall under a specific region, the usefulness of the model can be applied. If the targeted area is a large spacious area, the model can be workable on dividing sub-catchments and with the usage of advanced techniques relating to flood routing, multiple runoff hydrographs can be converged with the sub-catchment dividing areas. The spatial process is also involved in this model that formulates the interpretation regarding the characteristics of catchments and based on this; the bearing capability of the catchment areas can be detected. Categorizing, this model on the basis of the unique characteristics and features, the name of Quasi-distributed model and Lumped Model need to mention. The Lumped model regards the basin as a sole homogeneous aspect and attempts to create a single and unique outflow hydrograph. Additionally, the Quasi-distributed model makes a categorization among the homogenous various or sub-areas with respect to the quantity of watershed upon the determination of flow into sub-basin. The grid resolution is also provided by the rainfall model and it attempts to select every grid cell to ensure the spatial variation with regard to the detection of input parameters including rainfall and runoff. Moreover, Quasi-distributed model defines various absorbing conditions that can be evolved on the different characteristics of rainfall. Additionally, to be precise, The Lumped model emerges the detailed description upon the spatially ordinate physical system under the segregation of topology that is consistent with discrete entities. Depending on certain assumption upon the rain falling and flowing attributes, the characteristics of the distribution process can be detected through the usage4 of this model. Moreover, relating to the beneficial factors of Rainfall-runoff model, it has been discerned that through the involvement of this model, the government of Norway has consolidated the flood management process by detecting the characteristics of farming along with the determination of drainage capability within the country.

Implication of flood routing technique:

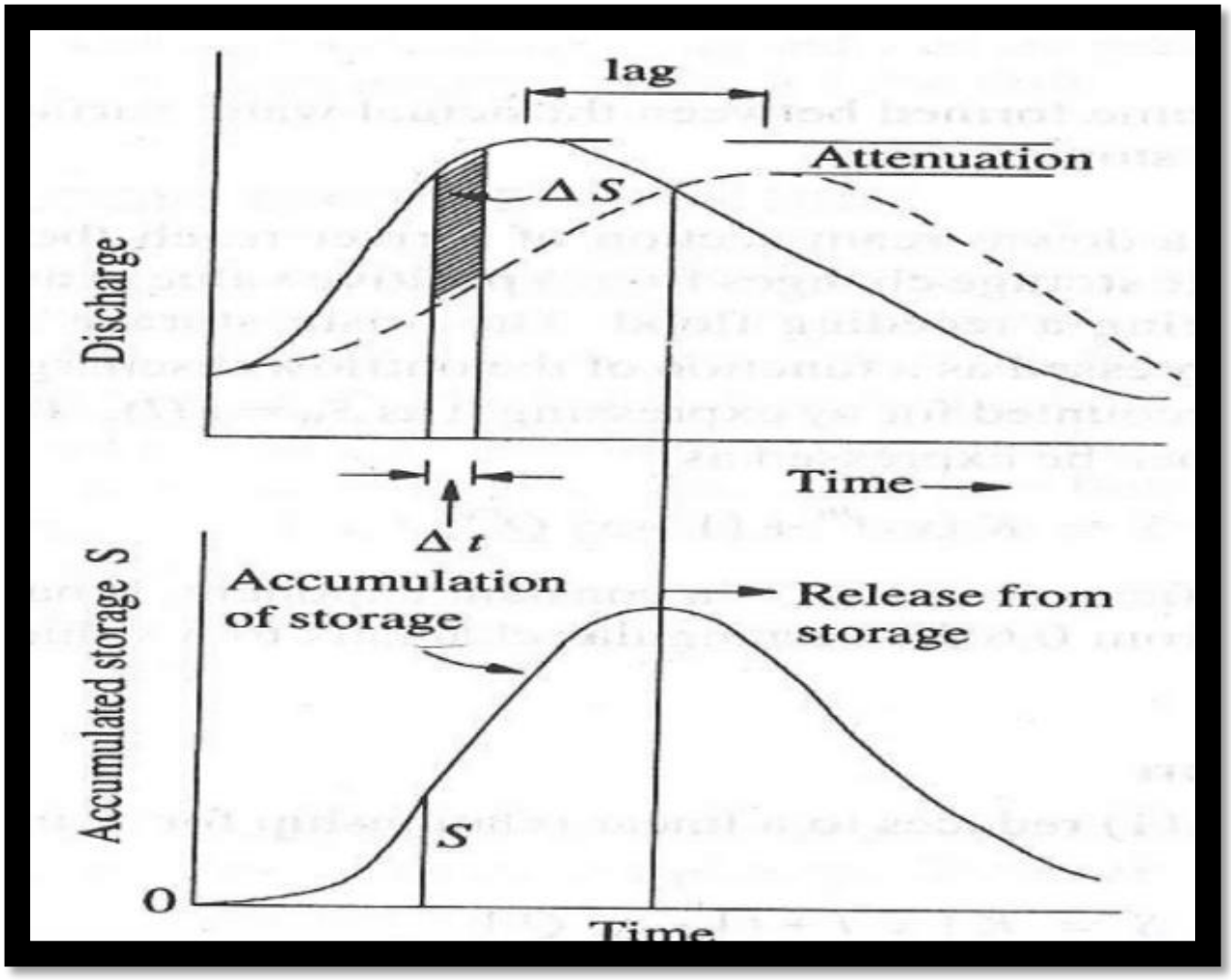

Figure 2.11: Flood routing technique

(Source: Marks & Lebel, 2016)

Flood routing is a significant technique with respect to flood hydrograph that helps in determining the water level of a particular section of a river. Through the usage of this technique, the changing shape of hydrograph can be detected as through the passing movement of water underneath river channels or through river reservoir. In the case of flood forecasting, this technique can be useful to detect the characteristics of short burst concerning to the intense rainfall. This technique assists in detecting the changing characteristics of rain as it enters into the city from the upstream based areas (Shafiai & Khalid, 2016). The duration of rainfall can also be evaluated through the alternating shape of hydrograph with the usefulness of this technique. Other factors such as decreasing moisturizing condition, the shape of watershed areas along with the evaluation

of the features of the land slope can be detectable by the routing technique. The shape of waves helps to calculate the depth of wave and considering the level of depth, the shape of hydrograph becomes changed. The shape changes accordingly to the evolution of channel storage, withdrawal concerning the wave flows and the lateral addition. During the passage of waves through the reservoir, the peak is emaciated and the base of time becomes enlarged for the rightness of storage. The attraction with respect to the peak within the hydrograph outflow takes place due to the condition of storage effect which is called attenuation. After the emergence of inflow peak with relating to the waves, the prevalence of outflow peak used to generate. The existing time difference between inflow and outflow with respect to the peak is known as lag which is measurable through routing technique. The modification techniques can be understandable through the undertaking of flood routing and with the usage of data concerning flood flow, the level of water and the characteristics of an impending flood can be detected (Poff *et al.*, 2016).

The methods of routing are involved with four segregations such as Modified Plus, Muskingum, Kinematic Wave, Dynamic and Muskingum-Cunge and each method are applicable for different purposes. Considering the uniqueness of Modified Plus, it can be visited that this method is the most significant and frequently using reservoir routing. Determining the situation of certain channels, this method under the routing process can be adopted. This method is also useful in indicating the storage capability of the catchment areas and delving into the continuity equation, the existing difference among various catchments areas can be calculated. Muskingum method is helpful in assuming the relationship with respect to single-stage-discharge and it definite the prevalence of discharge against the implication of single-stage height (Sörensen *et al.*, 2016). This method also detects that the level of friction is different between the rising and recession slide and depending on this difference; the level of the hydrograph is evaluated. In the context of hydraulic routing, the usage of Kinematic wave is indispensable since it defines the equality between bed slope and the friction slope that helps in formulating the calculation of the level of water. Additionally, Muskingum-Cunge is much similar to the method of Muskingum since in both these methods the derivation is initiated with continuity equation that is included with the diffusion emerged from the momentum equation. Depending on the advantages of Dynamic method, it can be opined that to emerge the possible solution against the appearance of food arising waves, these methods can be involved to ensure the mitigation of disastrous area (Kaufmann *et al.*, 2016). Under the governmental policies under the flood management procedures of Norway, it has been

evaluated that with the usage of this technique, not only the rising water level can be detected but also the emergence of the possible solution has been considered effectively.

Data-driven hydrologic models:

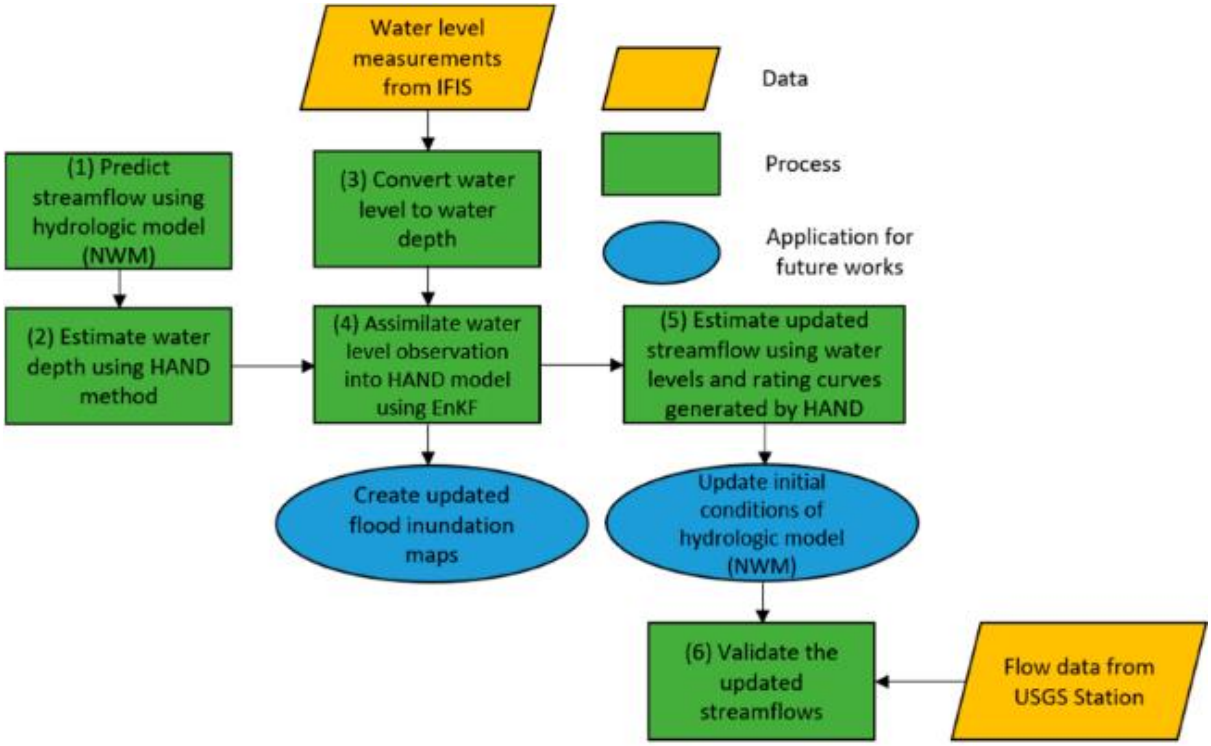

Figure 2.12: Data-driven hydrologic models

(Source: Alessa *et al.*, 2016)

Depending on neural networks, the use of a genetic algorithm can be subjected to the hydrological process that is based on data-driven procedures. A consolidated relationship is fostered by this model under which the variables (input, Output and internal) of system state are intertwined. Considering the fuzzy rule-oriented system, all the data are accumulated for helping the emergence of flood forecasting (Thorne *et al.*, 2018). Related to climate change, all the variables changing and the result also formulated in the form of additional data that can be significant in emerging the flow of water or rainfall intensity in an area. This model is also helpful to develop a cognizance regarding the implication of useful methods to detect the rising level of water

The peaks of the flood are variable in every year and the imposing magnitude is possessed with a diversified hydrologic series. Estimation of this magnitude is necessary to determine the

level of flood peak and with the usage of multiple methods, these detection procedures can be undertaken and the respective methods are mentioned herewith:

Rational method: This method is applicable for detecting computation with respect to the design discharge and based on the design of flood, this method detects the frequency level of distribution under the context of design flood (Hapsari & Zenurianto, 2016).

Studies upon flood frequency: Through this method, a frequent training area can put under measurable observation and through this, several flood managing techniques, as well as a prevention method, can be undertaken by the respective areas.

Empirical equation: This mathematical approach assist to pursue flood forecasting procedures and it also attempts to accumulate flood event and gather data considering the water level that becomes essential to produce unit hydrograph (Cook *et al.,* 2016). Presenting the hydrograph, the stimulated result can analysis the frequency level of flood in an area based on which, suitable prevention approaches can be undertaken.

Unit hydrographic technique: Considering the surface of runoff, the measurement of hydrographic techniques can be applied. This method is considered as a multiplying process that is enabled to transfer rainfall into runoff. Varying with time, the hydrographic unit can produce a surfacing runoff from rainfall along with the deployment of time distribution (van Vliet & Aerts, 2015).

Depending on the uniqueness of these models as well as techniques under the flood management procedures, the government of Norway becomes determined to extinguish the derogatory effect of flood from the country.

2.6 Requisites of Early Warning as put forward by International Agencies: UN & OECD

Figure 2.13: Components of Early Warning

(Source: eurasia.undp.org. 2019)

2.6.1 Infrastructure

Under the infrastructure of Early Warning of UN, the involvement of technologies needs to be mentioned and in many cases, multiple companies have applied their services for free. Under the infrastructure of Early Warning, GIS, one of the leading companies has engaged the application of ArcGIS software to deploy the risk assessment procedures (eurasia.undp.org. 2019). Telecommunication has also been undertaken as the major infrastructure by the UN and by collaborating with a Japanese telecommunication based companies, the UN has adopted warning providing infrastructure with the emergence of earthquakes. Averting the climate oriented disaster in the Philippines, the Weather Foundation of the country (WPPF) has involved the installation process of 1,000 automatic weather-specific stations that helps in monitoring weather by presenting weather metrics along with the provision of damage control. Additionally, the countries under OECD have also involved the data-driven flood detection techniques to determine the flow of waves and emergence of any uncertainty in case of unfavorable condition (Jones, Samman & Vinck, 2018).

Besides this, collaborating with a private group named MeteoGroup, the weather forecasting technologies has been undertaken and through this report with respect to global weather has been gathered speeding on this infrastructure of Early Warning. Collaborating with

the airlines of Cebu Pacific, UN has ended the provision of free flights to ensure the accession of the high-resolution weather forecast (eurasia.undp.org. 2019). Communication infrastructure has been followed by early earning of UN that helps in operating the technological advancement under the monitoring process of Broadcast plan

2.6.2 Manpower & Skills:

The components that have been inculcated within Early warning of UN, it can be evaluated the Early Warning procedures have been undertaken. Under The requisite of Early warning, consolidate human resources has been applied by the UN that has made effective training personnel along with the development of manpower of providing suitable wages for the employees (Law, 2017). Institutional capacity has been maintained by Early Warning of UN as this is the initial step of developing early warning activities. Through the deployment of capacity development, the government of the UN has enabled to stimulate their capacity in the context of developing cognizance as well as skills (eurasia.undp.org. 2019). Under the chain of Early warning, the development of legal instruments has been provisioned by the UN that has assisted in accelerating institutional capacities.

Emphasizing on the lack of environment -resilient flood management laws, the weak institutional structure has become consolidated by engaging effective communities under the procedures of early warning of UN. The other 35 countries under OECD have initiated to develop the legal acts based on climate resilient flood management by focusing on the level of sub-basin. Under the maintenance of technical guidance, Early Warning has become able to deliver its skilful activities through the involvement of effective manpower within the internal organization structure.

Citizen's knowledge and awareness

Figure 2.14: Approaches of Early Warning System for flood risk management

(Source: eurasia.undp.org. 2019)

One of the potential activities that have been maintained by Early Warnings is to develop the cognizance among the citizen reading the safety policies concerning the climate merged disaster. The activities of early warning is not only confined into the providence of activities to inform the respective citizens but also, it attempts to train them to ensure the persuasion of protective strategies. Maintaining a timely manner, EWS has undertaken risk knowledge approaches with respect to flood emerging disaster in front of the countrymen (Abbas *et al*, 2016). Based on the risk assessment procedures, the training methods have been applied upon the citizens and by sharing resources, EWS has developed awareness within citizens. Through the usage of '911 SOS', Early Warning has gained positive responses from the citizens in the context of an emergency situation and through this application, the affected community can ask for help from the government at any situation (eurasia.undp.org. 2019). Besides, community resilience has been fostered along with the development of citizen participation in the objectivity of EWS to ensure the imposed positivity of facing disastrous events with much resilience.

2.6.3 Training and development

Similar to the areas of infrastructure, manpower as well as awareness among the citizens, there are also a few prerequisites for training and development in the context of a country. These requisites are designed by the international agencies OECD and UN. There are a few important

requisites that should be taken into consideration before designing an early warning system. Training can be considered as a significantly important aspect of warning systems in Norway as well as any other countries due to the fact that the chances of getting an effective warning depend significantly on the people operating the systems (Tiller *et al.*, 2016). This aspect is related to Human resources and expertise. The efficiency of EWS does not only depend on the technology related to it. People responsible for operating and maintaining the services need to be competent as well as well trained.

These international agencies suggest that in developing countries, it can be often seen that most public sector workforce is not competent enough to maintain and operate EWS.

In addition, it is often observed that better wages in the private sector induce efficient personnel to shift to private sectors. UNDP or the United Nations Development Programs suggest that after detecting the hazard in the warning systems should be designed (Eurasia.undp.org, 2018). The success of an effective EWS depends largely on the preparedness of the community for a response. A community can play a major role in early warning systems in a country since regional people are more capable of understanding the risks and constraints related to the local hazard. A disaster preparedness based on community ensures that people in a community are mobilised in a systematic way to achieve a resilient community. In order to experience an effective EWS, it is imperative to customise the EWS as per community.

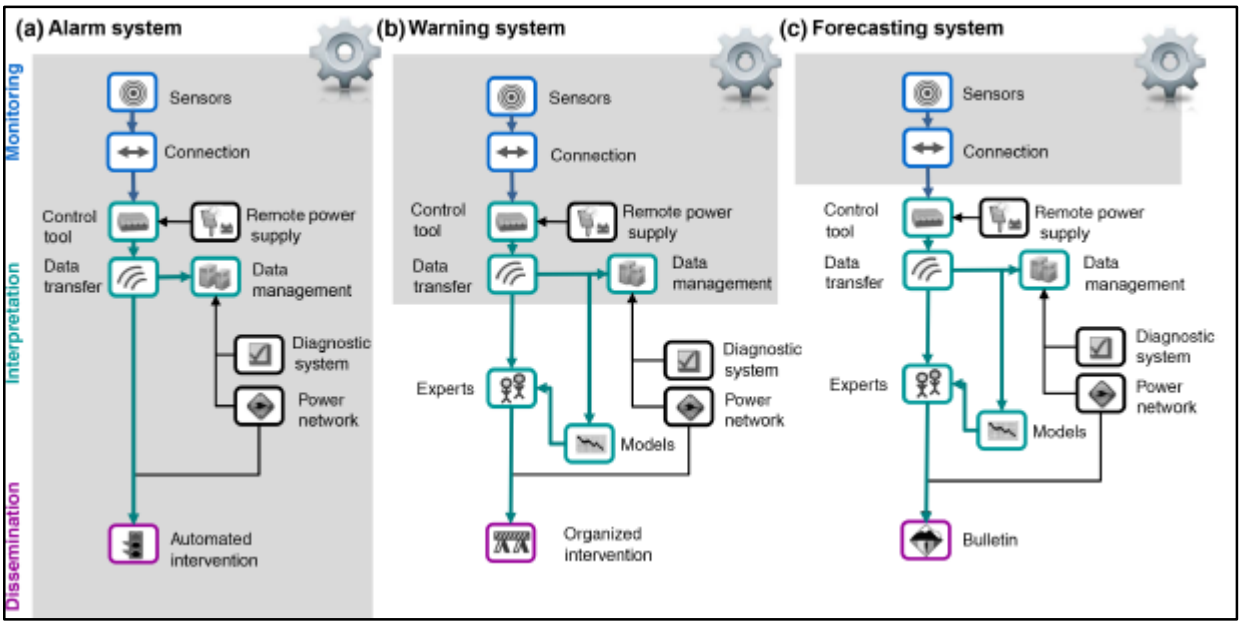

Figure 2.15: Classification of EWS

(Source: Sättele, Bründl & Straub, 2016)

Risk communication can be taken into account in this case as in EWS, it is significantly important. The process of risk communication depends on delivering several messages about the degree as well as the nature of risk. The international community has designed a set of guidelines and protocols such as UNISDR (Eurasia.undp.org, 2018). The focal point for these guidelines suggests that addressing the correct public and issuing an effective message for promoting actions. WMO or the World Meteorological Organization has also recommended having a CAP or Common Alerting Protocol (Wmo.int, 2018).

2.6.4 Technology

The mechanism of EWS works in order to assess and decide the extent of impending risk. Therefore, it is significant to enhance the technology related to EWS for getting a better forecast. Risk can be considered as the amalgamation of societal vulnerabilities as well as exposure to an impending hazard and the possibility of a hazard. In order to issue an early warning system, it is significant to know about the intensity and distribution of the risk. Every nation and community work differently (Demiroglu, Dannevig & Aall, 2018). Therefore, different nations and cultures require different types of EWS technology. In most of the countries, EWS is supported by institutional arrangements, public awareness, human resources as well as preparedness. The most important factor which can be added further is the technology which makes a EWS more effective. Technological solutions can help EWS to be less costly and it also adds up to the resilience.

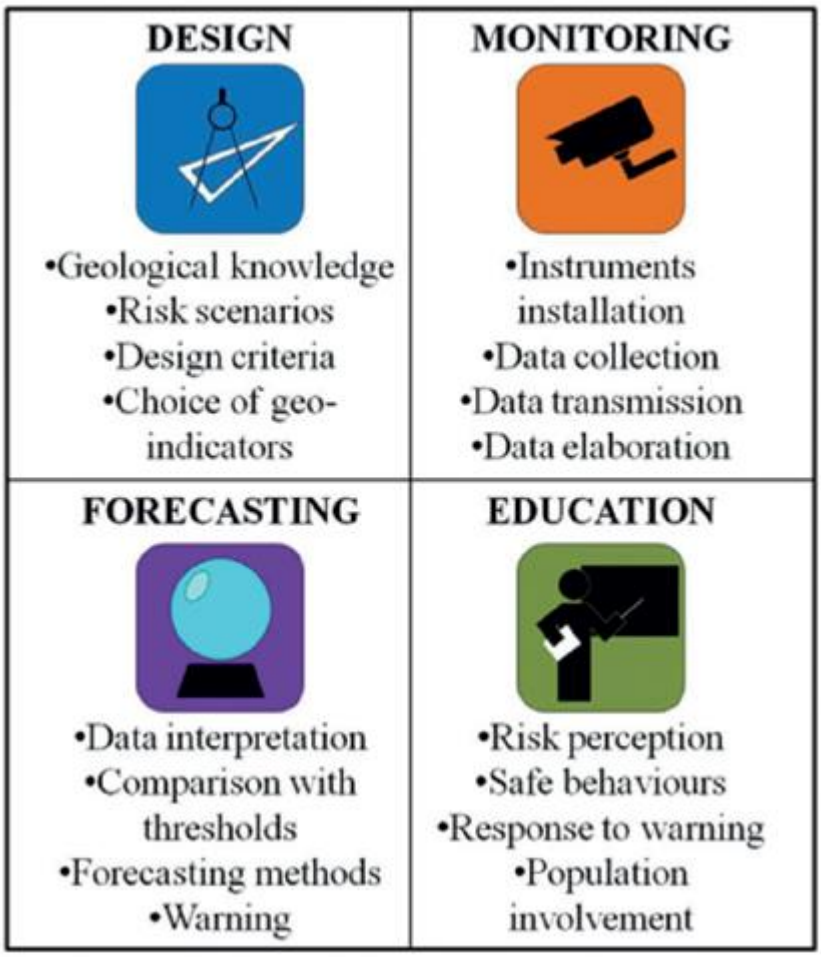

Figure 2.16: EWS for landslide

(Source: Calvello, 2017)

Technology helps the automation and also faster processing of the fundamental steps in the chain of EWS. It is suggested that effective EWS needs to be able to transfer information with the help of digital tools. This tool can help EWS to have an efficient process of risk assessment, observing and forecasting. Different countries have implemented different kinds of EWS models which are dependent on their regional characteristics (Wmo.int, 2018). The most significant prerequisites for having an effective technological solution can be the implementation of risk assessment, risk information sharing and risk mapping (Eurasia.undp.org, 2018). An accurate risk assessment, as well as hazard mapping, can reduce the risks of EWS. Risk assessment can be considered as an effective solution for improved risk management. The tools for multi-risk assessment ensure that EWS can provide the best forecasts (Martínez & Oda, 2018). Risk mapping can be considered as

another significant part in the context of technology which can increase the effectiveness of these prediction systems.

Another significant part can be risk information sharing which is another substantially important aspect for the technological aspect of EWS. Risk information sharing can ensure that people in the risk of an impending hazard can be able to evacuate and prepare for the risk. This ensures that the effectiveness of the warning system improves in the longer run.

2.6.5 Budget Investments

It is also significant to consider the budget requirement for increasing the effectiveness of a EWS in Norway. EWS needs a substantial level of technological support. Therefore, it can be added that there must a significant level of investment for establishing an efficient EWS (Schwanitz, Wierling & Shah, 2017). According to OECD, there is significant importance of early warning systems related to the flood. The project of Flash Flood Guidance System (FFGS) has been approved by the OECD in order to have a better disaster control measures in times of severe floods (Wmo.int, 2018). The solutions to the problem of frequent floods and other natural calamities can be mitigated by the implementation of EWS. However, the establishment and using this technology needs a significant level of budget. At first, the installation of EWS needs a significant level of initial investments in technology (Farkas *et al.,* 2017). Maintenance of new technology can be tricky as it is costly in terms of human resources as well as money.

Non-profit organizations often lack the required funds for financing the projects. However, private-sector corporations can have a major role in installing and establishing these EWS (Eurasia.undp.org, 2018). Investments made by the private sector needs to be monitored by investors. In these scenarios, it is significant to consider that the main factor driving the engagement is not always dependent on the needs of the community; it largely depends on probable economic returns. Tsiamis, Efthymiou & Tsagarakis (2019) stated that in order to have an efficient EWS, there are certain institutions that allow using the services at free of cost to ensure engaging in humanitarian actions. On the other hand, NGOs generally receive some software at free of cost to be used as a tool for assessing risks as well as mapping different stages of EWS. Inclusion of Telecommunication with EWS can also be effective to reduce the costs of EWS.

Telecommunications channels can ensure that issuance of warning is efficient. In addition, most companies also ensure that information about the people who are at increased risk is transported. In order to reduce the required costs for installing and implementing EWS, most of the countries need to have a partnership with the private sector media. These kinds of media can be such as radio channels, newspapers and television can be partnered with projects of EWS (Nævestad *et al.*, 2019). Distribution of early alerts can also be ensured with the help of this association. In addition, establishing the public as well as private partnerships needs to have an efficient response matrix that can help the company to assign responsibilities and roles.

2.6.6 Legalities

In most countries, it is often seen that early warning projects often fail due to some constraints. The most significant constraint that is responsible for the failure of a significant number of EWS projects is legal issues. Problems in institutional, co-ordination and legal frameworks often translate to the projects of early warning (Holen & Utne, 2018). Therefore, it is significantly important to ensure that risk information is integrated to decision making in all sectors of the country. Regulations and Laws in a country can have a significant impact on the implementation of EWS. An inefficient institutional and legal framework leads to complication and it can be detrimental in the situation of emergency. In these situations, time can be regarded as a crucial factor (Wmo.int, 2018). Therefore, in the case of delayed issuance of a warning, there can be several consequences. This scenario can compromise the efficiency of EWS and it can also result in reduced faith in the EWS by the public.

Every country has a set of legal rules and regulations related to EWS and predictive uncertainty. Therefore, it is imperative to consider that the legal regulations must be abided by before establishing EWS (Thieme & Utne, 2017). Rules related to early warning systems can be classified into certain categories. The aim of a productive EWS must be developing a national, legislative and institutional framework which can be beneficial for ensuring effectiveness. In addition, EWS should also include the responsibility of serving multiple sectors. These sectors include private as well as public sectors in the country (Eurasia.undp.org, 2018). EWS should also ensure that the accountability for warning must be taken into consideration in the context of legal requirements. It can be further added that the application of EWS can encounter with a significant level of issues

as per the law concerned (Lumbroso, Brown & Ranger, 2016). Therefore, it is imperative to consider laws related to the application of EWS.

Institutional arrangements and governance play a major role in deciding the effectiveness of EWS. Therefore, it is important to consider the rules enforced by the Government of the country.

2.6.7 Others

Other than these aspects there are certain aspects that should be taken into consideration while designing a EWS which have been put forward by OECD and the UN. The main aspect, in this case, can be the engagement of the private sector and multinational cooperation. EWS is most of the times initiated by the public sector in a country. However, it is often seen that the private sector does not have enough resources to continue providing the services of EWS. Private sectors often have more funds as well as skilled human resources which ensures that the warnings issued by EWS become effective (Berdal, 2016). In addition, the private sector often has a better connection with all the other sectors present in a country rather than the public sector. In such cases, the private sector can have more impact on the efficiency of warnings rather than public sectors.

2.7 Gaps and challenges associated with Norway's initiatives in comparison to international agencies' requisites

2.7.1Infrastructure

Norway is a country with frequent occurrence of floods and the country has experienced a significant level of damage due to these floods. The country has a national EWS which ensures that citizens can be aware of the upcoming floods. However, there are certain challenges that Norway has which has created issues in the efficiency of EWS. The most significant issues are related to infrastructure. In order to have an efficient EWS, a country needs to have a certain infrastructure. The most significant factor, in this case, can be the absence of adequate technological infrastructure for EWS. Norway has a substantial frequency of flood; however, there is a very minuscule amount of technological infrastructure regarding this (Corral et al., 2019). It can be further added that, for having an effective EWS, a proper infrastructure which Norway lacks. Therefore, Norway should also have effective facilities for implementing EWS.

However, in Norway, there are still certain gaps in the infrastructural area. In addition, the country does not have proper pre-construction planning for ensuring efficiency for EWS. Flood hazards in the country are perpetual and they are damaging. Another significant issue that should be taken into consideration is decision making. It is often seen that, while choosing the most effective method for issuing a warning, ineffective decision making takes place. In some cases, the chosen techniques are not effective enough to show corrective results. In addition, another significant aspect is resource consents (Dombrowski et al., 2017). Establishment of EWS needs usage of some resources. In Norway, there are situations in which resource consents are not maintained. Therefore, there are certain factors that are related to infrastructural issues. In addition, there are certain aspects that should be taken into consideration such as infrastructural approval. This is often not maintained in Norway.

2.7.2 Manpower & Skills

In Norway, the weather forecasting system is getting developed day after day. The structure of the meteorological organization in the country is going through a process of continuous development. However, these organizations are running out of efficient manpower and skills in their job. Though few experienced meteorologists are working very hard to make useful changes in the organization for the forecast improvement, there is not enough manpower to assess them to anticipate exact weather and environmental threats. In addition, the trainee meteorologists who are new joiners have not much experience in this work field (Graziella *et al.*, 2015). Therefore, the organizations are experiencing many difficulties and challenges while performing their respective job as the new joiners are not that experienced and skillful.

Designated jobs given by the senior colleagues in the organization cannot be performed well inadequate time and with excellence by the less experienced employees of the organization as they don't get enough support from their other co-workers. In the meteorological stations, there are numerous jobs to perform and the numbers of employees are few. Therefore, each employee is very busy to perform their job and for this reason, there is no such assistance can be expected from other employees. Hence, the employees who try hard to perform their job in the best possible way, without any assistance they fail to bring perfection in their job. Therefore, the people in Norway often do not get the right weather prediction from these meteorological stations. With time the experience of an employee increases and with experience the knowledge and skills of an employee are enhanced (Piciullo *et al.*, 2017). For the weather forecasting stations of Norway,

there are a few numbers of people who work in this organization compared to the amount of work they need to perform proficiently. The organizations face many difficulties in handling the technical issues as the organizations have all-over low experienced teams in the forecasting stations. Therefore, sometimes the services provided by these forecasting teams are also not forecasted in time and the services face technical issues.

2.7.3 Citizen's knowledge and awareness

Other countries across the world are developing fast in these days, whereas Norway is still not completely ready with its technical aids to anticipate environmental threats. The other countries, when launching various latest technologies to improvise their quality of service in the forecasting field, Norway is still using its old technological equipment for weather forecasting. These equipment's efficiencies are pulling down the meteorological development of the country. The skills of the meteorologists in Norway are also getting degraded day after day as there is no technical development in the industry (Hermanns *et al.*, 2016). In this international territory, whereas other countries are launching numerous technically improvised buoys for the last few years for gathering more technically appropriate and precise information about the water surface alongside the country, Norway has come up with just a few since the past years. The buoys the meteorological stations of the country have launched are not that technologically advanced. Therefore, the information they gathered via these types of equipment is not that precise and also it cannot cover all water surfaces alongside the country.

The people of Norway suffer because of the faulty and imprecise information given by the national meteorological department of Norway. The fishermen and all the other coastal regions experience huge adverse effects because of their unpreparedness to secure and protect themselves from the devastating environmental behavior. The people and various coastal businesses face uncertain disaster as they do not get a warning from the forecasting department of the country. The government of the country with the help of experienced weather analysts has identified the problems of the meteorological department of the country (Thiebes & Glade, 2016). One of the biggest issues in the meteorological department of the country is less manpower and insufficient skillful employees in the forecasting department. In present days, many people in Norway is choosing to be a professional meteorologist where the government of the country is also encouraging the students.

2.7.4 Training and development

In the department of weather forecast of Norway, there is no adequate professional training for the new meteorologists. In addition, there were not many institutions, in Norway which teach very basic lessons of weather forecasting and future environmental threats. For this reason, the knowledge of the meteorologists in Norway was not enough to perform their jobs efficiently. As the employees do not go through a professional and thorough training period in the forecasting department of the country, there is no skill development regarding the professional job that can be observed in the new joiners (Tiranti *et al.,* 2017). The organization faces various difficulties while forecasting the weather reports with its inept employees with no adequate knowledge and skills in the forecasting department. In addition, as in the country, there are not many institutions where subjective knowledge and professional information are being shared by experienced teachers to the students who have the interest to learn meteorology, causing every year a few students to be graduated with this subject.

Therefore, because a few number of students are coming out to serve the weather forecasting department of the country every year with their limited knowledge about the subject, facing many difficulties in their professional platform at the starting (Nygård *et al.,* 2018). These are spotting out the inefficiencies of the meteorologist in a more highlighted manner which is bringing huge challenges for the country to overcome these problems capably in the future to introduce perfection in the meteorological department. Already, other countries across the world have brought huge development and technical changes in their forecasting department by implying various training and development processes that are helpful and aiding (Anschütz *et al.,* 2015). The countries are getting too much assistance to assume and anticipate the most precise weather disaster can happen and taking precautions accordingly. However, In Norway, the country is still suffering from its unprofessional meteorologists to forecast the right weather report every time as they are not going through proper training and development procedures.

2.7.5 Technology

In Norway, the technologies which are being used in the meteorological department are of very outdated. The technologies have not been improvised in every sector of the department. This model of technology which is still used in the meteorological department of Norway is a model from a long time ago. Hence, on occasion, these technologies are complicated to understand and very difficult to handle some times. In the present time, the youths who are joining to serve the forecasting department of the country to bring a revolutionary change in the forecasting process

are suffering very much (Oppikofer *et al.,* 2016). As these new employees who have learned to handle a middle-age technology or the latest technology by training and developments are facing innumerable difficulties to perform their job more efficiently. In addition, these old technologies in which the forecasting teams are still working performs its job by taking a lot of time. The countries which have brought up-gradation in their technology works fast compared to the other countries. The technology improvisation includes good quality networking services throughout the transmission and reception of various important data about the weather condition.

The countries that have implemented various latest technology equipment as it bring more quality in their services regarding its meteorological condition are much ahead of the countries who are still using the old improvised equipment and practices for their weather forecast. Norway is one of them who is still using the old generation technology in their weather forecast department which causes many uncertainties to affect the nation's people's life adversely (Frauenfelder *et al.,* 2017). In Norway, there are a few numbers of improvisations in some sectors of the meteorological department in terms of technology and technicality which needs more improvement in the future to own a standard service provider in the meteorological department of the country. Otherwise, it can cause many environmental casualties to nation’s people and property because of the inefficiency of the meteorologists of the country.

2.7.6 Budget investments

The government of Norway is unable to fix a proper budget which can assess the development of its meteorological department. The money which government bodies invest in the weather forecasting department is not good enough to come up with the latest changes it requires. Therefore because of insufficient funding, the department of meteorology is experiencing various issues that obstruct the growth of the department (da Silva *et al.,* 2018). This is resulting in inaccurate predictions of the weather forecasting department which is causing many casualties in the country. Because of the outdated technology which is a result of insufficient funds, the experts of the department are sometimes predicting adversity at a certain time from where all the precautions are invaluable (Piciullo *et al.,* 2017). On the other hand, the countries which are in the top 10 list of growth are investing adequate money to bring the development of their weather broadcast department in every sector so that they predict the uncertainties from a long time ago and can resist or if not possible then take precautions to prevent themselves from a devastating fatality.

2.7.7 Legalities

In Norway, there is much legality which the highest authority of the country needs to follow so ads the meteorological department of the country. The barriers affect the service quality of the weather forecasting department and cause huge chances of environmental fatality (Kalsnes *et al.*, 2017). On the other hand, there are countries, by signing contracts among them have reduced these legal barriers and made numerous revolutionary changes in their meteorological department to protect the countrymen from different natural calamity.

2.8 Necessity and Techniques of Flood Early Warning System Ensuring Accurate

2.8.1 Prediction: Empirical Review -

A flood warning is an adaptive means that can help in reducing the rate of flood whereas this not only helps in reducing the risk that is associated with a project but also helps in minimising all the efforts in much effective way. Flood warning system provides good support to a country to decrease the overall performances. A flood warning is an important means that helps in reducing the stress and focused on reducing the rate of mortality within organisations (Lopez *et al.* 2017). Providing proper warning of a flood to the country helps in reducing the stress that has been associated with an organisation. Providing proper warning can help a country to take some preventive measures, this preventive measure reduces the affordability in the flooding process. Providing a proper warning inaccurate and incorrect time helps in removing the level of precaution as this increases the overall performance rate. Accurately forecasting pluvial events that cause surface-water floods is at the research frontier, with significant progress being made. Some of the key steps that a flood warning system should focus on as this increase the overall rate of performances.

- The flood forecasting system should forecast ina proper way so that the forecast can be understood by the number of people.
- The flood forecasting system is used to take some legal responsibility as this disseminates the flood warning and dissemination.
- The flood management system main purpose is to raise awareness about floods and also focus on the risks that are associated with the floods.
- The flood management system should focus on highlighting effective messages about floods as these increases the overall performances.
- The flood management system should be used by the government of a country to set up a proper communication with the flood-affected areas.

- A flood management system is used to address the level of uncertainties that surrounds the flooding systems.

Norway faces the vulnerability of flood for two major reasons; the first is the lack of proper infrastructure in the country for political and economic reasons. The second is due to the high melting of snow in the river.

2.8.2 The necessity of Flood Early Warning

This flood warning system helps to take preventive measures, these measures not only helps in reducing the rate of mortality but also can prevent in some significant loss. This flood warning system can help in reducing the economic cost of a [places, it reduces the post-flood rehabilitation process whereas the results also decrease. Flood is a natural phenomenon, this natural phenomenon cannot be prevented, but some preventive measures can be adopted to reduce the rate of damages (Fang *et a*l. 2015). Flood warning system can help in improving the flood management process, the response and recovery tactics can be minimised. Various steps can be taken if a proper flood warning system can be provided. For example, in some countries to minimise the effects of a flood, the country had created a dam. Opening the gates of the dam at a correct time can reduce the rate of damage of flood. Identifying this step can help in minimising all the consequences that are associated with floods. Different countries have a different flood management system; this flood management system not only helps in improving the response process. This flood warning can help in reducing the cost whereas the rehabilitation and rebuilding cost can be managed in many effective manners. Provides early-warning helps in increases the network communities whereas the local communities can able to set up quick research and recovery after post flood. This flood damages system helps in reducing the flood damages system but also helps in taking pot preparation that has been associated with the flood.

In the year 2013, the flood that had been taken place in Norway had highly affected the region but due to early warning, the mortality rate had been highly decreased. This step highlights that Norway flood management system is capable of providing a good phase of warning. this warning system can help in reducing the stress. In this modern world, for providing effective information about flood geologist uses various steps a ship step s can help in reducing the stress that is associated with the flood. Sensitivity analysis provides a performed test; this damage reduction helps in reducing the stress that is associated with a project. Effective disaster management highlights that the gap of preparation for proper prevention can be reduced (Qiu *et al*. 2017). Flood

forecast provides essential information as this helps the local and national authorities to take a proper decision as this clearly take proper infrastructures to save the citizens. Norway has experienced about 600 floods; this is due to high melting points. Irrespective of these Engeland *et al.,* (2017) commented that the continuous change in climate will create an issue as this increases the rate of contribution in increasing the level of participation. On the other hand, due to having a long coastline the chance of the flood has been increasing (Norwaypost.no, 2017). The streamline precipitation has been increasing due to autumn and for this reason, the chance of flood in Norway has been increased. The government of Norway had adopted different infrastructure to reduce the risk of mortality. Providing proper warning about flood can help the country to take care of civil liability. Hence, it can be stated that to have effective monitoring about the issue the flood management system is very much necessary.

2.8.3 Early Warning System

An early warning system is a technology and the policies that are associated with the prediction of natural disasters. An early warning system helps in reducing the risk that is associated with the flood. The early warning system has been focused on for major principle as this increases the overall management process. Berg *et al*. (2015) commented that the early warning system actively involves the communities as this reduces the risk that is associated with flood management. This early warning system can be induced for various purposes whereas this focus on reducing the risk that is associated with enacting proper responses. The early warning system has been used for the analysis of the flood, earthquake and landslides and droughts. In this modern world, this EMS system has been used for identifying the risks that are associated with flood management. This flood management system helps in having proper knowledge about the risk. Systematic data analysis helps in identifying the risk that is associated with the floods. Analysis of the proper risk can help in minimising all the issue in effective manners.

2.8.4 Risk Knowledge

Risk knowledge helps in minimising all the risks that are associated with flood, this risk knowledge systematically analyse all the data and the risk assessment performances can be analysed in a proper way.

2.8.5 Monitoring and warning systems

Provide a proper warning can help in reducing the rate of performances. Risk information and early warning help in analysing all the information in many effective manners. An early warning system is a chain of the information communication system as this engages the overall comprises and event detection process. The subsystem that is associated with this process helps in identifying the range of precipitations. The EWS both sensors and decision subsystem, this tools help in understanding the stability of the natural occurrences. Irrespective of this to understand the stability of the physical world and to provide proper and correct information about natural calamities this system is helpful. This system is used to monitor the risk as this helps in understanding the intensity of the flood.

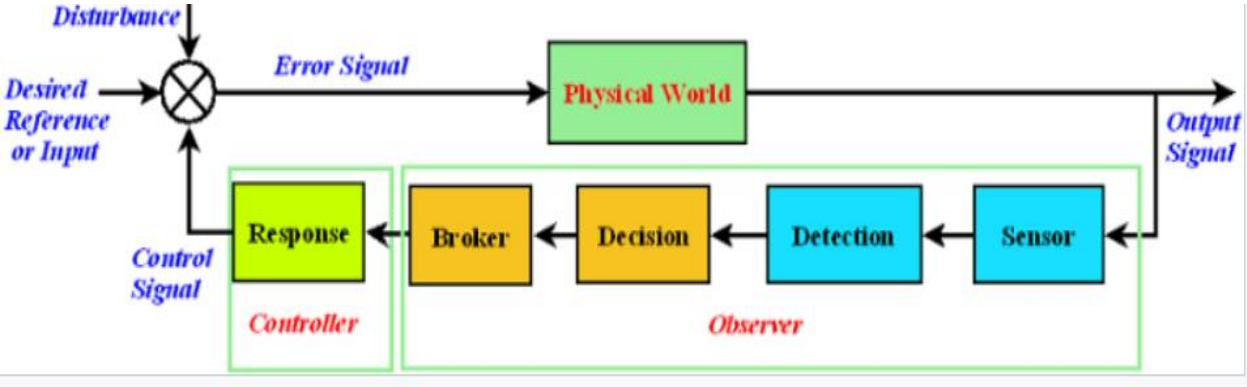

Figure 2.17: The function of Early warning System

(Source: Influenced by De Groeve *et al*. 2015)

2.8.6 Dissemination and communications

The messages should deliver in a proper way as this provides a perfect awareness about the communication process Good communication can help in setting up proper information as this increases the risk mitigation steps (De Groeve *et al*. 2015). Early warning messages help in taking a proper pre-flood step, irrespective of this proper warning can help in reducing the post-flood economical costs.

2.8.7 Response Capability

Providing correct information can help in providing a proper step about the flood systems. Providing proper information can help in reducing the negative straits that are associated with floods. This early warning system can help in minimising all the issue in effective manners. Risk analysis involves systematically collecting data analysis all the risk in a much-predetermined manner helps in establishing a proper change as this enhances the overall performances (Rahman

& Di, 2017). Effective early warning system helps in reducing the risk as this can creates awareness in local people. The risk that is associated with flood management can be conducted in a proper way if the proper facility can be done.

2.8.8 Flood Disaster Management

Norway had experienced about 600 floods, the prime reason are melting of snow and poor drainage system. Irrespective of this evidence, the shoreline of the country is more than 800 km. Flood disaster management system, help is the establishment of proper coordination. This level of coordination helps in reducing flood damages. Flood disaster management of Norway is focused on taking various preventive steps. Irrespective of this the government had adopted various policies to minimise e this issue is a much effective way. Early warning system had an acute upper hand in the flood that happened in the year 2013. The mortality rate is negative whereas due to poor damage management system the cost of the post-flood increases. This flood forecasting system provides good support for sending the warning as this reduces the economic loss. Berg *et al*. (2018) comment that flood warning often provided by EWS when the telemetric level of water increases. Irrespective of this the manual stick gauges also increases as this increases the flood warning. Operational flood forecasting helps in minimising all the issue in effective manners. Inadequate time preparation helps in minimising all the facts in many effective ways whereas this decreases the overall level of performances. Flood disaster management system works in three-level the first level focus on announcing to the district whereas the thesen\ the second level is focused on sharing information with the state level. Irrespective of this the third level focuses on sharing the information with the central level of relief committees.

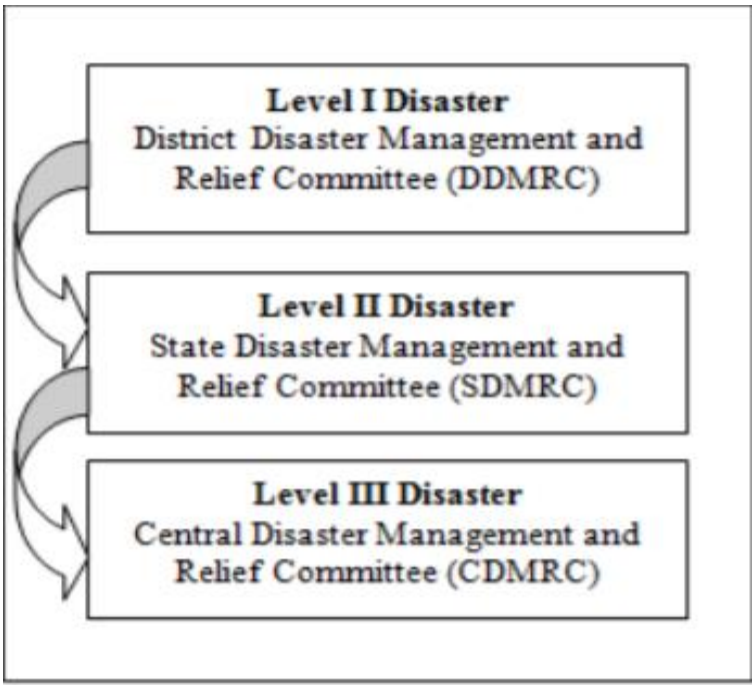

Figure 2.18: Different level of disaster management programmes.

(Source: Berg *et al*. 2018**)**

2.8.9 Early warning system for accurate Predictions for Flood Management:

Rainfall and snowmelt are two factors that create an issue for Norway. The Norway Water Resources and Energy directorate highlights that the early warning system is focused on managing internal responsibility. The Norway slope movement creates economic disruption whereas this regional warning system helps in reducing the stress. For providing accurate prediction tools that had been adopted under the early warning system is "regObs.no" The early warning system adoptions made to have proper analysis and forecast the poor meteorological condition in Norway (Graziella *et al.* 2017). Early warning system had been adopted by the Norway government to have a proper understanding of the landslide characterization. Irrespective of this the threshold development provides a good probability analysis and verification about the upcoming meteorological issues. This early warning system has been designed and developed for establishing a proper communication and computer networks. Irrespective of this the EWS helps in setup a proper operational infrastructure to enhance the overall performances. The EWS is a hydrological

model as this is the web tools used for detection of flood and snow avalanche where's this tool provides explicit information.

The first tool that is used is xgen.no, this is an expert tools helps in forecast natural hazards. According to Emerton *et al.* (2016), this portal develops a map-centric tool and this map-centric tool is useful for visualisations. This portal highlights daily observation and reduces the stress that is related to hydrological conditions as thematic maps are all-time series data are good for prognosis diagnosis. This tool provides a real-time database whereas the register observation provides accurate data that are related to flood. Public tools support the technology whereas this provides good support to the company.

2.8.10 Predictive uncertainty

The natural disasters like floods, earthquakes, landslides and others cannot be controlled by human means. However, the weather forecast department can extract the information and can take safety measures. In Norway, the flood forecasting and early warning system are controlled by Norwegian Water Resources and Energy Directorate (NVE). The department works with the nationwide flood forecasting and early warning system. The National Flood Early Warning Services (FEWS) is organized by NVE (Piciullo *et al.*, 2017) to look after the expectations from the public and advancement in technology. Concerned about the predictive uncertainty the department may face several problems. Due to this the department needs to gather and provide more information and data related to the flood forecast and early warning to control the uncertainty.

The uncertainty may affect every forecasting element and the nature of the uncertainty varies with a particular system. Storm and heavy rainfall results in the rise of sea level that makes flood one of the major risks which people should face. The flood can destroy the whole agricultural field, damaging the building and whole livelihood, can take people's life and may result in the loss of the nation's economy. Identifying the uncertainty and risk is one of the toughest tasks that the department may face for which the control measures must be taken. Researchers over the past 30 years have worked on giving the best techniques and theories for the flood forecasting (Kataria, B. 2015). However, there are no exact guidelines and techniques for the uncertainty which can affect the river and flood forecasting system. Flooding can take lives and it can cost the economic downfall of the nation. The forecasting department should be able to reduce the risks and hazards by providing safety measures. The information and early warning should be given before 1-2 days to keep people aware of the flood and these may take control measures. The storm and rainfall data

should be accurate for flood forecasting. The data can be obtained by using an instrument called rain gauge.

The researchers have divided the uncertainties into two groups namely (Kulinkina, et al, 2016) Aleatory uncertainty (AU) and Epistemic uncertainty (EU). Aleatory uncertainty (also termed as irreducible uncertainty), is quite unpredictable as the magnitude of storm and rainfall varies from year to year. This uncertainty cannot be controlled by the departmental information and it is natural. Epistemic uncertainty is due to the lack of information and errors in the measurement system. In history, the department faced many of the epistemic uncertainties that resulted in the loss of lives of humans and other animals along with the economic loss of the nation.

2.8.11 Other challenges and uncertainties in Flood prediction in Norway

The other uncertainties that the forecasting department may face include technical problem, predictive uncertainty and catastrophic risks. Among technical problems, an instrument is one of the major sources to gather information. It plays a vital role in calculating data that should require for the river and flood forecasting system. So the forecast department should not use the instrument that shows more errors and should be replaced by a new one (Auestad, Nilsen & Rydgren, 2018). Predictive uncertainty is the lack of knowledge and uncertainty of the future occurrence. Due to the implementation of wrong data and models, the department might face the uncertainty that may take the whole nation in the problem. To take control over it the department should hire the best employee for the job with proper knowledge and decision-making ability (Hungr, et al., 2016). The department should have proper knowledge of the hydro-meteorological phenomena

2.8.12 Catastrophic risks

Catastrophic risks are of low probability but high consequences that may lead to the major uncertainties. Almost all the catastrophic measures are probabilistic and there is no such instrument that can provide proper information and data of the climatic phenomena that are required to quantify the uncertainties (Lind, et al., 2018). All the uncertainties cannot be reduced by providing information and modeling. There is a huge difference in using the model for prediction and using it for gathering information. It is easy to predict but hard to gather information in the field of forecasting. All the information and data are predictive and no one can take control over the natural disaster that may come out. In the field of catastrophe modeling, there is long experience in quantifying uncertainty and risk-reducing analysis techniques.

2.9 Conceptual Framework

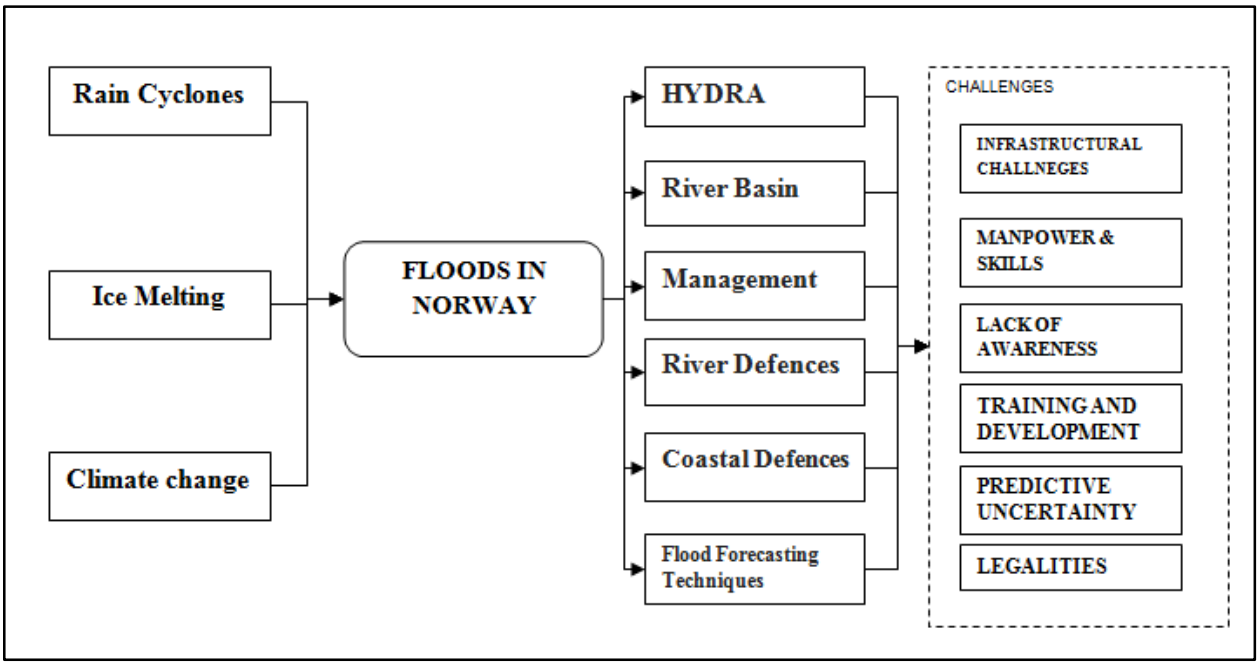

Figure 2.19: Conceptual Framework

The major causes of flood in Norway are Rain cyclones, Ice melting and some Climate change. The forecasting department has worked on quantifying the risks by implementing some river basin, river defenses, coastal defenses, flood forecasting techniques and other Hydra techniques. The management is good and for every construction, the maintenance and repairing work has been going on. However, the NVE is facing some challenges like infrastructural, manpower and skills, lack of awareness, training and development, predictive uncertainties and legalities. The research and observation are still going on.

2.10 Summary

Flood is one of the disastrous events of nature. The flood is frequent phenomena in Norway and the nation has experienced several instances of river floods over the years and most of them were intensive and devastating. The flood of 1789 was the most devastating flood of all time in the history of floods in Norway. The major causes of floods in a nation are rain cyclones, ice melting and climate change. Rise of precipitation in the country increases the rainfall and due to heavy rainfall, the sea level rises. Heavy rainfall is considered as one of the causes. The nation tends to get an occasional flood in autumn. Some of the early flood management and forecasting techniques have been implemented by the nation and the forecast department is working on the flood management project. However, the department is facing several challenges the risks and

uncertainties are increasing day by day as the whole forecasting system is predictive and the floods cannot be controlled completely but safety measures can be taken to quantify the risks. The department should focus on providing the best information, data and modeling for forecasting techniques.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

Research methodology highlights the theoretical and systematic discussion of methods used by researcher to collect and analyse primary and secondary data. Selecting authentic tools and techniques can help in provide effective strategy that can improve the conclusive decision about research study. In this research study, background about the topic will be discussed, whereas appropriate approach, philosophy and design beneficial for this research paper will be discussed in this research paper. Choosing proper approach and design are important as this help the researcher to provide conclusive strategy about Norway flood. In this research paper, proper data analysis and data collection process in necessary to have an effective understanding about the issues that are creating flood and the negative impact of flood on people of Norway.

3.2 Research Context and Paradigm

Riverine floods have some huge consequences across globes; this includes crop destruction and loss of lives and property damages, as this increases the chance of waterborne diseases. This riverine flood not only increases the chance of economic development but also enhances the chance of economic co operations. Due to the vast amount of rainfall, the coastal areas of the country have been suffering from floods. Most crucial effect of the rainfall is power blackout in vast areas of the country. Heavy rainfall creates not only challenges for the flood management system but also high lightning also increases the chance of high lightning. The high lightning creates blackouts in the country, resulting in creating various challenges. The evaluation and updates of potential floods are published as this can reduce warning potential as this can decrease the negative effects of a potential flood. An efficient warning system can help the people of the country to receive a clear picture of the effects of the flood.

The Norwegian Water Resources and Energy Directorate had introduced national warming services, as this helped the local people to get help in a quick way. The main goals of the services are to reduce the economic and financial loss that is caused by floods. Norway government has introduced potential services of warning. This warning system helps the population of the country to spread awareness. This Flood forecasting service that has been introduced by the Norway government helps the people of Norway. A better understanding of national floods early warning system in Norway improves the process of conduction of research. It can be further added that due to the aspect of inaccuracy is related to the aspect of predictive uncertainty; it can create

unnecessary stress and anxiety among the people of the country. Predicting the process of uncertainty can help in reducing the chance of unwanted disaster, the potential risk that has been associated with this disaster can be reduced. Norway is the country that experiences huge rainfall in order to reduce the harmful effects of floods and efficient forecasting systems. Norway challenges related to uncertainty and action related to their mitigation.

Efficient flood warning systems can help the local people of Norway to take people measures against the flood warning system. The main goal of the services is to reduce financial and economic loss. This flood warning system has been allocated to reduce the rate of risk and landslides as this can improve the chance of decreasing situation that can arise during a flood. This positivism philosophy had helped the researcher to gain a deeper understanding of the Snow Depth in colder areas and northern regions. The rise of floodwater has been an issue for the Norway government to manage this is due to lack of proper outsourcing process, whereas the main issue lays lack of proper strategy and preventive measures against flood system. Heavy rainfall has been accompanied by snowmelt, this creating issue for the government. Different issue that can be forecast is financial and economic loss, despite the fact that this loss of lives is an issue. This loss of lives is directly connected with economic loss, and for this reason, the Government of Norwegian is directly focused on mitigating all the issues.

3.3 Research Design

In the case of both primary and secondary research, researchers use Explanatory, exploratory and descriptive, the three types of research designs (Meyers, Gamst & Guarino, 2016). Among these types, in this research paper, exploratory research design had been adopted by researchers as a proper strategy is essential to minimize the economic and financial loss in Norway due to floods. Riverside flood and melting of snow are two issues that were creating floods in Norway. In order to gather both primary and secondary data regarding causes of floods, researchers had focused on exploratory research design which not only can help to gather data but also it has helped to explain and analyse the secondary information related to flood in Norway.

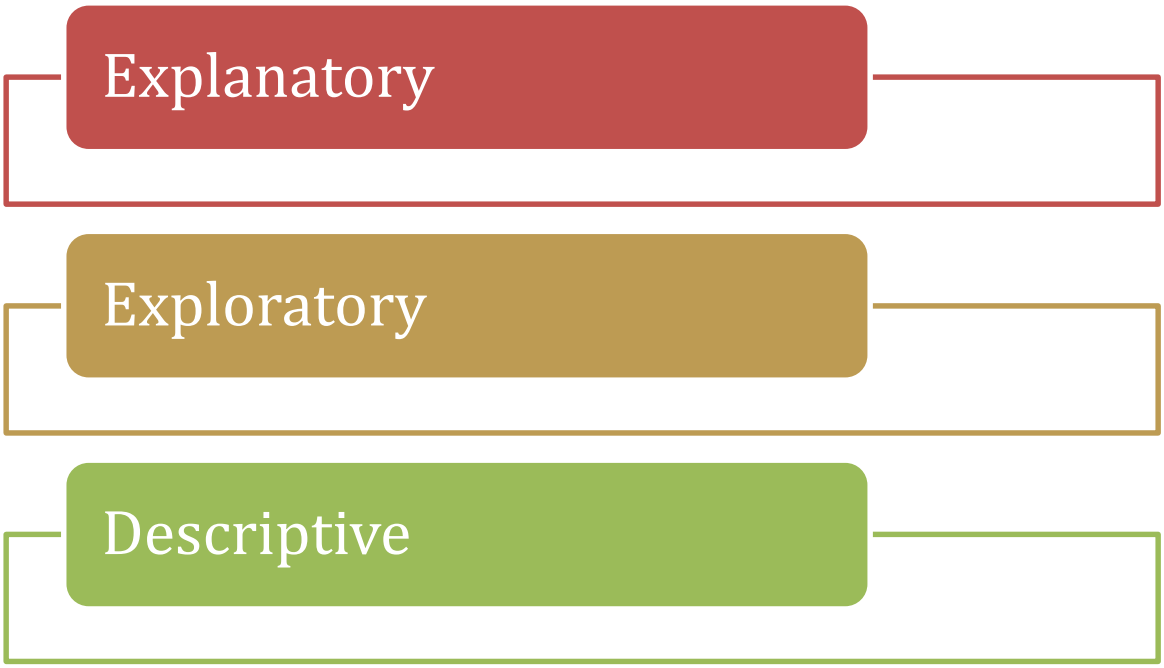

Figure 3.1: Research Design

(Source: influenced by Meyers, Gamst & Guarino, 2016)

3.3.1 Justification

In the research paper, exploratory research design is considered as this helps in identifying the problem to develop proper operational strategies. The risk that is associated with Norway river floods is not a uniform level; the country has experienced several floods during the last 20 years. The country had experienced both floods in Northern and southern parts of Norway due to the high melting of snow. Earlier researchers with help of this exploratory research design can highlight the issues that are related to this flood system. Exploratory research design helped the researcher to review all the instances that are associated with the flood in Norway. This research design helps in improving the data collection methods, irrespective of this main intention of choosing the exploratory research design as it helps in providing a perfect conclusion about the topic by analysing all the variables associated with the topic (Creswell & Poth, 2016). Norway's flood is the biggest issue for the country. The government has installed a flood warning system as this process can reduce the risk associated with floods. Another main reason for choosing exploratory research design is it helps in improving the decision making process. Due to the bad drainage system within the country, the country had experienced floods for several years. By using exploratory research

design, researchers can efficiently focus on every research method and be able to improve the decision making processes. The researcher had not used explanatory and descriptive research design for this research paper, as this research paper focuses on providing some in-depth analysis of developing some strategies to reduce the financial and economic losses that Norway suffers from floods.

Exploratory research problems help in improving flexibility in the research paper, the two primary issues are highlighted in a literature review that is riverine basin and snowmelt. Irrespective of this, exploratory research design helps the researcher to analyse all the issues and understand the rate of a percentage that the dependent variable impact on independent variable. In this paper, researchers had adopted positivism philosophy to generate hypotheses about different strategies associated with Norway flood. In these instances, exploratory research design has helped the research paper to develop proper hypotheses that can help both people of Norway and Norway government. This information is collected by researchers with the help of exploratory research design, and for this reason, exploratory research design had been adopted (Abdulkadiroğlu *et al.* 2017). From the literature review, it has been highlighted that snow melting is a reason that can create floods in these situations. Major flood of 1995 is occurred due to high snow melting in the northern region of Norway. Autumn floods are common floods in Norway. This data founded in literature review, using this data and exploratory research design researcher can focus on developing some new strategies such as inline drainage and good passage for transformation of water is necessary (Andrew, Pedersen & McEvoy, 2019). This is the primary reason for which researchers have not adopted a descriptive research design as a descriptive research design cannot help researchers to develop perfect hypotheses about research topics.

Explanatory research design is focused on conducting complex analysis about a situation, whereas exploratory research design focuses on carrying out the test relationship in a much more effective manner. Norway experienced a significant amount of rainfall in every part of the country. The most important aspect that has been creating challenges within the country is a lack of proper drainage systems. Due to continuous political changes, the country cannot implicate proper drainage systems within the country. Irrespective of this, an advanced weather forecast system can be a good option for the Norway government as this step can help the government to take preventive steps to reduce the rate of financial disaster for floods. Explanatory research design had helped the researcher to analyse the current weather forecast system that had been adopted by

the Norway government (Tight, 2016). Incorrect forecasts can be a huge issue for the government of Norway; hence explanatory research design has been adopted. This explanatory research design has been adopted as this research design improves the final output by understanding all the operational definitions. This exploratory research design had helped the author to provide a perfect strategy to improve the weather forecast system so that correct information about the flood can be obtained by the weather forecast system.

In this research paper, the researcher had not obtained a descriptive research design, as this design provided abroad finding of the research objective whereas to minimize the demographic issue, this descriptive research design is not appropriate. The researcher had not also obtained explanatory research design as this research design helped the researcher to meet the objectives, whereas the researcher is focused on providing some conclusive information against some measure so that flood issues can be minimised. Despite this, exploratory research design has helped the researcher to identify all the complex issues that are associated with Norway flood.

3.4 Research Philosophy

Research philosophy highlights the process in which data about research topics will be collected and will be analysed. In this research paper for having a proper analysis positivism philosophy had been adopted. Irrespective of positivism philosophy, there are two more types one is realism, and the other one is interpretivism. Research philosophy helps the research paper to deal with nature, sources and development of proper knowledge (Kennedy, 2017). The benefit of this research philosophy is that it increases the engagement with the topic results in improving the process of knowledge creation. In this research paper, researchers had adopted positivism philosophy as this helped in developing a good structure about the project. Irrespective of this, in-depth investigation about the research subject can be provided by this positivism philosophy. This is the reason for choosing positivism philosophy for this research paper.

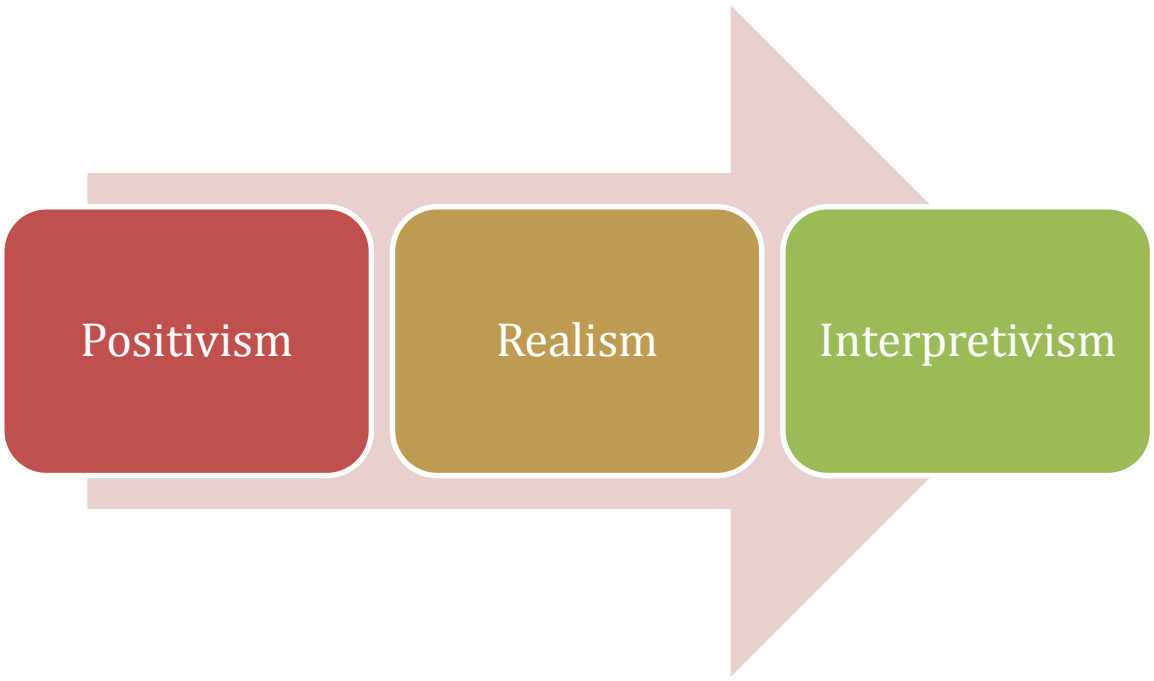

Figure 3.2: Research Philosophy

(Source: influenced by Kennedy, 2017)

3.4.1 Justification

In this research paper, both secondary and primary method of data collection has been conducted. This data collection process helps the researcher to gain new knowledge about the data; proper analysis can be generated to improve the level of the data analysis process. Norway is the country that has high coastal rainfall; this creates a disadvantage for the country due to improper water storage capacity. Norway has a significant amount of rainfall, Norway excessive rainfall this excessive rainfall creating issues for the country. In Norway, excessively heavy rainfall washes off the roads as well as the bridges which in turn cause transportation problems. In Norway, the incidences of excessive rains are increasing, whereas the potentiality of flooding in the near future. In this research paper, positivism philosophy has been adopted; this method can paper to have a proper understanding of the different issues that are generated with the Norway flood. Collecting good knowledge about the topic can help researchers to complete the project in a given time (Dougherty, Slevc & Grand, 2019). For this reason, the researcher had not progressed with other two research philosophical methods. Irrespective of this, collecting good knowledge about research topics can help the researcher to develop a proper strategy so that the Government of Norway can decrease the potential loss against the flood regime.

Research philosophy is a scientific approach based on certain assumptions; despite certain assumptions, this method has been adopted in this research paper to highlight the issues that are associated with Norwegian rainfall. Due to climatic issues associated with this project; hence this positivism philosophy will help researchers to get a perfect understanding of the issue in a broad manner. Positivism research philosophy helps researchers to improve the strategy that has been associated with research findings. This positivism philosophy had helped the researcher to develop proper hypotheses about the research understanding. The Norwegian government has installed a flood warning system. This positivism philosophy has helped the analyst to have a proper understanding of the working process of the system (Da Veiga, 2016). Despite this, positivism philosophy has been focused on increasing the level of engagement, and for this researcher had used these methods. The Philosophical methods had been helping the researcher to get more engaged about different issues related to the Norwegian flood. Irrespective of this, this philosophical approach had helped the researcher to have a proper understanding of the measures that are adopted by the population and government during floods. This positivism philosophy has helped the researcher to have a predictive understanding of flood warning systems and different challenges that are in predictive forms. Despite this, the field of forecasting has been decreasing the issue associated with the flood warning system to reduce the predictive challenges that are associated with the flood warning process.

Positivism philosophy can help the researcher to develop a perfect hypothesis as this process can help in reducing the rate of instances. Rain cyclones are regarded as one of the most important factors that create an issue for the government proper monitoring system has not been adopted for this issue. Positivism philosophy has been chosen for this raisin in the research paper. As this philosophy had helped in establishing a proper understanding of rain cyclones and different issues that have associated with these rain factors (Winit-Watjana, 2016). Despite, this philosophical approach has helped researchers to have a proper understanding of different issues that have been associated with the flooding process. Earlier researchers had highlighted that prolonged rain and thunderstorms are contributing factors. The researcher had adopted positivism philosophy to develop proper hypotheses about different contributing factors that have been associated with this research topic. Research philosophy has helped the researcher to understand prevalent rainfall issues that can create an existing issue for the country. Hence an overview can be estimated using this positivism philosophy is that researchers had used this method to have an understanding of

different methods that had been adopted by countries. Rainfall and thunderstorm are creating issue for the country to take preventive measures against the flood. Despite this positivism, philosophy has been supporting in understanding different strategies that have been adopted by the Norwegian government to mitigate different issues.

3.5 Research Approach

Research approach is directly forecasted on data collection and data analysis methods. Proper interpretation is necessary for removing all the issues in many effective manners. In this research paper, inductive research approach has been adopted as this helps in the collection of data that are relevant about the topic (Tuffour, 2017). Deductive and inductive are two types of research approach used by researcher for collecting effective data about the research topic.

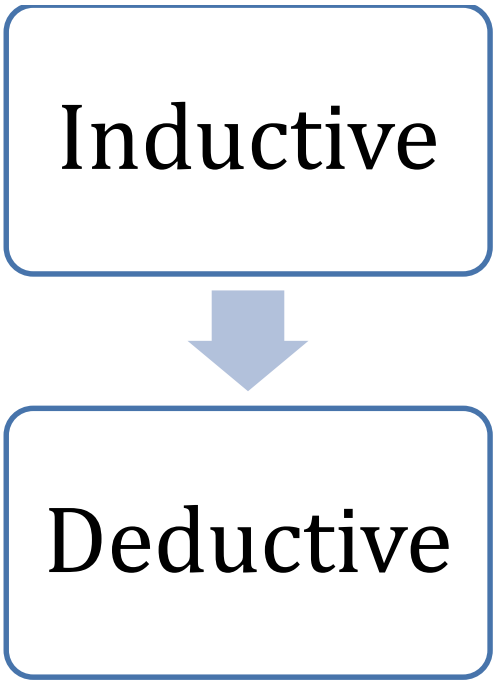

Figure 3.3: Research Approach

(Source: influenced by Tuffour, 2017)

3.5.1 Justification:

In this research approach, inductive research approach has been adopted by the researcher, as an inductive research approach help in a collection of explicit data about the research topic. Forecasting by EWS analysing sensors highlights the danger in flood; earlier researchers had used

an inductive approach to understand the explicit performance level of EWS analysing sensors. Due to flood the economic loss in the country's, this flood directly affects agriculture and affects the biodiversity of Norway. Local people Of Norway faced different issues as this research approach helped in the collection of explicit data about the impact of floods. On the other hand, researchers had not used deductive approaches as deductive approaches only focus on these issues. The deductive approach has been focused on providing some explicit conclusions, as this decreases the conditional performances (Mohr, Riper & Schueller, 2018). In this research paper, the researcher had adopted an inductive research approach as earlier researchers had not highlighted the negative impact of a riverine flood. Inductive research approach helps the researcher to gather information about the agricultural prices and the riverbank erosion, and inductive research approach has helped the researcher to develop a proper strategy about this issue (Wulfmeyer *et al.,* 2018). This can be a reason for the researcher to prefer inductive approach over a deductive approach. Riverine flood is the main reason. For this reason, the people of Norway are suffering a lot; this information has been collected as the researcher uses the inductive approach. A deductive approach is not focused on taking any risk associated with the topic

The inductive approach has been adopted by researchers for completion of this product as the sources are not generally available. The strategy that had been adopted by the Norway government during this flood is not available, highlights that the sources of information are minimal as this is tough for the researcher to use a deductive approach. Deductive approach had helped the researcher to provide general information about national authority's protection but using inductive approach proper strategy can be generated against the issues (Vanderhoven *et al.,* 2016). The information about early warning systems are gathered by researchers using inductive approaches, but due to lack of proper time, researchers cannot highlight the process by which this method can be improved. In this research paper, researchers had used an inductive research approach to improve overall performance strategy that can enhance the performance level of the EWS alarm system. Earlier researchers had highlighted that arm EWS prediction is high, but the perimeter of a flood cannot be discussed properly. Inductive approach had been adopted by researchers to improve the warning system so that proper parameter of flood can be highlighted by researchers in this research paper.

Norwegian Flood is a big issue for the Government of Norway to handle; this affects the overall process of a flood. Different substantial amounts of data collection help in reducing the

level of stress of research and for this reason, researchers had preferred over inductive research approach rather than a deductive approach. Collecting substantial amounts of data about the Norwegian flood is necessary for researchers to provide explicit conclusions about research topics. This research approach had been helping the researcher to collect explicit data about the frequency rate of rain for which the rate of flood has been generated. Irrespective of this Norwegian government had introduced a warning system to provide proper information about the rate of a flood. This inductive approach helps in reducing the rate of issues in proposed observation methods (Ajjawi, & Boud, 2017). Irrespective of this, inductive research approach has been focused on meeting the question that had been generated in the research question. Irrespective of this inductive approach has helped the researcher to develop empirical generalisation and this help understanding the relationship between generalisation process and progress reports. Empirical generalisation and ideas are some of the issues that are generated as this can reduce the level of stress. In this research paper, the inductive approach has been adopted as this improves the qualitative and quantitative theory.

Inductive research approach helps in setup interconnection between factors that are associated with the risk with a flood. In this research paper, researchers had not adopted a deductive approach, as this decreases economic loss. Inductive research approach helps in formulating principles that had been adopted to reduce the stress associated with following patterns. The joint water management system has been installed by the Norwegian government to have a proper understanding of the issue that arises during any flood monitoring process. On the other hand, this inductive approach had helped researchers to focus on conditions that are associated with river basins. Riverside defences can be an important matter that can reduce the chance of devastating floods in Norway. Irrespective of this, the inductive approach had helped the researcher to generate a computational integration process. This computational integration process minimises the issues that are generated during the flood management process (Bertoa, 2017). Inductive research approach had helped the research appear to have a proper understanding of the different economic issues and political situations. The way of the political situation is directly affecting the overall profit margin. The inductive approach had helped the researcher to have a proper understanding of global hydrological modelling as this can diseases complex geographical variation. Sendai Framework is another framework that had been associated with this process; the modern-day phenomena have been associated with understanding the complex geographical variations. An

inductive research paper has been preferred by researchers over deductive research approach for this reason. The researcher, with the help of inductive approach, can help in developing proper knowledge about flood forecasting systems. This flood forecasting system can help a researcher to understand the hydrological impact; inductive research process had been adopted for this reason to improve the understanding about the techniques. Earlier researcher with help of inductive research approach had found that Sendai Framework can highlight the frequency of disaster. This analysis paper had been created to develop a better understanding about the frequencies and exact time of occurrence of natural disaster. For this reason researcher had preferred to adopt inductive approach over deductive approach to highlight proper frequencies and exact time of natural disaster. Highlighting the frequencies of natural disaster can help the people and government of Norway to take proper measure to minimize the destruction rate.

3.6 Data Collection Procedures

3.6.1 Sampling Unit

In this research paper, researcher had both primary and secondary methods for collection of effective data. In the primary data collection method, the researcher conducted interviews on 3 meteorologists and also conducted surveys on 51 people from Norway. Conducting an interview with a meteorologist had helped the researcher to gain a good knowledge about the flood warning system that had been adopted by Norway government. Irrespective of this, the benefit of interviewing meteorologists is how flood warning systems are working in tight situations. Proper understanding of flood warning systems can help the researcher to develop proper strategies to use the flood warning system to enhance performance rate (influenced by Sarstedt et al., 2018). In the primary data collection, 51 people had been surveyed; surveying these people had helped the researcher to develop a proper understanding about the strategy that is taken by people and the government to reduce the loss. However, conducting surveys on these people had helped the researcher to have an effective knowledge about different strategies that had been adopted by the government (influenced by Zahlsen, Kilaas & Skjetne, 2018). Gaining effective knowledge about the weather forecast system and strategies adopted by the government had helped the researcher to develop proper hypotheses so that financial loss can be minimal for people of Norway.

3.6.2 Sampling Plan

Sampling methods help in choosing a smaller subset from a larger subset. In this research paper, researchers had adopted a random sampling method. Random sampling method provides

an unbiased representation of total populations. In this research paper researcher had obtained the simplest form of data collection; this sampling collection method provides proper opportunity to carry out the data collection process in a much swift way. In this research paper, researchers had obtained random sampling methods to provide effective conclusions about research topics. In this research paper, the researcher had preferred random sampling over non-random sampling methods as the population list was provided (Carlisle & Loadsman, 2017). In order to remove the biases in the data set, random sampling had played a pivotal role. The researcher had been focused on providing some explicit strategy about the flood issue, and for this reason, sampling issue should be done in a proper way.

3.6.3 Questionnaire Design

In this research paper, researchers conducted open-ended questions to collect explicit information about the strategy and issues faced by people during floods. The benefit of an open-ended question is that it will allow respondents to allow more information about the topic. On the other hand, the researcher had chosen open-ended questions as this allows researchers to identify the true feeling of the respondents.

3.6.4 Ethical Consideration

In this research study, 3 meteorologists had been interviewed, whereas 51 people had been surveyed. In order to participate in this research paper, none of the participants is forced to take part. However, none of the researcher's identities has been disclosed; all their names are highlighted as anonymous. This research paper was created by the author to help the people; none of the information has been used by researchers for personal profit. In this research paper, open-ended questions are conducted as this question is provided so that participants can provide information about the topic. None of the participants had been forced to provide more information about the issues. In this research paper, the participant had been provided with an opportunity to skip at any time they wanted; none of the participants was forced to complete the interview or survey process (Bilimoria, Chung & Hedges, 2018). All the questions that were asked are not based on particular fields; unbiased questions are asked to participants. None of the participants' personal information is collected, as this provides an opportunity for participants to express their true feelings about the issues. Data handling is an important issue, and in this research paper, all the in texting are done according to the name and information provided by authors. None of the data had

been vandalized in this research paper. All the information in this research paper is protected according to the Data protection act of 2015 (Gov.uk, 2015).

3.7 Data Analysis Procedures

3.7.1 Data Validity and Reliability

Data validity and reality are two types of research evaluation processes used by researchers to understand the quality of research. Straus (2017) commented that reliability in a research study highlights the consistency in data collection procedures and validity in research analysis highlights accuracy in data analysis process. Biasness on certain flood forecast models can decrease the accuracy in the research paper, providing some good strategy for this flood forecasting model is necessary to increase the quality of the research paper. The reliability and validity method had been used to create a strong research design by choosing proper samples about the research topic. In this research topic, data validity and reliability are needed to maintain consistency in the data; the methodological approach can be achieved with help of this process. The research is said to have high validity as the characteristics and validation depend on improving the social standards of people of Norway.

3.7.2 Analysis

In this research study, inductive research approaches were adopted by researchers. This approach helped in collecting proper data about different flood forecast systems such as flood forecasting model, correlation diagram. Inductive approach has helped the research study to generate the patterns so that research can improve the pattern associated with the flood forecasting system (Judger, 2016). The main issue that had been highlighted is that the flood forecasting system used by Norway metrologists is not advanced, and inductive research approaches can help in developing a phenomenal strategy associated with a flood forecasting model. Inductive research approaches help research papers to provide detailed observation about the issue associated with the topic. High riverine baseline, snow melting and lack of proper drainage system are highlighted by earlier researchers. This research study was conducted to find other issues that are associated with this Norway flood. Inductive approach had been adopted to provide proper strategy on the old and new issues that were found.

3.7.3 Software

In this research study, SPSS software has been used as this software helps in managing and organising the data about the topic (Wang & Zhang, 2019). SPSS software has been used to analyse the response provided by 3 meteorologists, with help of charts and graph. The metrologists had been interviewed to have an effective understanding of the flood forecasting model. On the basis of respondents' answers, the researcher will analyse the flood forecasting model to improve the strategy and performance of this model. In this research study, MS EXCEL software will be used to analyse the response provided by people of Norway (influenced by Hijazi & Curtis, 2018). Analysing the information that is collected from the people has helped the researcher to understand the strategy adopted by the government and people during natural calamity.

3.8 Summary

In this chapter, proper methods and tools have been adopted by researchers to conduct proper analysis on the challenges that are faced by Norway government against the flood issues. In order to provide a profound conclusion on the research topic, suitable methodological tools and design are necessary. In this research paper researcher used both primary and secondary methods of data collection, the primary qualitative data is collected with the help of interview form 3 Norway metrologists. On the other hand, primary quantitative method of data collection has been collected from 51 people in Norway. The open-ended question method has been used to collect explicit data. In this research paper, researcher had used an inductive research approach for collection of explicit data about Norway's flood and flood forecasting system. Inductive research approach had helped the researcher to collect explicit data about the strategy adopted by people and the Government of Norway to minimise the financial and economic crisis before and after flood situation. On the other hand, in this study positivism, philosophy and exploratory research design had been adopted. Positivism philosophy had helped the researcher to develop a proper hypothesis about the research topic so that proper strategy can be generated using the research topic. Exploratory research design has been chosen to improve flexibility in the research paper, and for this reason, researcher had used this method in this research paper. In the research paper, all the data will be protected under data protection act, and none of the participants is forced to participate in this research paper.

3.9 Time Frame

[Refer to Appendix]

Chapter 4: FOCUS GROUP ANALYSIS

4.1 Introduction

In this data collection process, group analysis has been conducted, and the group analysis has been conducted on 51 people to have an effective understanding of the group analysis process. 150 people are divided into four groups to have an effective understanding of the issue and the government measures to help and support the people of Norway. The riverine flood has some consequences globally, as this affects the economic situation of Norway. Norway government has been focused on mitigating the issue, and for this reason, the Norway government has focused on installing the flood warning system. In this group analysis, the opinion of different respondents has been gathered about the flood warning system and the issue that local people of Norway face during the flood in Norway. Information about different river management steps that have been taken by the Norway government, questions have been raised on these factors and different opinions have been taken from this group. The researcher in this research paper has adopted a group analysis process because the researcher tries to highlight all the problems that are associated with the flood factor of Norway. Critically highlighting all the issues can help the researcher to find a solution in both hypothetical ways. On the other hand, it can be stated that this focus group analysis will help the researcher to find questions that arise in the research question.

4.2 Group Analysis

Group 1

Q1. Do you believe that riverine flood is the main reason for the Norway flood?

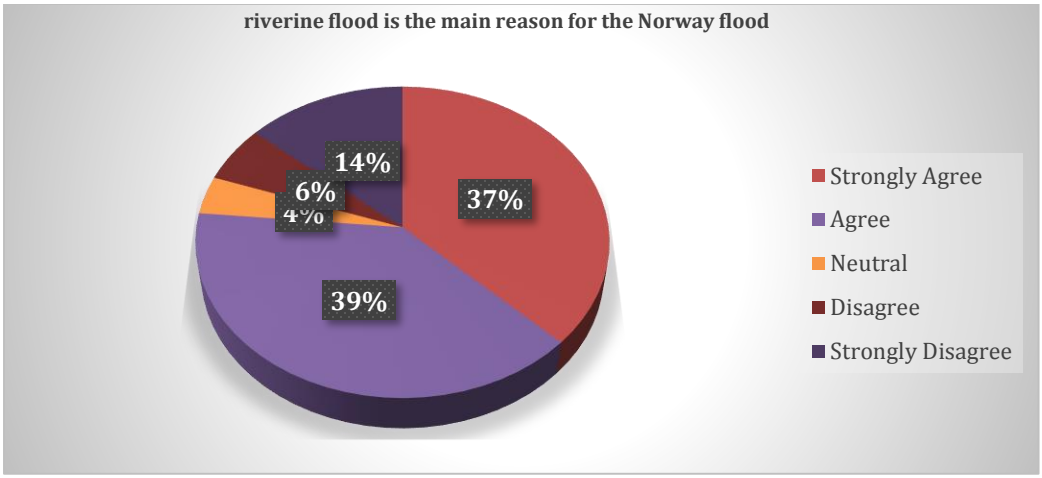

Figure 4.1: Riverine flood is the main reason for the Norway flood

In response to this question, most of the respondents have provided the same opinion that riverine flood is the main reason that creates a flood in Norway. The main reason for this is that all the respondents have agreed that the main reason for the Norway flood is riverine water; this is because of a lack of a flood management system whereas this lack of management system creates an issue in the economy of the country affecting the growth of the country. In response to this question, it has been found out that about 37% of the respondents have strongly agreed whereas 39% of the respondents have agreed on this question. The chance of the riverside flood is maximum because the depth of the river is less and the land surface of Norway is just above 800 metres above sea level. Hence, for this reason, the maximum number of respondents has agreed on this. On the other hand, 14% of people have strongly disagreed whereas 6% of people have disagreed. The people who had disagreed are because of the trends analysis highlights that snow melting and rain cyclones also play an important role in creating floods in Norway. The risk of river floods in Norway is not uniform as various other factors play an effective role in creating a riverine flood.

Q2; Do you believe that this seasonal change can be the reason for this flood?

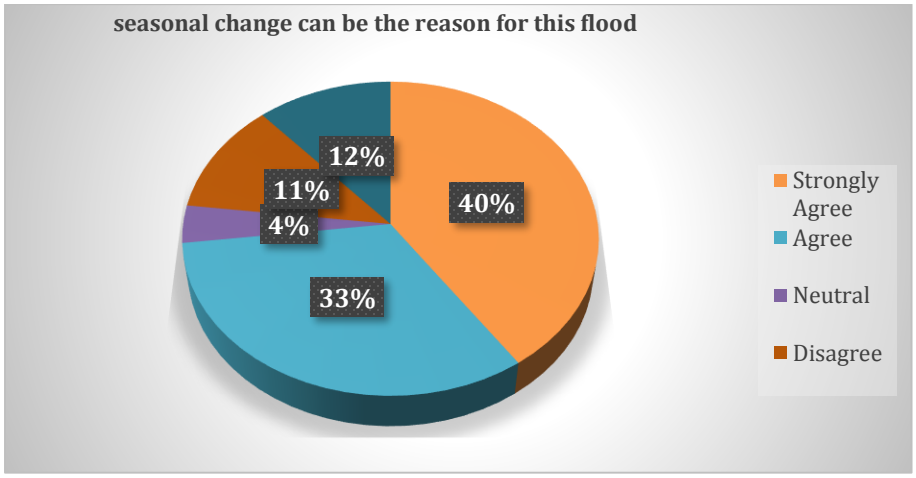

Figure 4.2: seasonal change can be the reason for this flood

In response to this question, it has been found out that about 33% of the people have strongly agreed on this question whereas 41% of people have strongly believed that seasonal

changes are another primary reason that causes flood in Norway. During seasonal changes, the snow started melting as this creates a huge issue for the government and the people of Norway. Focusing on the past history of Norway floods, it has been found out that due to the high melting of the snow and high temperature, the Eastern side of Norway has experienced a strong flood. Furthermore, it has been found out that the autumn floods are most devastating in Norway; this is because of high precipitation and high temperature in the Northern region. On the other hand, it has been found out that in response to this question, about 12% of people have strongly disagreed whereas 12% of people have disagreed. This is because of the political espionage that has been taking place in Norway for over the years and for this reason, proper infrastructure has not been developed; this lack of infrastructure affects overall performances.

Q3. Do you believe that a flood warning system in flood can be helpful for effective flood management?

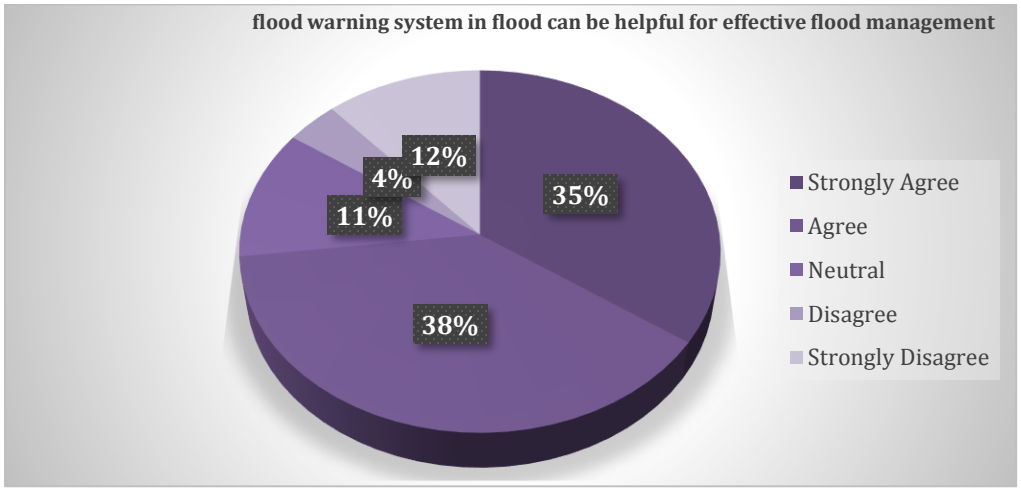

Figure 4.3: Flood warning system in flood can be helpful for effective flood management

In response to this question, it has been found out that about 41% of people have strongly agreed whereas 33% of people have agreed. Flood warning systems help in raising awareness among the people. This increasing awareness among the people helps the people to take preventive measures against the upcoming flood. On the other hand, the people neutral in this response has highlighted that this flood warning system can be used for effective communications. The people who strongly agree on this question have highlighted that the flood management system is used

for protecting people and take some preventive measures to minimise the rate of damages that can happen due to flood. On the other hand, it has been found out that about 12% of people have strongly disagreed whereas about 4% of people have disagreed on this question this is because of lack of visualization on this software. This lack of visualization often decreases the quality of providing proper functions.

Q4: Did the early forecasting system provide a good benefit to the people of Norway?

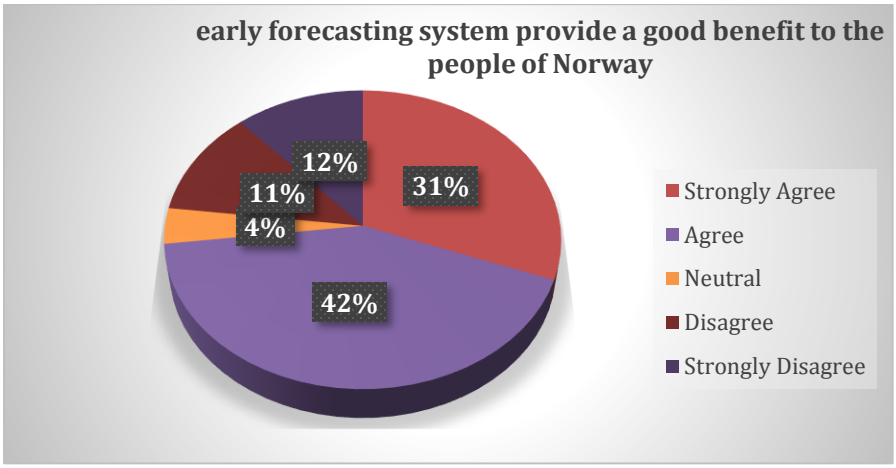

Figure 4.4: Early forecasting system provides a good benefit to the people of Norway

In response to this question, it has been found out that 31% of people have strongly agreed whereas 43% of people have agreed. Focusing on the historical information about the flood, in Norway, in the year 2001 and in the year 2013 people of Norway have been informed earlier by the flood management department with the help of flood management system. Providing early information helps the people of Norway to take the best preventive measures; these best preventive measures help in reducing the rate of mortality. This was reducing the rate of mortality has been a great achievement of the flood management system, whereas this effective step by the government has also helped in reducing the rate of mortality. On the other hand, from this survey, it has been found out that about 12% of people have strongly disagreed this is because of the 2011 flood as the rate of mortality is high, and the flood warning system provided information that is not effective.

Q5. Do you believe that the river basin management plan plays an effective role in forbidding the Norway flood?

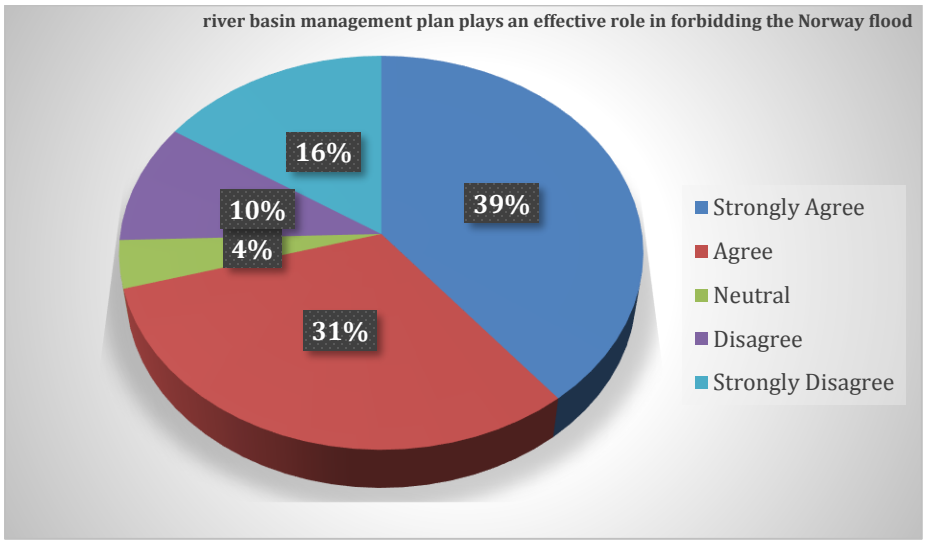

Figure 4.5: River basin management plan plays an effective role in forbidding the Norway flood

From the survey analysis, it has been found out that 39% of people have strongly agreed that a river basin management plan is an effective plan for managing the flood of Norway. 31% of people have agreed on this question; lack of infrastructures is another primary reason that affects the coastal areas of Norway. This process has increased the rate of creating proper infrastructure creating proper infrastructure in the coastal areas help the Norway government to minimise the economic damages that can happen due to flood. Respondents' opinion has been towards the river water management process as this helps in managing the condition and minimising all the issues that arise in flood. On the other hand, while 16% of respondents have strongly disagreed, whereas 10% of respondents have disagreed. This is because the critical infrastructure that has been situated in the country, such as the drainage management system is not up to mark. Improving this drainage management system is necessary, focusing on the river basin management system is not necessary.

Q6. Do you believe that lack of infrastructure is the reason for the Norway flood?

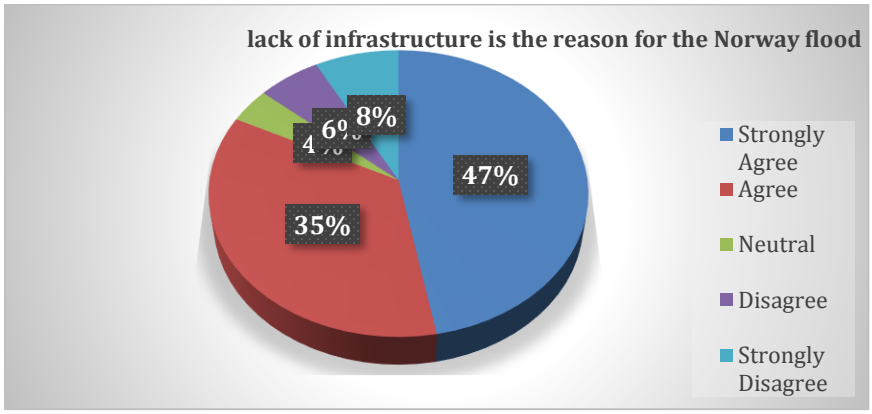

Figure 4.6: Lack of infrastructure is the reason for the Norway flood

47% of the people have strongly agreed where 35% of people have agreed on this question that lack of infrastructures is an issue that affects overall performances and created issues in the management services. The drainage system is not at all highly decorated, whereas the river water management system is not as good as this created issues for the local people to conduct their job in a much effective manner. The primary reasons for flooding in Norway are ice melting, rain cyclones and riverine floods. This flood has been uniform, and the government of Norway cannot adapt proper steps against this flood. Due to lack of proper drainage facilities, the snow melting water cannot be carried out in the river, and for this reason, the Northern side of Norway has been suffering from the high flood. On the other hand, high precipitation in the eastern region creates an issue for the people as flood scenarios can happen at any time. About 20-30cm precipitation the people of Norway living in eastern region experience flood this is due to lack of proper infrastructure, On the contrary, about 85% of the people have strongly disagreed as they believe that these natural calamities cannot be stopped with the help of proper measures.

Q7. Do you believe that a flood warning system can help in raising awareness among people?

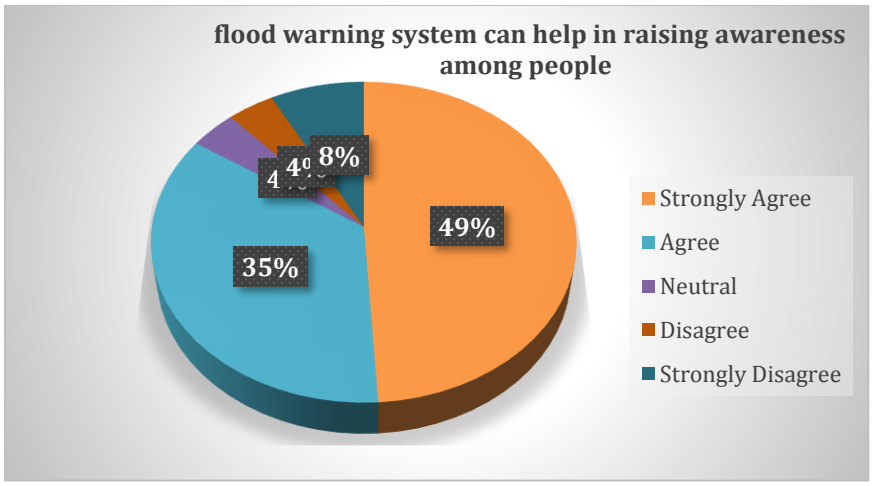

Figure 4.7: Flood warning system can help in raising awareness among people

In response to this question, it has been found out that 49% of people have strongly agreed whereas about 35% of people have just agreed. Focusing on history, it can be stated that this flood warning system has helped the country to take some preventive measures if this flood warning system is not situated. The Norway Government and people of Norway are able to face some huge crises. Due to this flood management early warning, the government of Norway faces crises that are minimal, and for this reason, the economic loss for the country is maximum. Flood forecasting systems have been focused on meteorological forecasts and providing correct forecasts helps the people to make a proper decision against the upcoming flood. On the other hand, it has been found out that a minimal number of people have disagreed on this as the post-rehabilitation process cannot be conducted in a swift manner. On the other hand, the flood intensity cannot be predicted accurately, and for this reason, most of the responders have not agreed.

Q8. Do you believe that the HYDRA programme is a complete failure?

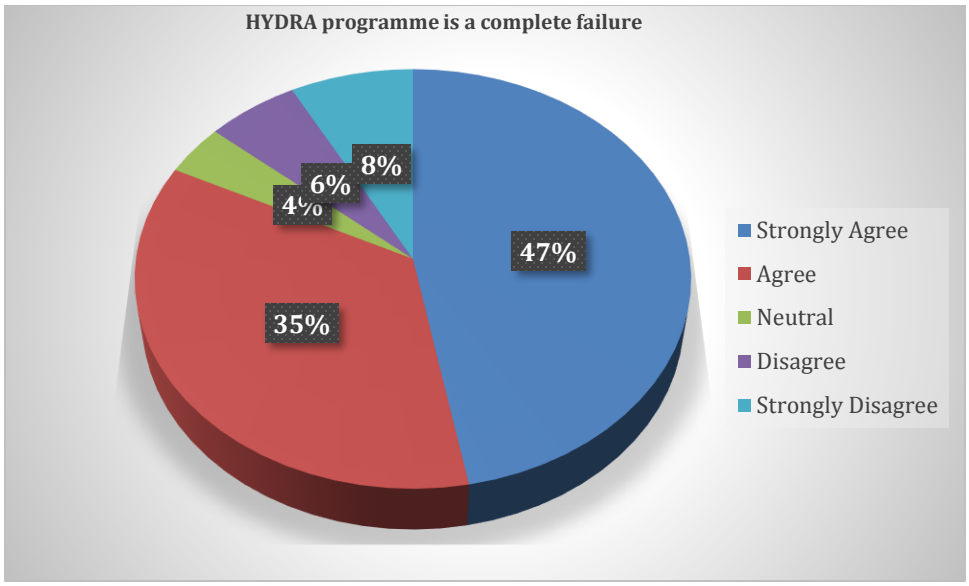

Figure 4.8: HYDRA programme is a complete failure

In response to this question, the maximum people have strongly agreed whereas supporting them about 35% of people has strongly agreed. The Main of developing Hydra is to highlight the level of risk that has been associated with the flooding process. Furthermore, the main task of HYDRA is to analyse the risk that has been associated with and focus on providing a proper solution to minimise the risk. The main cause of developing HYDRA is for flood reduction and flood protection process. The regional frequency analysis is high as this will directly affect overall performances. Hydra has been focused on establishing standard reports that can help in reducing the cost and improves the flood frequency analysis in a proper way. But the project Hydra fails to provide a proper solution, and for this reason, the project cannot be conducted in a perfect manner. On the other hand, few respondents have agreed that this project is a success because this project has highlighted places where flood affects maximum.

Q9. Do you believe that the political factor is affecting critical infrastructure building?

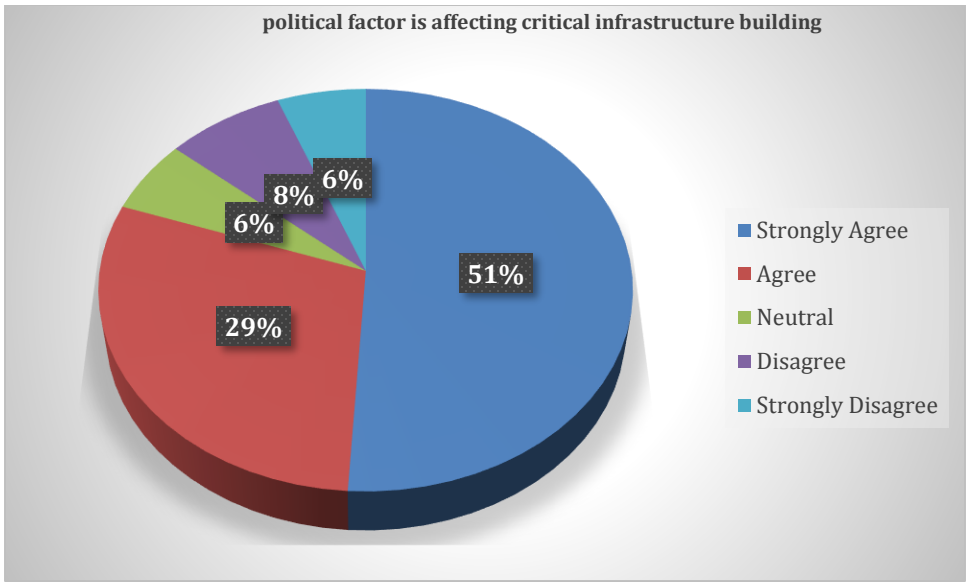

Figure 4.9: Political factor is affecting critical infrastructure building

51% of people have strongly agreed on this question, whereas 29% of people have agreed that political factors are creating issues in developing proper infrastructure in Norway. This lack of proper infrastructure has affected the country, and for this reason, effective development cannot be created. Flood affecting Norway is uniform, but due to this political espionage Government of Norway has not been able to develop proper infrastructure that helps in improving the rate of performances. On the other hand, this political crisis is creating different issues, and this issue affects the overall performances of the country. This flood effect creates a political crisis, and for this reason, most of the people have not focused on minimising all issues in many effective manners.

Q10. Do you believe that this flood management system can help the people of Norway in future?

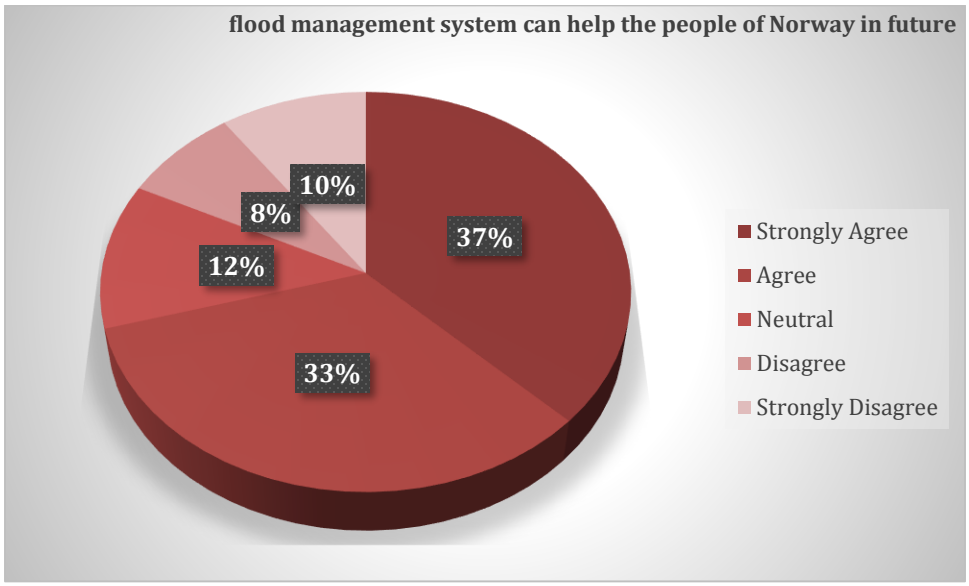

Figure 4.10: Flood management system can help the people of Norway in future

In response to this question, it has been found out that 37% of respondents have strongly agreed whereas 33% of respondents have just agreed. The evolution of technology has been helping the sector to grow, whereas this evolution process helped the people of Norway to take precaution against the flood. Irrespective of this, the intensity of the flood can be measured with the help of this technology, and this intensity measurement process helps in resolving all the issue in such effective manners. The government of Norway has been focused on several standards to control this flood management process, but investing in these techniques can help in both pre and post-flood management processes. On the other hand, a few people have disagreed on this issue and highlighted that this technology could not be able to provide a good solution in future.

Group 2

Q1. Do you believe that riverine flood is the main reason for the Norway flood?

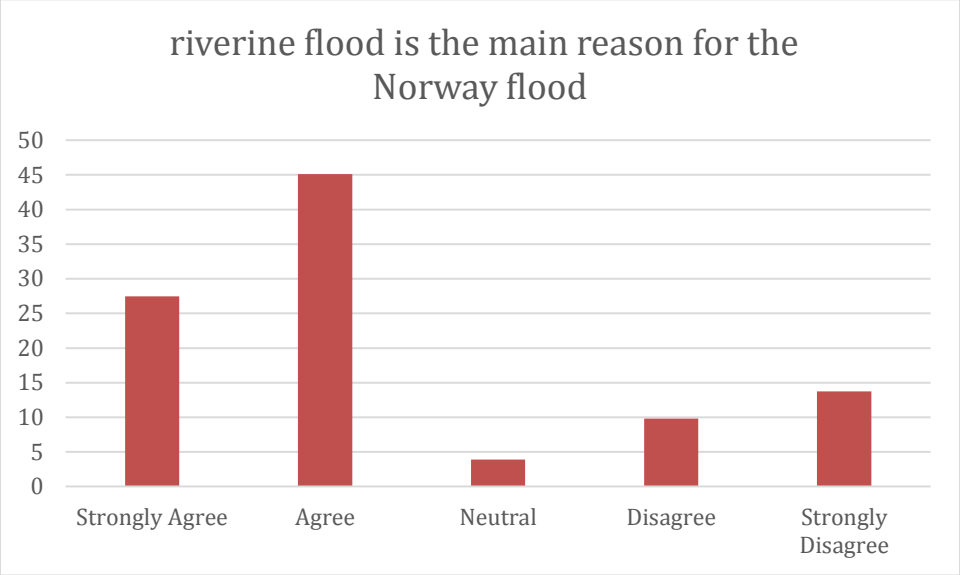

Figure 4.11: Riverine flood is the main reason for the Norway flood

In response to this question, it has been found out that most of the respondents have agreed and about 27% of people have strongly agreed on this issue, and the response has helped the researcher to find out the issues. Autumn floods are also common, which are prevalent due to the high precipitation and increased temperature. Norway also has a wide area having low lying lands which have a long river running through them. The impact of riverside floods can be considered as less intensive in Norway compared to the other floods. However, river floods tend to cause substantial damage to livelihoods and infrastructure. The other respondents who have disagreed on this question are minimal, for them the issue such as lack of proper infrastructure and lack of flood management system. Furthermore, for this people lack of proper infrastructure is an issue this lack of proper

Q2; Do you believe that this seasonal change can be the reason for this flood?

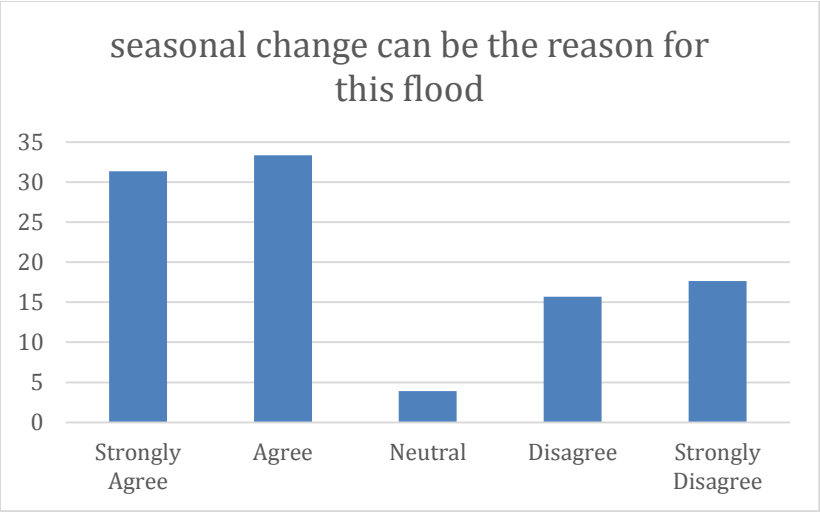

Figure 4.12: seasonal change can be the reason for this flood

In response to this question, it has been found out that 30% of respondents have strongly agreed whereas 33% has agreed on this situation. The entire amount of snow in the winter, which is named as SD or Snow Depth as well as SWE or Snow Water Equivalent, has substantially increased over the last few years in specific areas such as colder areas and northern regions. Most of the respondent has agreed that this snow melting is another primary reason that causes flood in Norway. Since 1962, the western and southern pieces of Norway were required to have more recurrence of precipitation because of snow stream release. Expanded degrees of precipitation in the nation additionally increment the degree of flood in the nation. On the other hand, it has been found out that the minimal number of respondents has disagreed as the reduction in the recurrence of a flood can be considered as a diminished degree of snow soften in the separate area.

Q3. Do you believe that a flood warning system in flood can be helpful for effective flood management?

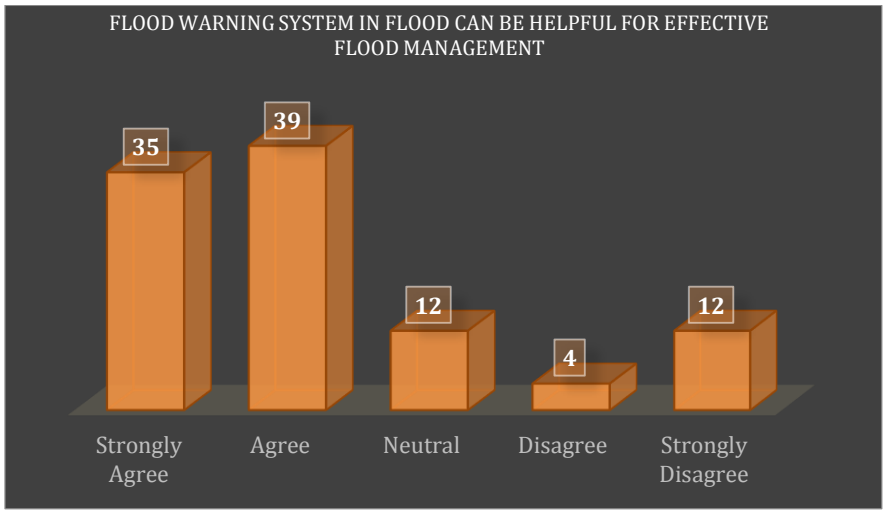

Figure 4.13: Flood warning system in flood can be helpful for effective flood management

From the above graphical representation, it can be stated that 35% of respondents have strongly agreed, whereas about 39% of respondents have agreed. The reason because most of the people have been focused on the flood management system is lack of proper functioning, and this proper functioning process affects overall performances. The flood forecasting system has been focused on analyzing the temperature, and precipitation level in the palliative and streamline flowFlood forecasting mostly depends on the meteorological forecast as this is an autoregressive procedure this helps in achieving probabilistic forecast. On the other hand, the minimal number of respondents disagreed because of Norway has been facing issues for this flood, there are various reasons for which the flood is taking place, the first is the ice melting, then rain cyclones is another reason for which the cyclones took place. Cyclonic rainfall is also caused by activities of the cyclone, and it often happens along the fronts of the cyclone. Sometime this flood management system fails to provide exact information on this cyclonic rainfall which creates a flood.

Q4: Did the early forecasting system provide a good benefit to the people of Norway?

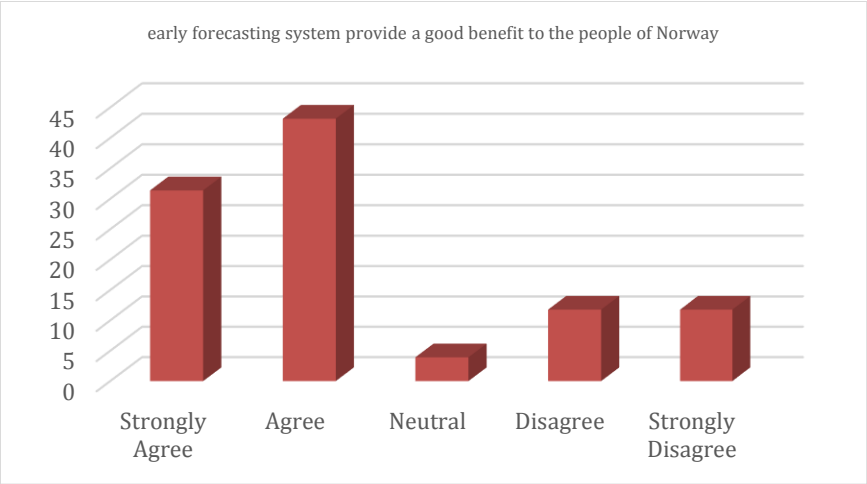

Figure 4.14: Early forecasting system provides a good benefit to the people of Norway

In response to this question, it has been found out that most of the respondents participated in this survey report have provided their opinion in favour of the flood management system. This flood system is focused on providing effective information as this improves overall performances and enhances the rate of performances and proper adoption of this step has been taken. In the year 2013, two major floods hit the Norway region, and this Flood management system plays a pivotal role in ineffectively managing the flood warning system. This flood warning system helps in improving the overall performances during pre-flood initiatives. The floods that are incurred happen due to frequent rainfall, and the flash flood creates an effective issue as this will effectively create an issue. On the other hand, respondents who have lacked awareness about the flood management system benefit highlights, that the primary reason for which the flood occurs is lack of proper infrastructure, lack of proper steps by the government and callousness attitude from the political faces. Ice melting is another issue for which the flood is creating in the autumn season.

Q5. Do you believe that the river basin management plan plays an effective role in forbidding the Norway flood?

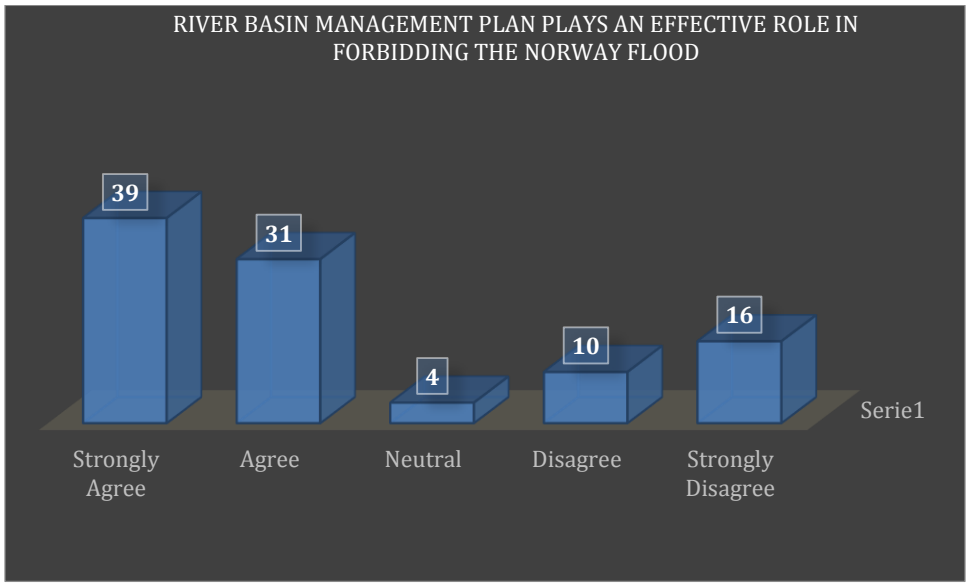

Figure 4.15: River basin management plan plays an effective role in forbidding the Norway flood

In response to this question, it has been found out that a maximum number of respondents has agreed that whereas 39% of people have strongly agreed. The Norway government has adopted various steps to minimize the disaster that happens due to floods. This Norway river basin management plan is focused on reducing the stress associated with the flood for the government. This river water basin system is focused on minimizing all the issues in a much effective manner. This river basin system has been focused on maintaining the river water situated in Finland and in the Norway region. Under this river defence management system, the government of Norway has been focused on introducing the river defence system. The northern and western part of the country is prone to have been suffering from the riverine flood. In the northern side of the country, it has been found that the land is above 1300 coastal land, this increase inland in the coastal plan increases the chance of the coastal plain.

Q6. Do you believe that lack of infrastructure is the reason for the Norway flood?

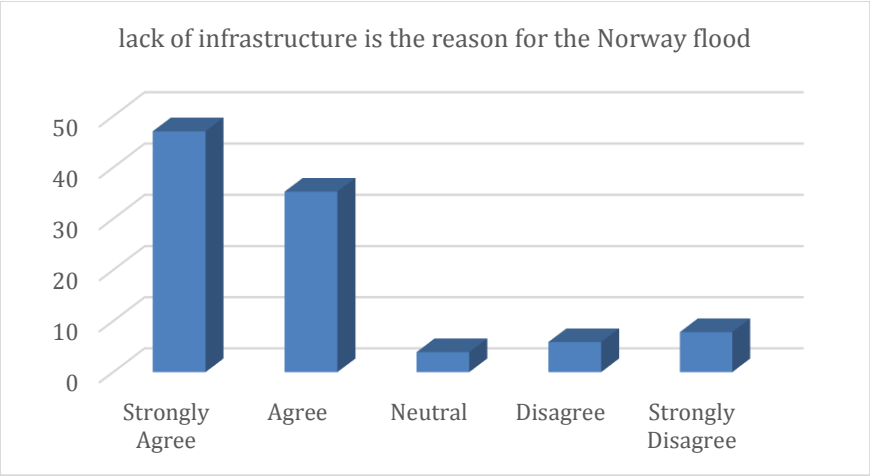

Figure 4.16: Lack of infrastructure is the reason for the Norway flood

The response from this group provides critical responses as this groups highlights that During the autumn season, the few inland seasons have been affected as this affects overall performances and this creates an issue for the people in the Northern part of the country. Snowmelt is largely a climate-controlled factor which regulates the state of hydrology in almost all the countries. Rapid snowmelt can cause severe flooding due to its incidence of frozen soil. Higher levels of snowmelt also cause erosion in some areas. For this erosion, the agriculture sector also gets affected as this affects the overall economy of the country. On the other hand, few of the respondents have not agreed with this question. The investigation of pinnacle stream release affects the country, and this stream realise she affects the country in the near future. The increases in the rate of temperature and precipitation in the Scandinavian region is very high, and for this reason, most of the people get affected by a flood.

Q7. Do you believe that a flood warning system can help in raising awareness among people?

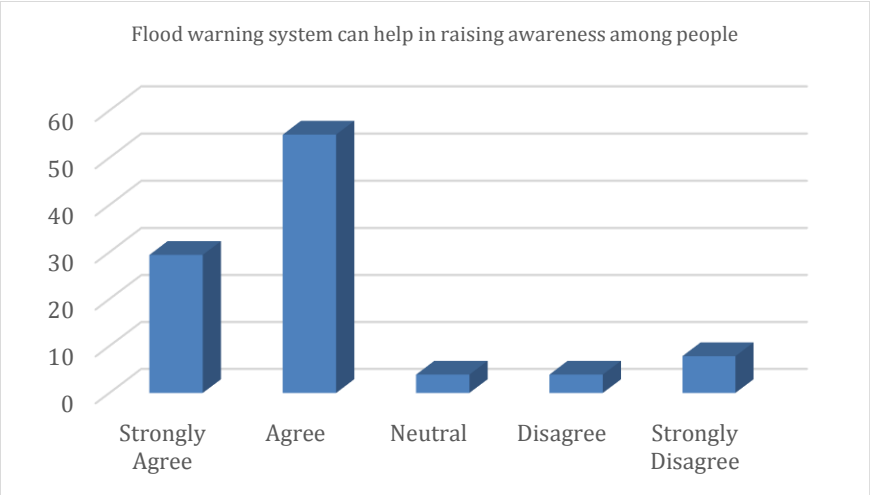

Figure 4.17: Flood warning system can help in raising awareness among people

In response to this question, it has been found out that flood warning management system plays an effective role in raising awareness, Most of the respondents who have taken part in this research paper have highlighted that the flood warning system that has been adopted by the company has been creating an issue for the people living in Norway.The rise in floodwaters was assumed to be the highest in the last 50 years. The issue of heavy rainfall was also accompanied by a substantial level of snowmelt in the country. This flood has created issues in various ways; first, it hampers the transport services, and this transport issue creates issues in the country's economy as good effective transportation gets affected. On the other hand, it has been found out that this flood warning system fails to provide proper information about cyclonic rainfalls. Cyclonic rainfall is also caused by activities of the cyclone, and it often happens along the fronts of the cyclone. The climate of Norway can be regarded as much milder than neighbouring countries, and for this reason, the cyclonic rainfall in this area is much higher due to low pressure.

Q8. Do you believe that the HYDRA programme is a complete failure?

Most of the respondents who have taken part in this research paper have highlighted that the flood warning system that has been adopted by the company has been creating an issue for the people living in Norway. The rise in floodwaters was assumed to be the highest in the last 50 years. The climate of Norway can be regarded as much milder than neighbouring countries and for this reason, the countries are not focused on reducing the rate of performances In Norway, the flood system that has been adopted by the government of Norway has launched the HYDRA project to provide regular updates to enhance the flood management systems. This Hydra project risk was highlighting the economic loss that had been associated with the flood. The Hydra research had been focused on providing a good level of knowledge about different factors of risk that are associated with the flood.

Q9. Do you believe that the political factor is affecting critical infrastructure building?

The river depth of most of the Norway River is very high, and for this reason due to heavy flood the rate of conduction of flood increases, and for this reason, most of the people living in the peninsular area get affected. The magnitude of rainfall is high, and for this, the rate of flood intensity is high where due to lack of depth of the river and lack of proper infrastructure affects overall performances of the country. In the region where the chance of flood is maximum in that same region the chance of the flood also increases this is due to less effective performances and lack of steps that have been taken by the government of Norway. The snowmelt flood is another issue, and for this reason, some of the respondents who took part in the survey have disagreed with the current question. Change in the session is creating issues for the Government of Norway. The change in season means annual flood rate, and despite an effective flood warning management system, Norway government has not adopted proper steps to increase the rate of performances.

Q10. Do you believe that this flood management system can help the people of Norway in future?

The resemblance of the precipitation helps in conducting the forecast, whereas the hydrological ensembles are focused on precipitation and temperatures. The streamflow ensembles post-processed process improves the overall sharpness and generally calibrates a perfect result.

The floods that are incurred happen due to frequent rainfall, and the flash flood creates an effective issue as this will effectively create an issue. This flood system provides the most accurate time of the flood, and accurate intensity of flood and people living in the flood-prone areas are able to take preventive measures to reduce the rate of a flood. In this survey, the people on the neutral side provided an opinion that the flood forecasting system and the operation should provide proper information and the information should be provided in such a way that most of the people are able to understand the rate. The People Who had agreed on this question have highlighted that the flood forecasting system's main duty is to create awareness and provide information about the risk that has been associated with the flood. The people who had strongly agreed provided the opinion that the government should focus on using this process for communication as this will help the people live in flood-affected areas.

Group 3

Q1. Do you believe that riverine flood is the main reason for the Norway flood?

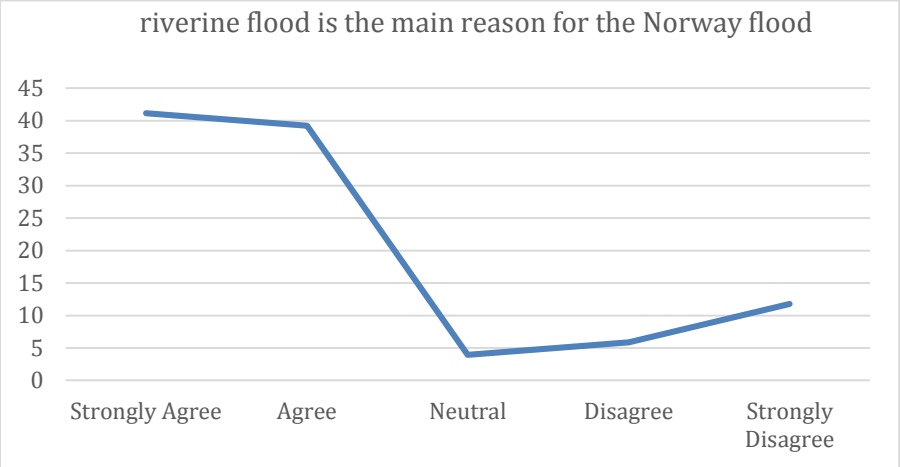

Figure 4.18: Riverine flood is the main reason for the Norway flood

In this group analysis, one of the respondents has provided a significant point highlighting that the Eastern region of Norway had suffered the highest number of floods. Some of the respondents have agreed on this issue, and this was to open a new research topic for the future researcher. Future researchers are able to look at the situation why the rate of a flood is high in the eastern region. Most of the respondents in response to this question have agreed that riverine flood is the primary reason whereas in spite of riverine flood, snow melting, flash floods and flood from

snow plays an effective part for conducting flood in Norway.An increasing trend in streamflow magnitude and trends of the timing of floods, the season flow in the near-natural catchment is maximum in the area of Denmark and Norway. The Scandinavian rivers show no statistically significant trend discharging the river peak. In Norway, it has been found out that 30% of the rain happens due to the precipitation, and for this precipitation rate of flood increases. The western part of the rain also suffers from high rain flow as this increases the chance of the flood. The chance of flood increases due to the rainfall as proper infrastructure related to the flood does not increase as this decreases the overall chance of flood in Norway.

Q2; Do you believe that this seasonal change can be the reason for this flood?

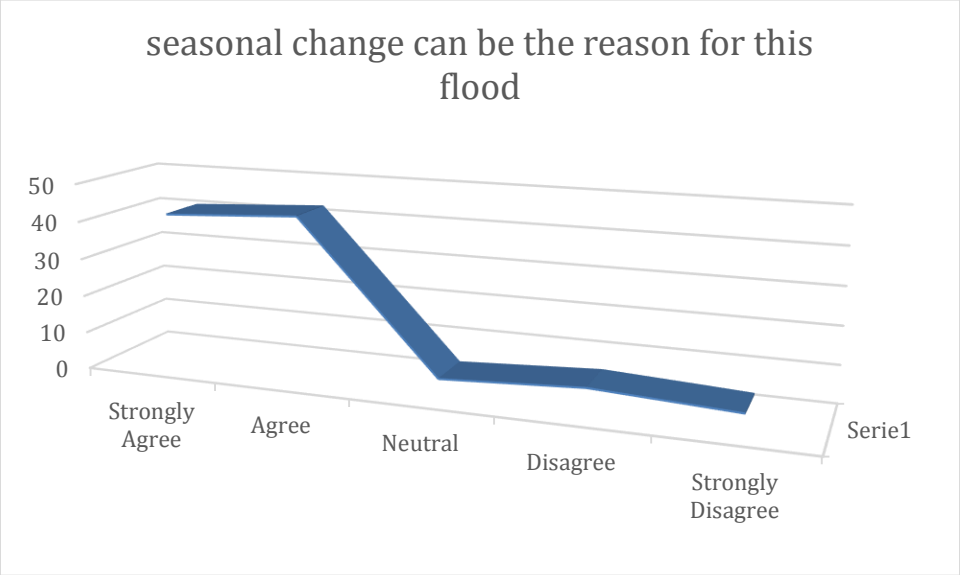

Figure 4.19: Seasonal change can be the reason for this flood

The snow melting process affects overall performances, and for this, most of the people get affected. Most of the people have agreed on this question because of the rate of the devastating flood that has been affected by the riverine flood. Large quantities of the snow melt water affect the flood, and for this, most of the people have agreed that season changes affect the flooding process. The flood of 1789 was regarded as the most devastating flood of all time in the history of floods in Norway. Autumn floods are also common, which are prevalent due to the high precipitation and increased temperature. In September of 1962, Norway experienced a detrimental flood which caused the damage of NOK 1 Million at that point of time. From this response, it can

be stated that most of the people believe that season changes create a flood, snowmelt as this creates a critical situation for the government and the people to tackle the situations.

Q3. Do you believe that a flood warning system in flood can be helpful for effective flood management?

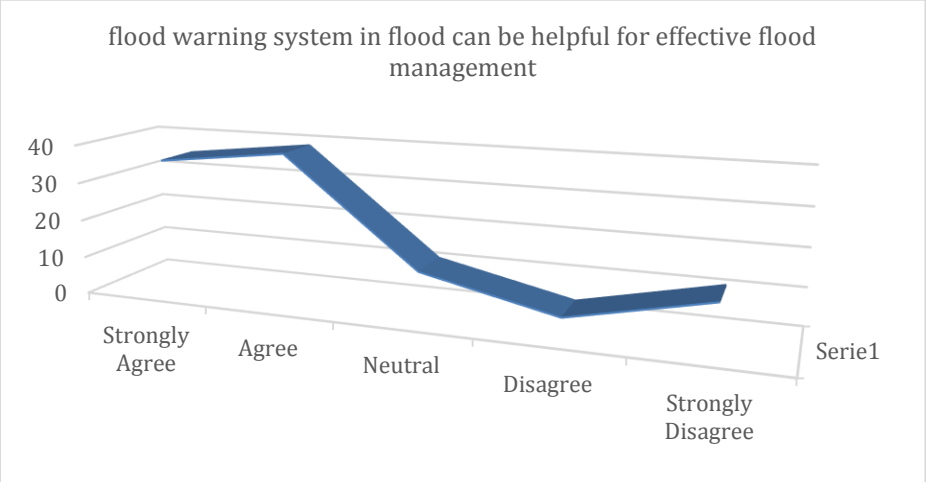

Figure 4.20: Flood warning system in flood can be helpful for effective flood management

According to the response of strongly agreed respondents, it has been found out that flood warning provides good support to the people of Norway for conducting evacuation and taking proper steps. In the riverine flood of 2003, it has been found out that the mortality rate of people of Norway is minimal; this is due to proper evacuation steps that have been taken by the government. This proper evacuation step has been taken due to proper information provided by the flood warning system. This flood warning system decreases overall mortality rate. A flood warning is an important means that helps in reducing the stress and focused on reducing the rate of mortality within the country. Providing proper warning can help a country to take some preventive measures, this preventive measure reduces the affordability in the flooding process.

Q4: Did the early forecasting system provide a good benefit to the people of Norway?

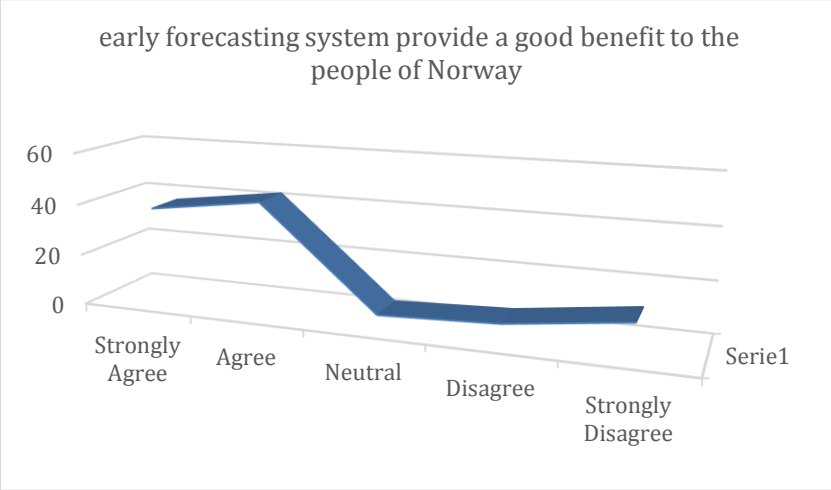

Figure 4.21: Early forecasting system provides a good benefit to the people of Norway

Most of the respondents have agreed that the flood forecasting system has helped the government and the people live in Norway. On the other hand, few people have agreed. A little number of people had been on the neural side. The people who are strong on the flood forecasting system are focused on forecasting the system in many effective manners. The people have strongly agreed because the flood forecasting system has been focused on minimising all the issues in many effective manners. The people highlighted that this flood warning system not only focused on providing information to the government but also focused on creating proper awareness as this will decrease the rate of mortality in the flood forecasting areas. Some of the respondents have highlighted that the flood forecasting system is so much forecasted in providing proper information, it helps people to take proper information as this helps in minimising all the issues in many effective manners.

Q5. Do you believe that the river basin management plan plays an effective role in forbidding the Norway flood?

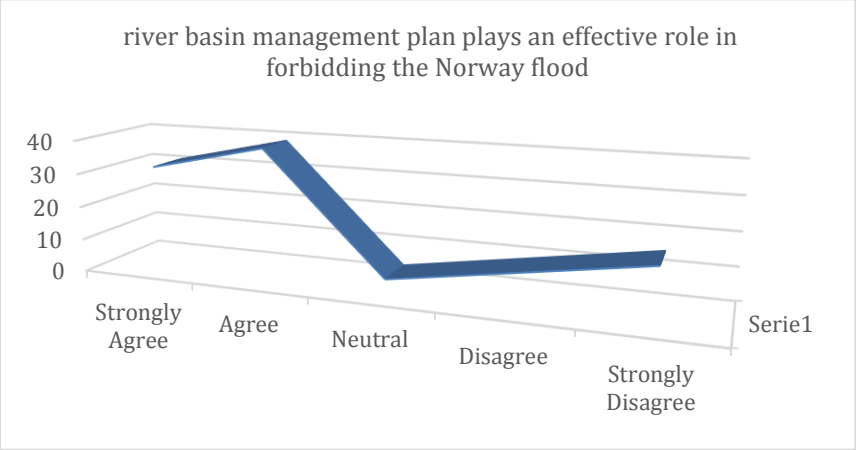

Figure 4.22: River basin management plan plays an effective role in forbidding the Norway flood

Most of the respondent has agreed while some of the respondents have highlighted that river basin management plan is another project that plays an effective role in improving the condition of the river basin whereas maintaining this basin can help in reducing the chance of the Norway flood. Hydropower production is another issue that affects the overall quality of the river water management process.

Q6. Do you believe that lack of infrastructure is the reason for the Norway flood?

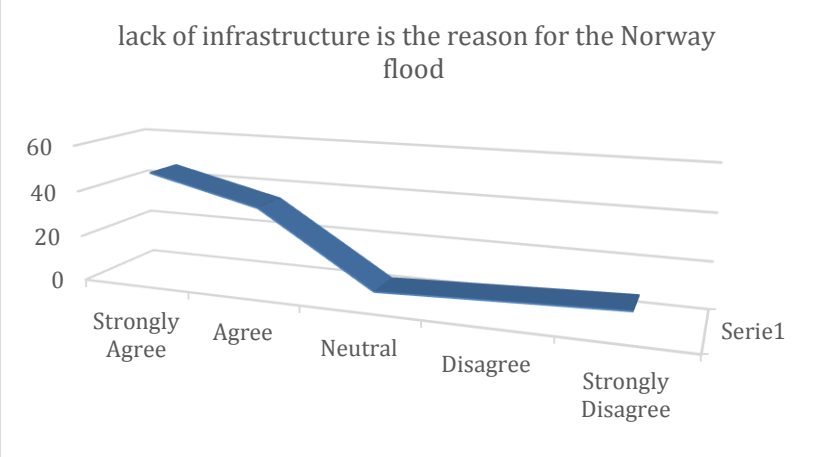

Figure 4.23: lack of infrastructure is the reason for the Norway flood

. The change of the precipitation and the recent changes in the coastal region pressure affects the overall flow, and for this, the rate of flood intensity in Norway has increased. The people who had strongly agreed on this question try to highlight that the rate of flood processing is maximum, and for this reason, the rate of flood flow is instantaneously high.

Q7. Do you believe that a flood warning system can help in raising awareness among people?

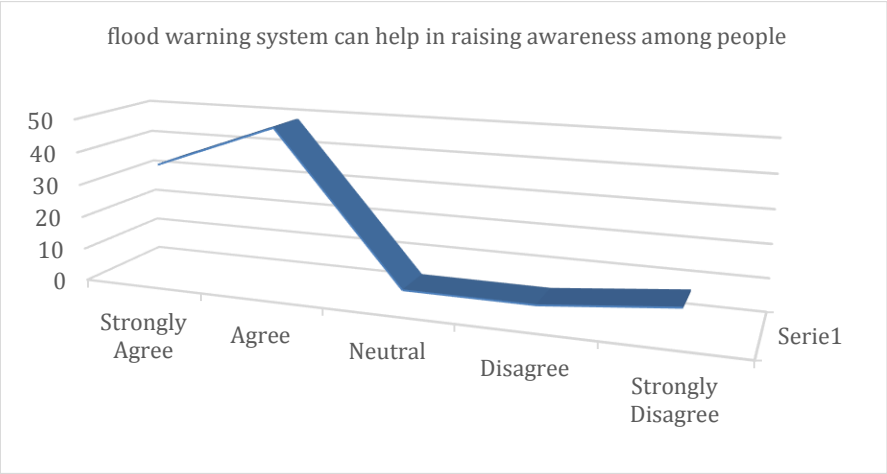

Figure 4.24: Flood warning system can help in raising awareness among people

In response to this question, most of the respondents have agreed that the flood management system raise awareness, and for this awareness, the rate of mortality has decreased. On the contrary, it has been found out that some respondents have not agree with this question.

Q8. Do you believe that the HYDRA programme is a complete failure?

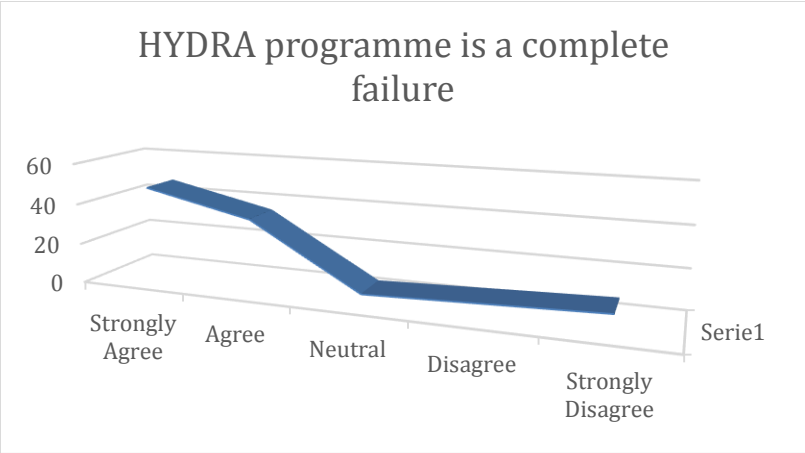

Figure 4.25: HYDRA programme is a complete failure

The main task of the Hydra is identifying flooding zones and the main task of HYDRA is to improve the regional flood frequency analysis. Irrespective of this, Hydra has been focused on establishing a standard report that can help in reducing the cost and improves the flood frequency analysis in a proper way. Hydra was considered as the research programme that can help in establishing a proper decision-making process related to the flood. According to the Government of Norway, the main task of the Hydra is identifying the flood zone and developing a proper critical structure that helps in creating the proper infrastructure to minimise the rate of damage of HYDRA. The global warning creates a concept era, and this process reduces the rate of performances and this creates an issue for the organisations. The Hydra research had been focused on providing a good level of knowledge about different factors of risk that are associated with the flood. The government of Norway has taken different functions to minimise the rate of flood management systems, and for this, the government has introduced some of the programmes such as Hydra.

Q9. Do you believe that the political factor is affecting critical infrastructure building?

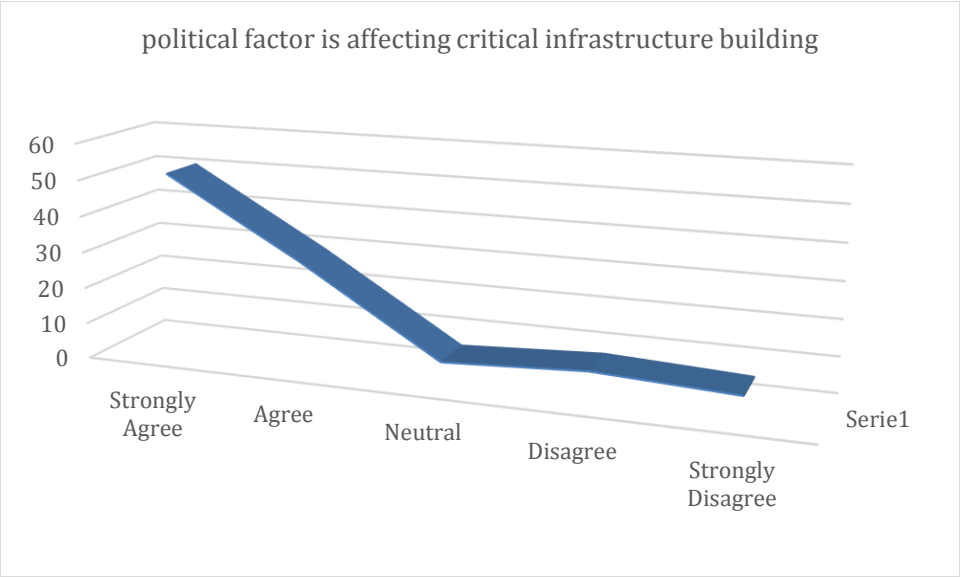

Figure 4.26: Political factor is affecting critical infrastructure building

Most of the respondents have agreed that the political factor of the country is affecting the critical infrastructure of the building. This critical infrastructure is affecting the overall performances of the country as this overall affecting profitability and economic condition. This regular flood also created an issue for the country to increases the flow of the country.

Q10. Do you believe that this flood management system can help the people of Norway in future?

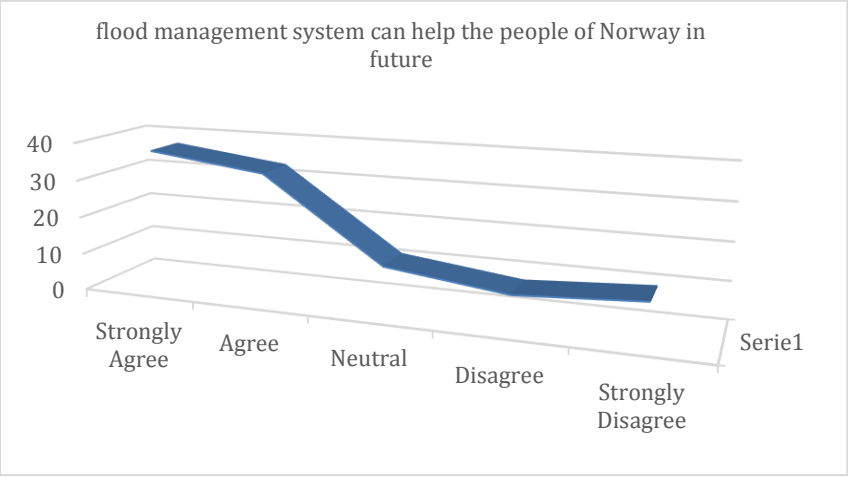

Figure 4.27: Flood management system can help the people of Norway in future

A flood warning system plays an important role, and this process reduces the rate of flood process and the risk associated with the flood. This flood warning system is focused on providing early warning to the people, and this process not only decreases the mortality rate but also helps in reducing the rate of economic loss. Flood warning system decreases overall performances, and for this reason, most of the people focused on minimising all the issues in many effective manners. Most of the respondents in this response have strongly agreed that a flood warning system helps in an effective flood management system. This flood management system not only decreases the disaster rate; the government is able to take preventive steps to reduce the rate of mortality.

Group 4

Q1. Do you believe that riverine flood is the main reason for the Norway flood?

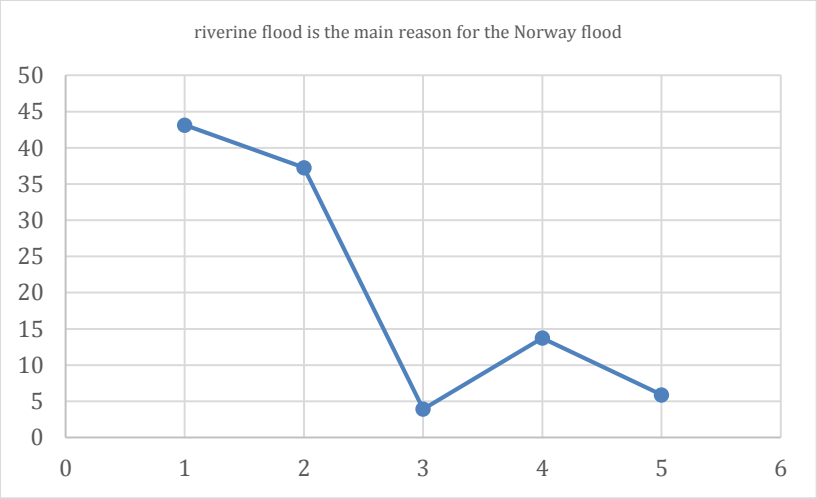

Figure 4.28: Riverine flood is the main reason for the Norway flood

In response to this question, most of the respondents have agreed that riverine flood is a primary reason that created the flood issue in Norway. Norway is a country that has been significantly prone to flood, and this process affects the overall economy and affects the overall infrastructure of the country. In Norway, there are several reasons behind the incidence of floods such as rain cyclones, ice melting and increased precipitation and climate. Flash floods, snow melting and rainfall are some of the essential factors that are affecting the flood situations.

Riverine flood has different characteristics, and the flood cannot be analysed all the time. The country has experienced the flood in the spring felts, and the Northern and Southern parts of Norway happen to form the units at different times.

Q2; Do you believe that this seasonal change can be the reason for this flood?

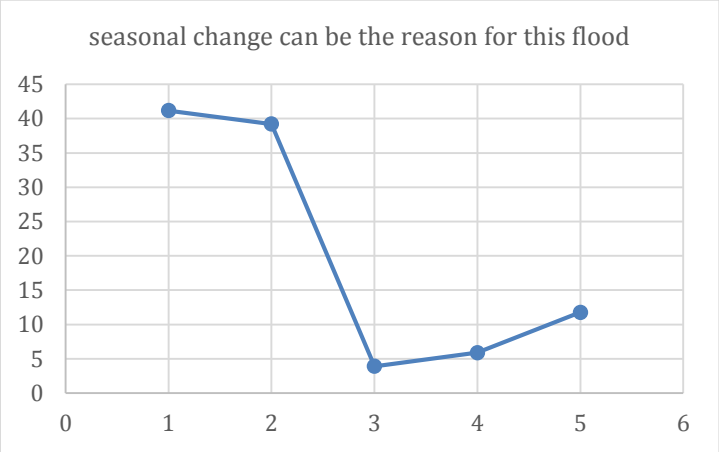

Figure 4.29: Seasonal change can be the reason for this flood

In response to this question, most of the respondents of this group have agreed, whereas few on supporting this question have strongly agreed. Looking at the trends and scenario of Floods in Norway, it can be effectively stated that the occurrence of the flood is the frequent phenomena, and most of the river flood is occurred due to riverine flood. The risk of flood in Norway is not uniform. On the other hand, the country has experienced several floods, and all floods are not all time related to riverine flood or from high rainfall. Sometimes Norway has experienced floods from different situations, some of them are lacking trust and effective management processes. The risk of the river flood in Norway is high, and due to the change of season, the flood from the northern region of Norway experienced several floods.

Q3. Do you believe that a flood warning system in flood can be helpful for effective flood management?

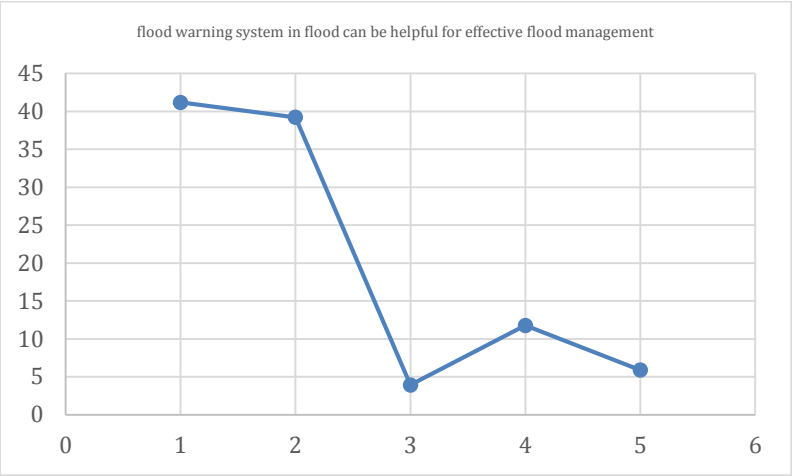

Figure 4.30: Flood warning system in flood can be helpful for effective flood management

In response to this question, it has been found out that the flood warning system can able to manage all the issue in a much effective manner as this help in uplift the level of performances. This flood warning system creates awareness among people and for this flood warning system, it has been found out that the flood warning system help in taking an effective decision.

Q4: Did the early forecasting system provide a good benefit to the people of Norway?

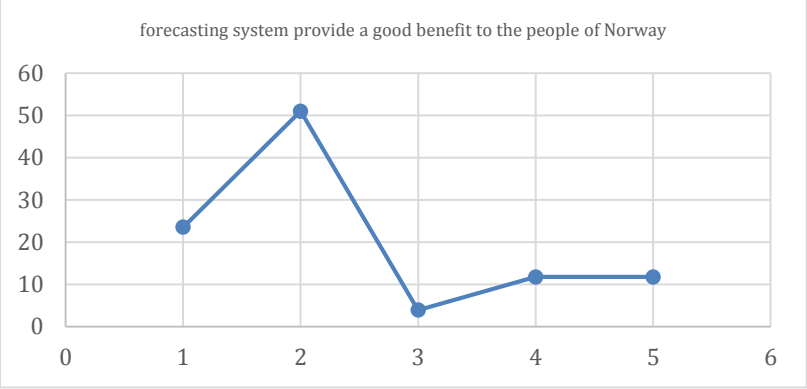

Figure 4.31: Early forecasting system provides a good benefit to the people of Norway

In response to this question, it has been found out that about 50% of respondents have agreed that early forecasting system can help in resolving all the issue in many effective manners. Cyclonic rainfall is also caused by activities of the cyclone, and it often happens along the fronts of the cyclone. Sometimes this flood management system fails to provide exact information on this cyclonic rainfall which creates a flood. Despite this limitation, most of the people have highlighted that this flood warning system is beneficial for them.

Q5. Do you believe that the river basin management plan plays an effective role in forbidding the Norway flood?

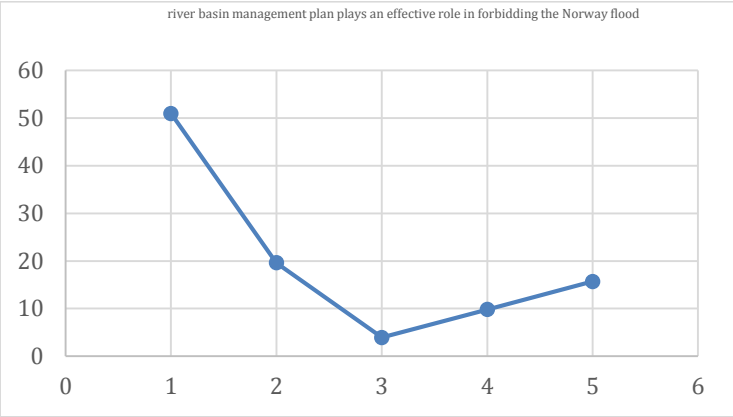

Figure 4.32: River basin management plan plays an effective role in forbidding the Norway flood

Most of the respondents have voted on behalf of the river basin management plan as this plan help them to improve the level of performances and enhances the infrastructure in the coastal regions. Flood affecting Norway is uniform, but due to this political espionage Government of Norway has not been able to develop proper infrastructure that helps in improving the rate of performances.

Q6. Do you believe that lack of infrastructure is the reason for the Norway flood?

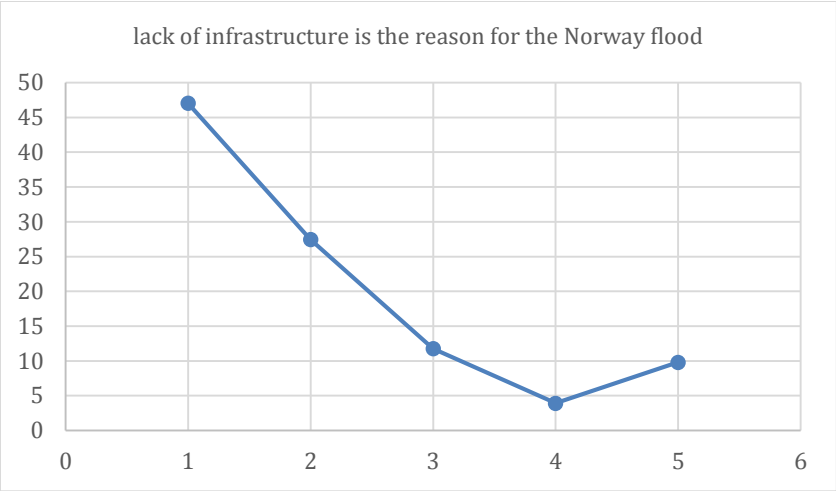

Figure 4.33: Lack of infrastructure is the reason for the Norway flood

The analysis of the peak flow in the Norway region highlights that the country had been experiencing various flow flood streams. On the other hand, the government has also introduced Norway river basin management plans. This river defence system has been focused on reducing the risk that is associated with the flood. Irrespective of this the river waterflood management system has been focused on building critical infrastructure. Under the river water defence system, the Government of Norway has built a good infrastructure in the northern side of Norway for effectively controlling the flood that has been happening due to the river basin. In these territories, occasions identified with precipitation have caused a huge increment in the recurrence of rainfalls. Right now, a significant explanation for the In the current time, the recurrence of precipitation in Norway is viewed as the principal contributory factor to the recurrence of floods. Moreover, the occurrence of precipitation in different pieces of the nation has additionally diminished altogether.

Q7. Do you believe that a flood warning system can help in raising awareness among people?

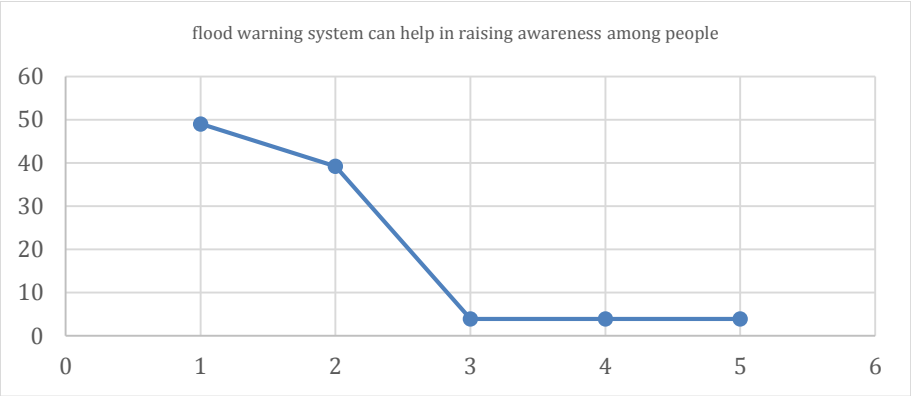

Figure 4.34: flood warning system can help in raising awareness among people

Cyclones can be regarded as an area with low pressure in which the direction of wind flow is counter-clockwise. The issue of heavy rainfall was also accompanied by a substantial level of snowmelt in the country. This flood has created issues in various ways; first, it hampers the transport services, and this transport issue creates issues in the country's economy as good effective transportation gets affected. Cyclonic rainfall is also caused by activities of the cyclone, and it often happens along the fronts of the cyclone.

Q8. Do you believe that the HYDRA programme is a complete failure?

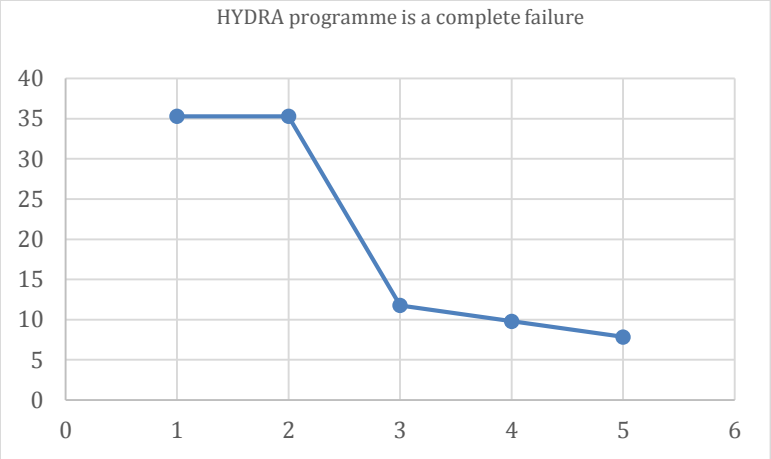

Figure 4.35: HYDRA programme is a complete failure

The major cause of the Norway flood is the lack of proper infrastructure created by the government as this increases the chance of the flood. The NVE is facing some challenges like

infrastructural, manpower and skills, lack of awareness, training and development, predictive uncertainties and legalities. The government of Norway has taken different functions to minimise the rate of flood management systems, and for this, the government has introduced some of the programmes such as Hydra. The Hydra research project had been focused on providing a perfect knowledge about environmental consequences that are associated with the floods. On the other hand, some of the responses from the respondents are that Hydra programme had been focusing on flood reduction and flood protection process.

Q9. Do you believe that the political factor is affecting critical infrastructure building?

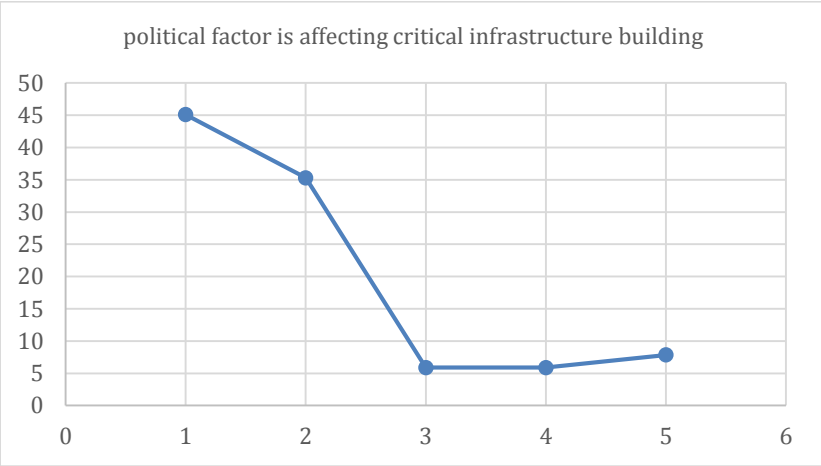

Figure 4.36: political factor is affecting critical infrastructure building

Political crisis plays an important role in the phase of this political crisis, and lack of proper monitoring is creating an issue for the country in conducting an effective flood management system. In order to develop a perfect hypothesis, it has been found out that the researcher has adopted a descriptive research design. The mountainous areas are considered to have a lesser amount of risks of the riverine flood. Building critical infrastructure can help the government of Norway to prevent the riverine flood but also helps in an effective post-flood management system. Cyclone can be regarded as an area with low pressure in which the direction of wind flow is counter-clockwise. Various types of precipitation affect overall performances, and this effective participation creates an issue as this affects overall performances. The floodwater management system gets affected as this creates an issue in the management cycle, whereas the government has been focused on minimizing all the issues in a much effective manner.

Q10. Do you believe that this flood management system can help the people of Norway in future?

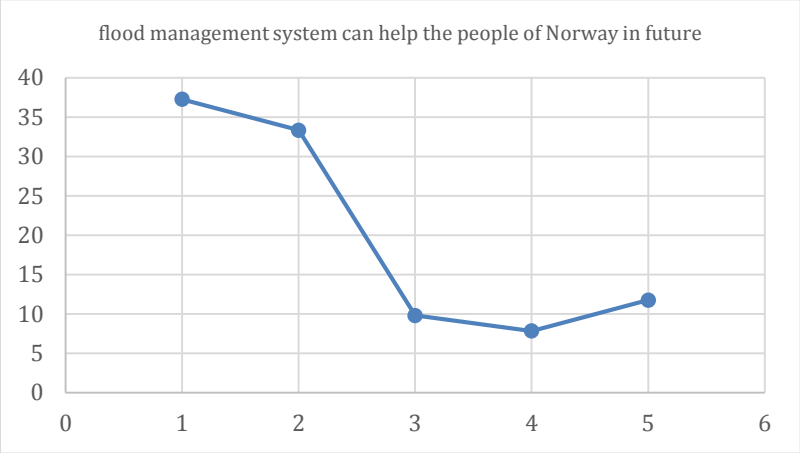

Figure 4.37: Flood management system can help the people of Norway in future

More than 30% of respondents have strong agreed, whereas a minimal number of respondents has not agreed with this question. Cyclonic rainfall is also caused by activities of the cyclone, and it often happens along the fronts of the cyclone. The climate of Norway can be regarded as much milder than neighbouring countries in the area. The western part of the country is considered to be wilder than the other parts. The western part of Norway and the coastal region of Norway have faced the highest number of floods. This is due to the high rate of snow melting and the high rate of coastal zone experiences. Most of the respondents have provided the same opinion highlighting that the flood management system can help the people to get aware of this flood management system and help people to improve their decision-making process.

4.3 Gap and Challenges of the methods

In this research paper, group analysis has been conducted on four groups, and each group consists of 51 people. In conducting the group survey, proper information from one person cannot be gathered where this group analysis can create an effective issue in understanding whether the flood management system is really effectively helping the people of Norway. On the other hand, collecting the data in this way sometimes effectively increases the issue, as the researcher has been focused on providing effective hypotheses. Collecting negative responses can create an issue for the researcher while publishing this journal article. The researcher has conducted this research,

and this research paper can be helped in minimising all the issues in a much effective manner. The researcher collecting this group analysis can increase the level of misconception among the people of Norway. Furthermore, the government of Norway cannot be able to take a proper step for this research process.

4.4 Summary

In this research paper, the primary quantitative method of data analysis has been conducted. This primary method of data analysis helps the researcher to resolve all the issues in many effective manners. In this primary quantitative data analysis, the researcher has adopted group analysis; this group analysis process helps the researcher to overcome all issues in many effective manners. Furthermore, this survey has helped the researcher to gain understanding about the effective issue and understanding the effective issue of Norway flood help the researcher to conduct more research to find some explicit solutions. Furthermore, the researcher has been focused on providing a holistic approach to the issues that are related to the flood of Norway. The researcher from this data analysis has come to know that riverine flood, snow melting, avalanche and landscape are some of the factors that lead to this flood whereas, on the other hand, the researcher has also come to know that the Government of Norway does not take effective steps in resolving all the issues. The critical infrastructure of the country plays an important role, and for this reason, the researcher has tried to highlight all the issues that are associated with this flood management system.

CHAPTER 5: DATA ANALYSIS: PERSONAL INTERVIEW

5.1 Introduction

The chapter is based on the analysis of the interview questions prepared for 3 meteorologists and the questions are centred on the effects of flood in Norway. This chapter has helped in identifying the causes of flood from the perspectives of the targeted participants in the interview. Moreover, the way the preventive method has been used to prevent the emergence of the flood is also analysed from the details of the interview participants. A detailed analysis has also helped in determining the significance of early warning to forecast the cycle of sea level for the detection of flood occurrence. Delving into the depth of this chapter, it is also known that the prevalent gaps within the flood management practices of Norway that are responsible for the outcome of flood not once but many times. Overall, the chapter has helped to identify the causes and effects of floods along with the identification of major causes related to the Norway flood management practices.

5.2 Qualitative Analysis

Q1: What are the causes of floods in Norway?

Several causes have been identified from the responses of the meteorologists participated in the interview. The 1st participant has focused on the rain cyclone as the major cause of the flood. Rain cyclones are not general rainfall; rather it elongates heavy rainfall along with the great flow. This flow of rainfall cannot be accepted by the sea level and eventually it outbreaks as the huge surge of water at the coastal area. Considering the rain cyclone as the substantial cause of the flood, 2nd meteorologist has supported that trough rain cyclone precipitation is brought along with cloud and with the prevalence of low pressure, the cloud outbreaks into heavy rain. The force of this including the flow of wind becomes so devastating that it breaks all the general level of the sea. Furthermore, through a detailed analysis of 2nd meteorologist, it becomes clear that ice melting is another major reason for increasing the sea level which at the final stage, comes out as the dreadful flood. In Norway, it is a common cause for flood occurrence and in this context, this meteorologist has pointed to the increasing temperature of Norway's weather. Generally in spring, the snow gets melted in Norway and simultaneously it exceeds the original level of the sea. Ice melting is considered as the major climate-controlled aspect that increases the rate of precipitation. Global warming due to the excessive pollution in Norway holds

the responsibility for flood occurrence. While merging the melted ice water with the sea level, it affects the soil underneath the sea. The power of infiltration gets damaged after receiving the snow melted water and as a result, the upward water level of the sea becomes increased. With the gradual expansion of the sea level eventually formulates as the devastating force known as the flood.

In order to respond to this question, the 3rdmeteorologist has opined that climate change is equally responsible for the outcome of Norway's'. It is analysed that climate change has occurred mainly due to human activities due to the eruption of excessive carbon into the climate. This excessive emission is addressed to climate change and the surface level of the earth becomes excessively warm. Climate change affects the entire environment as there remains no demarcation among the seasons and in every season, the threat of a rain cyclone can emerge. Climate change not only causes floods but also extracts all the humidity from air that leads to drought. While drought remains in the county, the existing water level becomes evaporated to a large extent and this excessive amount of water into the air ultimately shapes in the form of excessive rain. Therefore, depending on the answer of the 3rd meteorologist, it is analysed that due to their climate change, the outcome of rainfall is not limited in the autumn, but also it can outbreak at any season.

Q2: How seasonal changes can raise the cause of flood?

This interview question has been prepared for gaining the answer from the perspective of 3 meteorologists upon the liabilities of season change for the occurrence of a flood. The impact of season change is dreadful in the context of the flood. Especially in the northern regions, the colder areas are losing temperature due to global warming and as a result, the natural climate of those areas is becoming changed. Based on the response of the 1st meteorologist, it is analysed that due to the increasing rate of snow melting, the threat of flood is increasing. The natural hydrology is affected with the outcome of excessive snowfall and this has also degraded the climate of the earth. The high risk of snowmelt is addressed to the risk of frozen soil. The threat of frozen soil is also affecting flood emergence as due to the ineffective infiltration of the soil, the water-absorbing power of the soil becomes low. As a result, the eventual m level of the seawater increases and formulated into a dreadful shape of the flood.

On the other hand, the response of the 2ndinterviewee has helped in analysing the improper cycle of the season due to the environmental changes. This meteorologist has denoted that due to

global warming, all six seasons are not capable of coming in their respective form accordingly and this deterioration of the climate cycle affects the weather condition in that country. In autumn of the recent years, the incidences of heavy rainfall have not been reported in Norway, but at the mid-time of summer, without any heavy rainfall, the flood has entered into the country. In this context, the 3rdmeteorologist has stated that the cause of flood in summer is the heavy snowmelt in the northern areas. Due to the excessive level of snowfall in summer due to the increasing heat spreads out the threat of flood in Norway. Therefore, in the context of responding upon the impact of seasonal change, it has been analysed that seasonal change is equally responsible for the occurrence of the flood even in summer. Therefore, the result of this analysis shows that due to the increasing pollution in Norway, the normal temperature of every season keeps fluctuating. The raised temperature fails in holding the temperature of snow and eventually, it melts into the sea with extreme force formulates into the flood.

Q3: What preventive ways do you prefer to be undertaken by Norway?

The detailed analysis of this question has helped in analysing the significance of the flood warning technique as one of the effective systems for the prevention of impending flood. In order to respond to this question, the 1st meteorologist has opined that the necessity of a flood warning system is very much required as this helps the entire countrymen to warn about the upcoming threat of flood. The warning technologies would help in detecting the detailed functionalities of the water that develops identification of the flow related to streamlining. The precipitation level along with the analysis of current temperature, the flood warning system can detect the direction of water level. Supporting to this response, the 2nd Meteorologists have mentioned that detection of weather tremors helps in measuring if there are any rain cyclones that are likely to be merged into the country. Based on the proper measurement, the countrymen along the coastal areas would be warned so that in any type of external activities they are engaged in. Moreover, by measuring the depth of a rain cyclone, the government can take active steps for directing the falling rain underneath the soil. This preventive way would give enough protection to the countrymen with respect to the outbreak of flood as the natural disaster.

In addition to this, the 3rdinterviewee has declared that in order to avert the economic disaster, Norway could adopt this technique for ensuring an active warning for the flood disaster

in the country. Based on the trading or transportation through the sea level, the country receives most of its earnings from the sea and for this reason, it is also necessary to detect the level of the sea every time to avoid the outcome of natural calamities. Therefore, the role of flood warning system is unavoidable as this could only be effective for reaching the report sea level at the environmental office of Norway to take proper action to save the country. Therefore, analysing all these responses from the interviewees, it is discerned that the flood warning system not only provides warning at the right time to the weather department but also it protects the lives of the country along with strengthening the economy of the country.

Q4. What is the significance of flood management practices that can be adopted under the determination of reducing the threat of flood?

The question is centred on several flood management practices that have been pursued by the government of Norway as the effective ways for flood prevention. In this context, 1st meteorologist has denoted that the invention of the HYDRA phase is impactful in the process of flood management. This is considered as one of the effective research programs for the purpose of flood prevention. Through this project, Norway has focused on the economy of the country that had been previously affected by the outcome of the flood. At the initial stage of the Hydra program, the researcher has investigated the causes of the flood and based on this investigation, the funding for the flood prevention activities is increased. Increasing the investment on flood research the flood management procedures have become consolidated. This process is also supported by the 2nd meteorologist as it is analysed from his viewpoint that HYDR program has detected the root cause of increasing frequency of regional flood. In this way, the excessive cot investment upon the unnecessary flood prevention activities has been averted in Norway.

Additionally, it is further analysed that basin management plans in Norway have strengthened the procedures of flood management. Through the deployment of this management plan, the country has proceeded with maintaining strong relations with Finland. The joint management system with respect to water has increased the flow of water in two separate basins. This flood management procedure is considered to be very effective according to the 3rd meteorologist. Undertaking this management system, in case of increasing water level, the excess

flow of water used to be distributed to another basin and in this way, Norway has tried to reduce the threat of sea level due to the heavy rainfall.

Q5. What are the most dreadful floods you have gone through in recent years?

This interview question is centred on the accumulation of the data regarding the devastating flood experience of the interview participants. Based on the response of the 1st meteorologist, it is known that the emergence of flood in Norway used to be considered as the frequent incidents that not only submerged the lives of the entire community but also the economic slowdown of the country has degenerated the country's position in the international field. The flood of 1789 is worth remembering for its demolition gesture towards the countrymen and the meteorologist has delineated the dreadful after effect of this year's flood. The monsoon rain has increased the sea level to a large extent and eventually, it takes the form of a devastating flood in history. Furthermore, snow melting is considered as one of the major concerns for the outcome of this flood and this has also raised the level of sea addressing the occurrence of this year's flood. Global warming is regarded as the main factor for snow melting and for this reason, large amounts of snow melts that would mingle with the seawater. From the views of these interview persons, it is known that the 1789 flood is possessed with some devastating incidents in Norway.

Responding to this question, the 2nd meteorologist has opined that the flood of 1860 is as devastating as 1789. The increase of temperature at a rapid pace has increased the level of water in the sea and this is known as the major cause of this year's flood occurrence. The rise of temperature is subjected to the increase of evaporation throughout the year. The increased rate of evaporation is added to the air and eventually formulates the lump of precipitation. The detailed causes of this flood have been analysed from the response of the 2nd meteorologist. The effect of this flood was far-reaching and this has also considered as one of the detrimental floods in Norway has affected the country at a certain point of time.

The response of 3rd meteorologist has pointed the large effect of the flood of 1995 and from the details of this participant; it gets known that this flood is also housed with dreadful effect upon the specific countrymen. The autumn rain can also cause the emergence of floods that impact the coastal area. The effect of floodwater was so deviating that the urban areas failed to withstand the floodwater from entering with the huge force in the country. Therefore, considering all three

responses, it has been analysed that the researcher has experienced the frightful effect of the flood occurring in three different years with the same dreadful effect.

Q6. What is the significance of a flood forecasting system and how its functions are used for flood detection?

The significance of flood forecasting has been analysed through the responses of this question. In this question, the 1st interviewee has responded that the techniques used for flood forecasting help in identifying the current hydrological function in Norway. This forecasting process is useful for the prevention of flood as, during the measurement of unfavourable forecasting, the coastal defensive processes are becoming strong under the surveillance of government. In this context, the role of a meteorologist is indispensable as, without their effective measurement, the hydrologic condition would be perceived. Additionally, the 2nd interviewee has opined that the frequency level of natural disasters can also be measured by the usage of flood forecasting techniques. The advanced technology is appropriate for the detection of different hydrologic cycles at various temperatures. In case of uncertainty, the parameter within this technique denotes improper meteorological performance related to the sea level.

Based on this measurement, an effective decision is taken by the government or the authority of the weather department. In addition to this, the 3rd meteorologist has declared that the probabilistic forecast is dependent on the flood forecasting technique and in this way; the hydrological resemblances related to the abnormal precipitation can be measured. Besides this, the streamline flows can also be calculated through this technique that not only helps in developing defensive practice with respect to flood management. Therefore, through the accumulation of all the responses upon this question towards the interview the general analysis shows that with the outcome of advanced technology in the form of flood forecasting, Norway would easily detect the direction of water flow and in case of any abnormalities, prompt actions can be undertaken by the government for the protection of countrymen.

Q7. What is the role of river basin management planning in the context of preventing Norway flood?

The interview question has centred on the implication of basin management of Norway as an effective flood management activity. The analysis of the responses of the 1st meteorologist, it becomes known that Norway is not capable of developing its infrastructure at the river basin area for flood prevention. Another risk that is prevalent besides infrastructure is the ineffective manpower in the flood management practices. Due to the improper knowledge, the country has failed in detecting the cause of flood at the initial stage. If the pre-identification process would be adopted by the countrymen, the threat of flood at the eventual stage can be mitigated. Moreover, the analysis shows that Norway has proceeded to implement the HYDRA project in the basin areas of the rivers and at 145 basins, this program has been conducted by the government of the respective country. Based upon the responses of the 2ndinterviewee it is known that the HYDRA program arrangement has developed the knowledge regarding the flood activities that need to be conducted at the initial stage from the identification of weather change uncertainty. The several risks that are associated with flood have also been measured by the implication of this project. Furthermore, in this context, the 3rd meteorologist has mentioned that the water condition of each basin of Norway has been measured by the deployment of Hydra program and thus the government of the country's maintained synergic attitude for developing the capabilities of the river defence or coastal defence for the flood management activities.

Q8. What is the effect of riverine flood in the outcome of Norway flood?

This interview question has been prepared for understanding the effect of riverine flood in Norway. Responding to this question, the 1st meteorologist has stated that the country has been severely affected by the riverine flood. This flood has been caused for many reasons such as excessive rainfall in cyclones, seasonal change, ineffective river defence and ice melting. Whatever the causes are, the effects of this flood are inimical to the countrymen. The hazardous flood also destroys the coastal areas that are used for crop production. Uprooting the crops production areas, this natural calamity diminishes the crop production process within the country. Due to this, the unavailability of crops increases the threat of famine in the country. Moreover, it

is analysed from the response of the 1st interviewee that riverine flood not only addressed the loss of lives but also it is liable for thwarting the livelihood of countrymen.

In this context, the 2nd interviewee has also opined that the country' economy is mainly based on trading, agriculture and technological advancement. All these mediums for earning get diminished due to the outcome of the riverine flood. The excessive force of riverine flood not only destroys the houses of the coastal areas but also it demolishes the large buildings in the countryside. The larger industries get affected by this and as a result, the prevalent industrialism of the country becomes standstill. This affects the development of the economy of the country to a large extent. Besides this, the gradual development of agriculture in the country gets severely dismantled with the outcome of the riverine flood. Therefore, the income from the country's agriculture has been obstructed. It is also analysed that the drainage system of the country becomes disrupted that affects the sewer process of the country.

Supporting this viewpoint, the 3rd meteorologist has stated that due to the riverine flood, trading through the sea path gets hindered. This attempts to shatter the possibility of import and export in the country. As a result, the trading facilities cannot be utilised by the country for the sake of economic growth. It also submerged the facilities of transportation of the country that act as an impediment for tourism and as a matter of fact, the riverine flood becomes responsible for this deplorable condition of the country. The detailed analysis of this interview answer shows that the prevalent biodiversity level gets affected by the emergence of the riverine flood. The hampered ecosystem makes a worse environment for the countrymen and this flood obstructs refining the ecosystem for making the surrounding environment as an optimized one. The available water becomes too filthy to drink after the flood occurrence in the country and for this reason; the health condition of the countrymen becomes much worse. This meteorologist has also started considering the dreadful effect of flood; Norway has attempted to induce an effective flood warning system to increase the awareness of the countrymen.

Q9. How river defences can be helpful in the process of flood management?

This interview question analysis has helped in analysing the relevance of river defence under the flood management system. Responding to this question, the 1st meteorologist has delineated that suitable infrastructure is used by the Norway government to withstand the outcome

of flood into the specific country. As per the response of this interviewee, it is known as in case of river defence, Norway has failed to build a strong infrastructure for preventing a flood. In order to handle the devastating force of flood, Norway has used sandbags. The power or capability of this sandbag in the coastal areas is not enough to extract the excessive forces of water.

Relating to this perspective of 1st interviewee, the 2ndobe supported that the adoption of the sandbag is not appropriate for river defence. In this context, this meteorologist has stated that a strong earthwork could be placed at the riverside for consolidating the river defence. Furthermore, the flood defence system has affected the road structure across the coastal areas and has also attenuated the flow of air from the riverside into the country. In order to give a proper response against this question, 3rd meteorologist has denoted that due to the improper infrastructure, Norway has not succeeded to build a proper river defence as the effective process for flood management. Therefore, the overall analysis is centred on the ineffectiveness of the involved infrastructure due to the lack of potentiality of the Norway government regarding suitable flood management practices.

Q10. Is coastal defences potential in case of flood management?

Asking this question to the interviewee, the researcher would detect whether the application of coastal defence is appropriate for flood management in Norway, or it is as ineffective as the river defence. Responding to this question, the 1st interviewee has declared that coastal defence at the beach area is sufficiently substantial as this elongates the capability of handling the excess force of the sea. Through the help of scientific knowledge, the government of the country has decided to diminish the economic threat related to floods. In this defence process, several lines of defence are arrayed at the coastal areas so that during the outrage of the flood, no gap would be found by the water force. The art of the coastal area has reinforced the areas of beach and thus, flood prevention ways can be practised by the government. Additionally, the 2nd meteorologist has discussed the effectiveness of coastal defence for the purpose of country flood prevention. The reinforced economic optimization in the country has maintained a configured integration with respect to the coastal defence practices as this flood managing process has ensured the security of the countrymen.

Relating to the answer of the 3rd interviewee, it is analysed that coastal defences prevent the excess flow at the very initial stage of the water surge. Preventing it from the initial stage has minimised the formulation of excessive power under the force of water surge. Therefore, based on the overall responses, the in-depth analysis has shown that the provision of coastal defence has not only developed the possibilities of flood reduction but also the economic crisis has been placed in order to ensure effective flood management.

Q11. What are the impactful initiatives the government has taken as effective flood management projects?

The way the government of Norway has initiated to undertake some projects for flood management has been analysed by asking this interview question to the meteorologist. In order to give proper responses to this question, the 1st interviewee has opined that the government has started an institutional structure for managing the devastating outcome of floods in the country. The result of a detailed analysis shows that the government has implemented an institutional structure for the threat reduction of the flood. In this project, Norgenian Water has been used as the main actor for the establishment of the relationship between flood management by focusing on degrading environmental quality. In order to accomplish this project, Norway has induced a Building Act for the area planning of the most flood-affected places. In those places, through the execution of in this project plan, Norway would establish the flood warning or prevent facilities. Through the erection of these facilities, the country would become capable of delivering a suitable environment for its countrymen by preventing the forceful outcome of the flood. In supportive of this statement, the 2nd meteorologist has added that besides the provision of institutionalism structure, the government has taken initiative for the deployment of regionalised states. Through the implication of this project, the government starts making a unique planning system for the moment of emergency so that at the time of unfavourable weather conditions at the coastal areas, the government takes active steps for the protection of people. Through following this project, governmental policies have been reinforced for the development of public awareness regarding the outcome of devastating floods.

The way effective precautions can be undertaken by the countrymen has been analysed by this regional state development project as opined by 3rd interviewee. After detection of the damages at the coastal defence or river defence, this project has helped identify the prevalent gaps

in the flood management system and take proper steps accordingly. This project also assists in the evacuation process related to the underdeveloped flood management practices and by ensuring this evacuation, the country has become initially strong to handle the outcome of natural calamity in the form of flood at any season. Therefore, the analysis has shown that through the upliftment of these impactful projects, Norway has enhanced the power of flood management to make the country preventive in case of flood intrusion.

Q12. What are the potential techniques and models that are used for hydrograph techniques for early flood detection?

The interview question is relevant for the identification of suitable models as well as techniques used for early flood detection as well as management. The interview response of the 1st meteorologist revolved around the effectiveness of local power structure as one of the potential techniques for flood detection. Making this technique as one of the proactive systems for flood management, the country has enabled the establishment of flood-prevention techniques. Under this technique, a map for flood zone areas has been established so that the lack of infrastructure in the flood detection can be identified. Following this technique, the government has decided to improve the infrastructure of the coastal areas so that the countrymen would remain secured during the outcome of forceful sea waves. Improving the local power, Norway has pursued the active process for flood management along with reducing the dreadful effect of flood emergence.

Another supportive statement is provided by the 2nd meteorologist and through the analysis of the detailed statement has presented that due to the persuasion of flood management technique, the country had made a balance between the preventive ways for flood and the infrastructure adopted for handling the dreadful effect of this disaster. Furthermore, in this technique, decision making is involved that helps the local community to undertake proper decisions at the moment of disaster. The forceful flood is considered as the momentum of environmental abnormalities and the outbreak of this momentum can be avoided with the placement of local structure technique. Through the reinforcement of this technique, the general ideology of flood management becomes more innovative and thus it can assist to improve every phase under flood management.

In responding to this answer, the 3rd interviewee has responded that with the usage of several forecasting models for flood detection, the government can take on time preventive measures for the detection of the threatful impact of the flood. Making correlation diagrams with these models, the weather department of Norway would detect the direction of the hydrologic cycle so that the force of water level can be easily measured and calculated with this correlation diagram. It is also analysed that flood design is conducted by the coxal diagram and it is impactful for the detection of flood flow estimation. Using two variables for the flood prevention methods including wave force and weather condition, the correlation value analyses the result of streamline flow condition. If the result shows that the position of these two variables is very high, there lies an excessive risk for flooding. Therefore in this aspect, the analysis shows that Norway can take preventive measurement by evaluating the position of two variables within the flood managing procedures. The time of peak flow of the water condition would also be measured by using this diagram and here lies the effectiveness of pursuing this model for the purpose of flood management.

Q13. What are the methods adopted by the environment forecasting team to detect the water level in the sea?

This question has mentioned the uniqueness of some models that are generally used by the weather forecasting department of Norway for flood management. In order to respond to this answer, the 1st meteorologist has declared the popularity of the Rainfall-runoff model. Through the application of this model, the weather forecasting process has become effective with respect to the detection of sea-level conditions. The runoff modelling has helped in checking the quality and depth of precipitation. The abnormalities in precipitation are not the sole reason for a flood but also other factors are equally culpable for the formulation of a heavy flow flood. Through the collection of statistical data, this model helps to identify the recent condition of river depth. The gradual changes of the river condition are recorded in the statistical format that defines the emergence of risk from the impending flow of water.

The result of the interview analysis shows that the role of the runoff model is indispensable in the context of flood management. Along with the detection of hydrological cycles, this model can be engaged to make the excessive precipitation return to the sea level. The controlling system

of this model is very high as it attempts to take control over precipitation that is addressed for an effective flow of the stream level. Therefore, the analysis upon the respective model has denoted that the runoff model can be used for managing the excessive power of precipitation by distracting its direction to other sources of water. Supporting this response, the 2nd interviewee has declared the necessity of a runoff model for flood management practices. In addition to the benefits of this model, the analysis is centred on the detection of rain falling areas through making an effective catchment. The amount of rainfall is calculated by this model through which a normal form of precipitation is measured for making a weather analysis. The conversion process from rain is also conducted by the hydrograph prepared by this model that eventually outcomes as the rain off the model. In this way, the conversion process helps to make the weather department aware of the current weather condition for eventual flood management.

The perspective of the 3rd interviewee has been matched with the usefulness evaluation of rain off the model. The analysis presents that with the engagement of non-lining reservoirs the surface level of the catchment areas can be detected and thus, the power and quality of the rain can be detected by gathering the sample of the surface area. Even in the large areas, this model can be adopted as within the large areas, several hydrographs are presented as per the area diversification. The division of the sub-catchment areas has helped in analysing the characteristics of rain within the divided areas. In this context, the interviewee has also mentioned the name of Lumped model and Quasi model as both these models are useful for strengthening the functionalities of coastal defence at the basin areas. Quasi model is helpful for the absorption of rainfall by aligning with the sub-basin and thus, the excessive flow of water can be kept under control. Therefore, through the adoption of the mentioned models, the weather department of Norway can take proper steps during the uncertainties of water flow by making a calculated hydrograph under the resolution for flood management.

Q14. What components are involved in the Early Warning procedures adopted by the UN?

Responding to this question, the 1stmeteorologist has stated that infrastructure is the main component of the EWS of the UN. With the engagement of effective technologies, the flood forecasting system would become more authentic. Arguing to this view, the 2nd interviewee has helped in analysing the relevance of manpower in the forecasting system of UN as, without the

manpower, the excellence of work cannot be proved by the country in case of flood managing. It is also analysed from the view of a 3rd meteorologist that the infrastructure usage would be effective without the involvement of proper training to the community about the awareness of flood management.

Q15. Is it necessary to increase the awareness of the citizens, especially the people of coastal areas during the deployment of early warning procedures?

Based on the view of the 1st meteorologist, it is analysed that public awareness is necessary as they are the first sufferer of this disaster. Therefore, suitable precautions need to be undertaken by the community along with the development of flood management related knowledge. Supporting this aspect, the 2nd and 3rd meteorologists have declared that preventive steps need to be followed by the inhabitants across the coastal side. The way they would save their lives and the cross of the supply of food after the flood would also be known by in the form of flood managing cognizance.

Q16. What are the different classification of Early warning systems and how they are impactful in flood management?

The question is centred on making different classification under the procedures of the early warning system conducted by the UN with respect to the flood management. Based on the response of 1st interviewee it is analysed that technology is one of the major aspects under EWS of UN. The technologies are used for identifying the hazards related to the flood and also help in calculating the depth of water along with streamline flow. Technology is used for fostering the geological knowledge relating to the weather forecasting system. The risk scenarios are also measured with the usage of these technologies and in this way, the UN has presented the active formulation of the warning system for flood management. Based on the identification of risk scenarios, the technologies are used for making design criteria and with the help of this design, EWS introduces the proper medium of hydrologic cycle identification. Being directed by the indicators involved in the warning system, the UN has made technological advancement for curing effective weather detection practices.

In this context, the 2nd meteorologist has declared that budget investment helps a strong formulation of a flood warning system. It is analysed from this response that the formulation of an active EWS system requires a proper investment as without considerable funding, the advanced technologies would not be used by the country. In order to get that large amount of funding, the UN suggested making collaboration with the neighbouring countries. In this, the threat of demolishing the flood could be reduced. Moreover, based on this large investment, the existing manpower of the weather forecasting department can be improved.

Supporting this point, the 3rd meteorologist has opined that the persuasion of legal entities under the system of early warning, for flood management. If a country fails to maintain the laws or legislations for the procurement of effective flood management, the government would not provide the facilities of insurance in case of occurrence of any disaster from flood management. Maintaining an institutional framework would help the country to develop the potentiality of EWS as all the flood managing practices have been implemented through the following legal requirements. The UN has attempted to follow certain regulations in case of flood management while asking monetary help from the influential private sector. Depending on this funding, all the regulations under EWS would be conducted appropriately.

Q17. What gaps have been prevalent in the flood management practices arranged by Norway by contrasting to the flood requisites of international agencies?

The question is based on the identification of gaps that are prevalent within the underdeveloped flood management practices of Norway. With respect to this question, the 1st meteorologist has stated that the lack of infrastructure is the main reason for the challenge of flood prevention. Without incurring a suitable infrastructure, the country would not withstand the outcome of a devastating flood. In case of making a strong flood gate, the country has not engaged advanced technologies and due to this reason, the power of the flood gate is considered to be more vulnerable with the comparison of the forceful impact of the flood. Based on the flood frequency, the country has failed to involve a substantial process for consolidating the flood prevention infrastructure. Due to this huge gap, Norway has involved ineffective facilities that could not be further utilized by flood management practices. Due to the constant contact with water, the

temporary infrastructure starts getting damaged and as a result, the flood gates do not stand strong for preventing the force of dreaming flood.

A supportive argument has been provided by the 2nd meteorologist as this perspective also revolves around the underdeveloped technology engagement within the infrastructure development practices of Norway. The analysis shows that corrective results have not been availed by Norway due to the engagement of improper infrastructure. In addition to this point, the analysis shows that Due to improper manpower and skills, the weather department of Norway fail several times to increase the awareness of citizens regarding the necessity of precautions related to floods. It has been found that there is few skilled staff in the weather department who does not succeed in using cognizance for the development of flood management techniques. Due to the lack of skill, the country has not restrained the emergence of the flood. Moreover, there is not enough manpower that could be used for accessing or anticipated the weather condition through a perfect measurement. The lack of excellence is prominent in the flood management activities and for this, the performance of floodgate and weather measurement model fails every time. The adoption of non-potential technologies in the flood management practices, the proficiency of the weather department has not been experienced by the countrymen. The large gap in the manpower of weather forecasting team has considered being inimical to Norway with respect to flood management.

Q18. What is the impact of risk knowledge in diminishing the risk subjected to flood?

The significance of risk knowledge has been identified through the analysis of this question. In this context, the 1st interviewee has mentioned that risk knowledge would help in minimizing the risk of the flood with the reinforcement of performance associated with flood risk assessment. This ensures that all the data gathered for weather forecasting has been analysed properly. Monitoring activities are an integral part of risk knowledge as, through proper monitoring, the uncertain flow of water along with unfavourable weather conditions can be detected. Supporting this viewpoint, the 2ndmeteorologist has opined that undertaking risk knowledge assessment procedures, the unfavourable weather condition can be taken control. Considering the effectiveness of the warning system, the risk assessment practices would assist in identifying the possible risk from the uncertain report of weather forecasting. In this aspect, the

3rdmeteorologist has opined that due to the EWS, the flood management procedures have become much improved. In the monitoring process, the risk can be identified from the data collection process related to the weather. The data transmission would help in detecting the inherited risk and with the emerged result; it facilitates the flood management practices with innovative flood prevention process.

Q19. What predictive uncertainty has been engaged in the flood management process of Norway?

Based on the response of the 1st and 2nd meteorologist, it is an analyst that due to the gap of citizen's knowledge, Norway has not become successful for increasing cognizance amongst the general people. Norway keeps using the old technologies for flood forecasting and based on this huge gap, the general people, especially the inhabitants around the coastal areas get no knowledge regarding the necessity of knowledge improvement. It is further analysed from the response of the 3rd interview that in case of any unfavourable weather forecast, the inhabitants do not take suitable precautions to protect their lives. They neither take any steps for protecting their belongings from submerging it under the water, nor do they take any actions for increasing the awareness among the surrounding people. Weather cannot be controlled, but with the increase of proper knowledge related to flood management, the country could reduce the life-threatening risk of the riverine flood.

Q20. Is there any gap in the training process for upcoming meteorologists due to which Norway has failed in making effective flood management practices?

In response to this question, the first meteorologist has provided a distinctive opinion that lack of technological instruments is the primary reason that creates hindrances in conducting their job in an effective manner. Norway experiences different types of a flood, and for this reason, it has been difficult for the meteorologist to tell exact information about the flood level. From the meteorological point of view, the flood warning system that has been provided by the Government of Norway is not highly inductive as this affects the overall performances of employees. Due to this old school machine, proper coordination cannot be created as this creates difficulty for a metrologist to provide exact information about the flood. Furthermore, Norway in the Northern Side experiences high flood due to snow melting. On the other hand, due to high precipitation and

high-temperature western region of Norway also faces high flood. Furthermore, due to the rain cyclone, Norway's flood warning management team cannot provide proper information to both the government and the people. This lack of providing effective information creates issues for the people and the government. From the opinion of the 1st metrologist, it can be stated that the metrologies fails to provide proper information to the people and local government because of a lack of proper tools and modern-day equipment.

In response to this question, the second meteorologist provides a different opinion, and the opinion of the 2nd meteorologist contradicts the opinion of the second meteorologist. The second meteorologist provides the view that lack of training can be an issue for the meteorologist. For this lack of training, the meteorologist cannot be able to use modern-day flood warning tools. Lack of training and lack of operative skills has affected overall performances of metrologists; for this reason, this Government of Norway should focus on providing some inevitable training to meteorologists. The 2nd meteorologist also highlights a piece of important information that despite effective training, proper equipment is also necessary without having proper equipment, the meteorologist cannot be able to provide correct and good information.

The third respondents' opinion is somewhat similar to both the 2nd and 1st metrologist. The third meteorologist has provided a lack of modern-day tools and techniques is an issue whereas an effective step of providing proper training is another issue. The third meteorologist highlights that preventing natural disaster is near to impossible, but preventive measures can be taken to reduce the rate of economic damage and mortality rate. The 3rd meteorologist highlighted that due to effective responses by the flood warning system in the year 2013 the rate of mortality in the flood-hit area is zero whereas in the year 2001 the mortality rate is high. The first sequence highlights that installation of upgrade technology has helped the meteorologist to provide proper information about the flood. Effective training is required to manage these tools in a much effective manner, and for this reason, the government should focus on conducting proper training to meteorologists.

Q21. Do you believe that lack of critical infrastructure plays an important role in the flood?

In response to this question, the first interviewee highlights that lack of critical infrastructure is an issue for the people and the government of Norway. The first metrologist from his working experiences highlights the western part and the southern part of Norway experience higher flood, and the frequency of the rainfall in these two regions is high. Due to lack of proper effective management and political crisis affects overall performances of the country. Due to high political issues, the funds allocated for developing critical infrastructure is less, and this affects in developing proper infrastructure. In the northern region, the flood happens due to snowmelt this snowmelt creating the flood is an important issue for the country. The government of Norway fails to make proper critical infrastructure as this directly affects the overall region and it affects the economic conditions.

In response to this question, the 2nd meteorologist viewpoint is the same but mentions some initiatives that have been taken by the government to minimise the rate of the flood. The second metrologist HYRA is an initiative project that has been taken by the government to identify the place in Norway where the flood hitting rate is high. Furthermore, the two and meteorologist has provided an opinion that HYDRA is a good initiative as this can help the government in future, but due to ineffective cooperation from the government, the initiatives have been stopped. Proper coordination between Hydra and the Government of Norway can help in developing preventive measures. These preventive measures help in reducing the rate of flood destruction; perhaps this process can help in improving the performances of the Norway economy.

The third respondents have provided a unique opinion that the government has tried to minimise the disaster that happens due to floods. The 3rd meteorologist highlights that the government has tried unique initiatives to minimise the rate of a flood that happens but fail to carry out the initiatives due to lack of proper funding and economic support. The critical infrastructure from which people of Norway have been deprived of is because of a lack of proper economic support. The third meteorologist has highlighted that the Hydra project has helped the government to highlight all the phases where the flood hits most. On the other hand, river basin management is another step that helps the Government to manage the river basin located in Norway and Finland. Effective managing this river basin can help the government to reduce the rate of intensity of flood

that hits the shore. Decreasing the rate of intensity can help the people, and the government as the rate of damage due to the flood is minimal. The three meteorologist viewpoint is not contradictory with the viewpoint of the other two managers; the 2nd manager viewpoint is far more different from the other two managers. The third manager has focused on providing distinctive opinions from the manager.

5.3 Gaps and Challenges of the Method

There are several gaps in the primary data collection method since this method has only focused on collecting data from the survey and interviewing process. The major gap of the primary method is that there is no mention of authentic journals regarding the effect of Norway floods. The effect of past floods has been analysed from the knowledge of the interviewees. If the respective knowledge could be gained from the journals or news articles of that time, more reliable information would be gathered for the research. Moreover, the journals would provide proper information regarding the technologies used by the recent meteorologists and the old technologies are different from the advanced one. Therefore, in the case of gathering authentic knowledge, there remains a huge gap between the undertaken primary method and secondary method. In the previous research upon the flood management procedures, all the research areas are covered with the usage of data from the secondary sources to justify the authenticity of primary data. This resource gap has attempted the reliability of present research which effect could be far-reaching in the research world.

There are some challenges in using primary methods as in the case of analysing huge amounts of data, the researcher has faced issues to handle the large sample. The respondents many times give incorrect responses against the question and this puts a severe effect on research progress. The interviewee does not give a proper answer as per their knowledge and for this reason, the researcher has faced challenges to deal with authentic resources for the research conduction.

5.4 Summary

Based on the above details regarding the flood management practices, it can be concluded that Norway has faced, for several times, the dreadful effect of riverine flood. Through the implementation of the interviewing process by targeting 3 meteorologists, the causes of the flood

in Norway have been analysed. The cause of snow melting due to the increasing temperature and rain cyclone are pointed as the major causes of flood. Moreover, the necessity of flood management practices is analysed from which it is detected that due to the lack of technological development in the weather forecast procedures, Norway has failed in undertaking preventive measures for the flood. The in-depth analysis shows that flood warning system has not been properly adopted by the country and as a result, the countrymen also failed to increase their awareness regarding the suitable precaution for the devastating outcome of the flood. UN has taken early warning system procedures to take control over flood with the usage of rain off the hydrograph model.

CHAPTER 6: DISCUSSION

6.1 Introduction

In this research paper, the researcher has been focused on finding all the issues that have been associated with the flood in Norway. Furthermore, the researcher had also been trying to find out the steps and measures that had been adopted by the Government of Norway in reducing effective damage by the flood. The researcher from the research can get effective knowledge about the working condition of the flood warning system. In this research paper, the primary data collection step has been adopted to have an effective knowledge about the trouble and all related factors associated with the flood management system.

6.2 Discussion

In this research paper, researchers have been focused on providing effective information about the economic and financial loss that the people and the Government of Norway have suffered during this flood. The researcher, as a peripheral of recommendation, has tried to highlight some of the steps, but before proper recommendation, the researcher needs to understand all the associates in this flood of Norway. In order to understand the associates in the Norway floods, the researcher has adopted positivism philosophy. This positivism philosophy has been focused on improving the knowledge that has been associated with the flood. In this research paper, I need to understand the benefit of adopting modern-day technology and modern-day flood warning systems. Impactful use of this research tool needs high quality of training, and the researcher has been focused on understanding all the issues that have been associated with the underlying process. In order to get effective information about the research topic, the researcher has used the focus group data collection process.

This focus group data collection process has been focused on minimising all the issues in a much effective manner. In this focus group analysis, the researcher has asked ten questions to 4 groups of people living in Norway. Each group comprises 51 people, and the researcher has also conducted the primary method of data collection. Researcher in order to have some effective knowledge about the flood warning system and the benefits of creating critical information about the research topic. They used a qualitative method of data collection. This qualitative method of data collection has been conducted on the three metrologists. Conducting an interview with 3

meteorologists, the researcher came to know each fault that a meteorologist faces while conducting their operations.

From group 1 analysis in quantitative data collection methods, ten questions have been asked to 51 people, and all questions are associated with the flood and the effect and intensity in Norway. The respondents of the first group highlight that they believe that riverine flood is the main reason that causes flood in Norway. On the other hand, the respondents have also agreed that due to less number of critical infrastructure within the country is an issue that affects the flooding condition. For collecting evitable data about Norway, flood researcher has conducted a holistic approach, and this holistic approach has helped the researcher to minimise all the issues that have been associated with the flood. In response to the season changes it has been found out that most of the researchers have agreed that the season changes are another reason that causes a flood. On comparing the responses, it can be stated that both this issue plays an effective part in creating a flood in Norway. In this research question, the flood warning system and flood warning management process has been asked about by respondents from the group analysis. It has been found out that the flood warning system plays an effective role in creating awareness. On the other hand, due to lack of proper technology and proper training to meteorologists proper information during the rain cyclones cannot be provided.

In Norway, rain cyclones play an effective part in creating flood, whereas due to lack of technological innovation and implementation, the flood warning system cannot provide proper information during the rain cyclones. In this group, a question about critical infrastructure has been discussed, whereas the question about critical infrastructure not only helps in highlighting the political espionage but can highlight economic situations. Most of the respondents during this question have tried to highlight that critical infrastructure is poor; this is due to lack of proper funding. Furthermore, some of the initiative such as river water management process has been taken by the government to reduce the rate of damage in flood. Respondent has replied that the initiatives are good, but due to lack of proper funding, these initiatives cannot be carried out in proper manner. The river basin water management plan has been an effective step that has been taken by the government; this step not only affects overall performances but also affects the instinct of the people living in Norway. From the group analysis, it has been highlighted that the poor critical infrastructure is due to lack of economic support, whereas the Government of Norway has

desperately tried to take preventive measures against floods. Due to political espionage and lack of proper funding, some of the important projects such as HYDRA have been stopped as this affects the overall geographical condition of Norway.

From the 2 and group analyst, it has been found out that most of the respondents believed that seasonal changes and riverine flood are the two prime factors that are creating a flood in Norway. Thin comparison to the group 1 response, the respondents are much more agreed on this issue. Comparing these two responses, it can be stated that most of the people in Norway believe that season changes create floods. In the autumn season, the snow melts and this snow melting process enhances the rate of the flood system. On the other hand, due to political issues, the respondents cannot perform well; this lack of performances affects overall performance rate. Despite critical infrastructure, some of the steps taken by the government, such as the HYDRA project and river basin management system. The respondents participated in the group analysis highlights some of the benefits and also stated that if this project continues, then it will be highly beneficial for the country and the people. The HYDRA project that has been launched by the Government of Norway is very much effective, and the Hydra project is able to highlight different locations and different places of Norway where the level of the flood rate is maximum.

Floodwater management systems play an effective role in creating awareness among people as well as also help in developing proper knowledge about the flood intensity. The respondents took part in this response team, highlighting that the flood warning management system plays an effective role in creating awareness. For this awareness, the rate of mortality has been decreased. In conversation with the respondents, some highlighted that in the year 2013, the mortality rate of Norway flood is zero. On the other hand, some of the respondents have highlighted that the lack of proper guidance by the flood warning monitoring experts has increased the mortality rate in the flood of 2011. From this information, it can be highlighted that the metrological department of Norway has been using old technology. This lack of technology is creating an issue for the government and people to make effective decisions during this flood or the massacre. On the other hand, it has been found that the lack of use of proper technology is creating issues in communication. From this group analysis, it can be highlighted that the flood warning system plays an effective role in reducing the rate of mortality in an effective manner.

From the 3rd group analysis, it has been found out that most of the respondents have agreed that seasonal changes and riverine flood are the primary reason that causes flood in Norway from ancient times. The main intention of creating this research is to highlight a different issue that has been affecting in developing all the functions in a proper manner. The early forecasting system plays an effective role in reducing the rate of performances as this increases overall performances. This increase in the rate of flood forecasting affects overall performances as this will enhance the overall performances. Defence river system plays an effective role in minimising all the issues that can arise due to coastal floods. This riverine flood plays an effective role in minimising all the issues that can happen to flood. In conversation with this group, it has been found out that lack of proper training can be a chance for providing efficient information by a flood warning system. The flood warning system minimises all the issues in a much effective manner. Deploying new tools and techniques can help in resolving all the issues that are related to the flood management system. From this group analysis, it has been found out that lack of use of proper tools plays an important role, and this lack of proper monitoring creates an issue for the local people of Norway.

From the fourth group analysis, it has been found out that the lack of proper financial status is affecting the overall infrastructure building process. In this research paper, the researcher has queried about the river basin management process helps in improving the rate of performances. This process helps in an effective management process and reduces the mortality rate. In this research paper, it has been found out that due to lack of proper installation of technology, the organisation cannot resolve all the instances in a much effective manner. The river basin water management plan has been an effective step that has been taken by the government; this step not only affects overall performances but also affects the instinct of the people living in Norway. From the group analysis, it has been highlighted that the poor critical infrastructure is due to a lack of economic support, whereas the Government of Norway has desperately tried to take preventive measures against floods. From this analysis, it has been found out that river basin management is essential for managing the Scandinavian rivers. Managing this Scandenian river helps in resolving all the issues in many effective manners. From the overall analysis, it has been found out the gaps are in flood warning management systems, lack of use of critical infrastructure for managing the flood in an effective way.

Finally, the interview section has been conducted to analyse all the gaps in most important ways. For collecting all the information, researchers have conducted an analysis of the flood that created the issue in Norway. In this primary data collection method, the data are collected by interviewing three meteorologists. All the meteorologists have answered that riverine flood, seasonal change, high precipitation in the autumn region leads to flood. On the other hand, the meteorologist also highlights that lack of proper infrastructure in Norway created an issue for people issued this lack of proper infrastructure affects overall performances and creates issues in managing the flood in much effective manner. The meteorologist has also highlighted how the agriculture sector got affected due to this flood. Generally in spring, the snow gets melted in Norway, and simultaneously it exceeds the original level of the sea. Ice melting is considered as the major climate-controlled aspect that increases the rate of precipitation.

Global warming due to the excessive pollution in Norway holds the responsibility for flood occurrence. While merging the melted ice water with the sea level, it affects the soil. In this research paper, the researcher has provided a view of the research study. This research paper not only affects overall performances but also creates a lot of issues. The meteorologist has tried to provide a good distance as this will improve the overall finding and overall instinctive performance. In this research paper, it has been found out that the rate of performances of the meteorologist is not good because of a lack of proper functioning process. In this research paper, the researcher has been focused on providing the minute detail that has been associated with the Norway flood, and the researcher needs to focus on all the distinctive performances in a much effective manner. From the interview it has been found outta lack of proper support from the Government is an issue for the meteorologist and for this reason most of the metropolis cannot provide a good rate of information that of providing inevitable information affects overall performances. Irrespective of hiss it has been found that lack of proper highlighting of all the tasks is an issue for the meteorologist. From this interview analysis, it can be stated that the flood warning management system plays an important role in taking preventive measures against natural calamities. Rain cyclones play an important role in managing all the issues in a much effective manner, and for this reason, it has been found out that the flood warning system cannot provide good support. In this primary data collection process, the research metrologist highlighted that

modern-day flood warning system could play an effective role in minimising all the issue in a much effective manner.

6.3 Summary

In this research paper, the primary form of data collection has been adopted, both quantitative and qualitative methods of data collection have been adopted. The qualitative method of data collection has been conducted on 4 groups; each group, there are 51 members. On the other hand, a qualitative method of data collection has been conducted on 3 meteorologists of Norway for collecting efficient data. In this data collection process, the researcher is able to understand that lack of critical infrastructure plays an effective role in increasing the rate of a flood. Due to lack of proper financing by the government, some of the effective steps have been taken by the government. AS this creates an issue in developing critical infrastructure in Norway. This lack of critical infrastructure increases the rate of an issue for both the government. From the second group analysis, it has been found out that lack of effectiveness from the flood warning system is another issue; this lack of effectiveness creates an issue, and for this reason, most of the respondents cannot be able to take preventive measures. The flood warning system plays an effective role in reducing the rate of mortality in Norway, and for this reason, effective and modernised should be used. This place helps in managing all the matters in a much effective way. From the third group, it has been cleared that the flood warning system plays a good role, and this flood warning system development can help in future. Finally conducting an interview has helped the researcher to understand the gaps and this gap analysis can help in uplifting the level of performances and enhances the performance rate. Identifying the gaps can help the researcher to provide evicted solutions about the research topic, providing the ultimate solution so that using this solution, the government can minimise the rate of economic loss and the mortality rate.

Reference List

Abbas, A., Amjath-Babu, T. S., Kächele, H., Usman, M., & Müller, K. (2016). An overview of flood mitigation strategy and research support in South Asia: Implications for sustainable flood risk management. International Journal of Sustainable Development & World Ecology, 23(1), 98-111. Retrieved from: https://s3.amazonaws.com/academia.edu.documents/50094353/Flood_Risk_Mgt_Research___Policy_IJSDWE.pdf?response-content-disposition=inline%3B%20filename%3DAn_overview_of_flood_mitigation_strategy.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20191214%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20191214T043905Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=f079354564f6dd5631a47e91eaa159ff120a009e334c6ae7f9e59070e08994a1

Abdulkadiroğlu, A., Angrist, J. D., Narita, Y., & Pathak, P. A. (2017). Research design meets market design: Using centralized assignment for impact evaluation. *Econometrica*, *85*(5), 1373-1432. Retrieved From: https://www.nber.org/papers/w21705.pdf

Ajjawi, R., & Boud, D. (2017). Researching feedback dialogue: An interactional analysis approach. *Assessment & Evaluation in Higher Education*, *42*(2), 252-265. Retrieved From: https://eprints.mdx.ac.uk/21398/1/A%26B_feedback_dialogue_accepted_AEHE15.pdf

Alessa, L., Kliskey, A., Gamble, J., Fidel, M., Beaujean, G., & Gosz, J. (2016). The role of Indigenous science and local knowledge in integrated observing systems: moving toward adaptive capacity indices and early warning systems. Sustainability Science, 11(1), 91-102. Retrieved from: http://netcapaz.org/media/red-4/publicaciones/bLocal_observing_systems._Alessa_et_al_2016.pdf

Alfieri, L., Dottori, F., Betts, R., Salamon, P., & Feyen, L. (2018). Multi-model projections of river flood risk in Europe under global warming. *Climate*, *6*(1), 6. Retrieved from https://www.mdpi.com/2225-1154/6/1/6 [Retrieved on 13th October, 2019]

Andrew, D. P., Pedersen, P. M., & McEvoy, C. D. (2019). *Research methods and design in sport management*. Human Kinetics Publishers. Retrieved From: https://books.google.co.in/books?hl=en&lr=&id=8rG8DwAAQBAJ&oi=fnd&pg=PR1&dq=Research+Design+&ots=prICAzX6Ee&sig=vDIyZJn24BUDV06bNmMpVHdXp-k

Anschütz, H., Pfaffhuber, A. A., Real, C., Domaas, U., & Sture, B. (2015). Combined airborne and ground geophysics as a first phase towards a landslide warning system–a Norwegian case study. *Österreichische Ingenieur-und Architekten-Zeitschrift*, *160*.https://www.researchgate.net/profile/Bjorn_Rosenvold/publication/290427722_Combined_airborne_and_ground_geophysics_as_a_first_phase_towards_a_landslide_warning_system_-_a_Norwegian_case_studynter_title/links/5697485a08aea2d74374c0a5.pdf

Auestad, I., Nilsen, Y., & Rydgren, K. (2018). Environmental restoration in hydropower development—Lessons from norway. *Sustainability*, *10*(9), 3358. https://www.mdpi.com/2071-1050/10/9/3358/pdf

Berg, T. F. V., Berg, K. L. V., Berg, D. B. V., & Berg, S. T. V. (2018). *U.S. Patent No. 10,035,509*. Washington, DC: U.S. Patent and Trademark Office. https://patents.google.com/patent/US10035509B2/en

Berghuijs, W. R., Harrigan, S., Molnar, P., Slater, L. J., & Kirchner, J. W. (2019). The relative importance of different flood-generating mechanisms across Europe. *Water Resources Research*.https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019WR024841

Bertoa, F. C. (2017). It's been mostly about money! A multi-method research approach to the sources of institutionalization. *Sociological Methods & Research*, *46*(4), 683-714. Retrieved From: https://nottingham-repository.worktribe.com/preview/753990/Manuscript2028SM26R29.pdf

Bilimoria, K. Y., Chung, J. W., & Hedges, L. V. (2018). External validity is also an ethical consideration in cluster-randomised trials of policy changes. *BMJ quality & safety*.Retrieved From: https://qualitysafety.bmj.com/content/qhc/early/2018/10/12/bmjqs-2018-008777.full.pdf

Blöschl, G., Hall, J., Parajka, J., Perdigão, R. A., Merz, B., Arheimer, B., ... & Čanjevac, I. (2017). Changing climate shifts timing of European floods. *Science*, *357*(6351), 588-590. https://science.sciencemag.org/content/357/6351/588.abstract

Carlisle, J. B., & Loadsman, J. A. (2017). Evidence for non-random sampling in randomised, controlled trials by Yuhji Saitoh. *Anaesthesia*, *72*(1), 17-27.Retrieved From: https://onlinelibrary.wiley.com/doi/pdf/10.1111/anae.13650

Carrivick, J. L., & Tweed, F. S. (2016). A global assessment of the societal impacts of glacier outburst floods. *Global and Planetary Change*, *144*, 1-16. https://www.sciencedirect.com/science/article/pii/S0921818116301023

Chen, Y., Bruland, O., & Li, T. (2018). Flood estimation in ungauged catchment using ENKI simulation: A case study in Norway. *EPiC Series in Engineering*, *3*, 428-437.https://yahootechpulse.easychair.org/publications/download/VGGD

Cook, B., Forrester, J., Bracken, L., Spray, C., & Oughton, E. (2016). Competing paradigms of flood management in the Scottish/English borderlands. Disaster Prevention and Management, 25(3), 314-328. Retrieved from: http://dro.dur.ac.uk/17844/1/17844.pdf

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications. Retrieved From: https://www.academia.edu/download/55010759/creswell_Qualitative_Inquiry_2nd_edition.pdf

da Silva, L., Yang, Z., Pires, N., Dong, T., Teien, H. C., Storebakken, T., & Salbu, B. (2018). Monitoring aquaculture water quality: design of an early warning sensor with Aliivibrio fischeri and predictive models. *Sensors*, *18*(9), 2848.https://www.mdpi.com/1424-8220/18/9/2848

Da Veiga, A. (2016, July). A cybersecurity culture research philosophy and approach to develop a valid and reliable measuring instrument. In *2016 SAI Computing Conference (SAI)* (pp. 1006-1015). IEEE. Retrieved From: http://uir.unisa.ac.za/bitstream/handle/10500/23164/Cybersecurity%20Culture%20Research%20Philosopy%20and%20Approach%20SAI%202016.pdf?sequence=1&isAllowed=y

De Groeve, T., Thielen-del Pozo, J., Brakenridge, R., Adler, R., Alfieri, L., Kull, D., ... & Salamon, P. (2015). Joining forces in a global flood partnership. *Bulletin of the American Meteorological Society*, *96*(5), ES97-ES100.https://journals.ametsoc.org/doi/full/10.1175/BAMS-D-14-00147.1

Devoli, G., Tiranti, D., Cremonini, R., Sund, M., & Boje, S. (2018). Comparison of landslide forecasting services in Piedmont (Italy) and Norway, illustrated by events in late spring 2013. *Natural Hazards and Earth System Sciences*, *18*(5), 1351-1372. Retrieved from https://www.nat-hazards-earth-syst-sci.net/18/1351/2018/nhess-18-1351-2018.html [Retrieved on 20th October, 2019]

Dougherty, M. R., Slevc, L. R., & Grand, J. A. (2019). Making research evaluation more transparent: Aligning research philosophy, institutional values, and reporting. *Perspectives on Psychological Science*, *14*(3), 361-375. Retrieved From: https://psyarxiv.com/48qux/download?format=pdf

Dupuits, E. J. C., De Bruijn, K. M., Diermanse, F. L. M., & Kok, M. (2016). Economically optimal safety targets for riverine flood defence systems. In *E3S Web of Conferences* (Vol. 7, p. 20004). EDP Sciences. https://www.e3s-conferences.org/articles/e3sconf/pdf/2016/02/e3sconf_flood2016_20004.pdf

Dupuits, E. J. C., Diermanse, F. L. M., & Kok, M. (2017). Using graphs to find economically optimal safety targets for multiple lines of flood defences. *Natural Hazards and Earth System Sciences*, *2017*, 1-20.https://www.researchgate.net/profile/Hua-Peng_Chen/publication/280100533_State-based_stochastic_performance_deterioration_modelling_of_flood_defence_assets/links/55a93dde08ae481aa7f97dbb.pdf

Dyrrdal, A. V., Lenkoski, A., Thorarinsdottir, T. L., & Stordal, F. (2015). Bayesian hierarchical modeling of extreme hourly precipitation in Norway. *Environmetrics*, *26*(2), 89-106. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/env.2301 [Retrieved on 13th October, 2019]

Ec.europa.eu (2015)https://ec.europa.eu/environment/water/pdf/Finnish_Norwegian_international_river_basin_district.pdf

Emerton, R. E., Stephens, E. M., Pappenberger, F., Pagano, T. C., Weerts, A. H., Wood, A. W., ... & Baugh, C. A. (2016). Continental and global scale flood forecasting systems. *Wiley Interdisciplinary Reviews: Water*, *3*(3), 391-418.https://onlinelibrary.wiley.com/doi/pdf/10.1002/wat2.1137

Emerton, R. E., Stephens, E. M., Pappenberger, F., Pagano, T. C., Weerts, A. H., Wood, A. W., ... & Baugh, C. A. (2016). Continental and global scale flood forecasting systems. *Wiley Interdisciplinary Reviews: Water*, *3*(3), 391-418.https://onlinelibrary.wiley.com/doi/pdf/10.1002/wat2.1137

Emmer, A. (2018). GLOFs in the WOS: Bibliometrics, geographies and global trends of research on glacial lake outburst floods (Web of Science, 1979–2016). *Natural Hazards and Earth System Sciences*, *18*(3), 813-827.https://www.nat-hazards-earth-syst-sci.net/18/813/2018/

Engeland, K., Wilson, D., Borsányi, P., Roald, L., & Holmqvist, E. (2017). Use of historical data in flood frequency analysis: a case study for four catchments in Norway. *Hydrology Research*, *49*(2), 466-486. https://iwaponline.com/hr/article-abstract/49/2/466/37840

eurasia.undp.org. 2019. EARLY WARNING SYSTEM. Retrieved from: https://www.eurasia.undp.org/content/dam/rbec/docs/UNDP%20Brochure%20Early%20Warning%20Systems.pdf

Fang, S., Xu, L., Zhu, Y., Liu, Y., Liu, Z., Pei, H., ... & Zhang, H. (2015). An integrated information system for snowmelt flood early-warning based on internet of things. *Information Systems Frontiers*, *17*(2), 321-335.https://link.springer.com/article/10.1007/s10796-013-9466-1

Floodlist . (2015) Online . Available At : http://floodlist.com/europe/norway-may-2013

Forecast.weather.gov (2019) *Detailed Forecast*https://forecast.weather.gov/MapClick.php?CityName=Norway&state=MI&site=MQT&textField1=45.8026&textField2=-87.9146&e=0#.XfIckNIzbcc

Fouinat, L., Sabatier, P., Poulenard, J., Etienne, D., Crouzet, C., Develle, A. L., ... & Bonet, R. (2017). One thousand seven hundred years of interaction between glacial activity and flood frequency in proglacial Lake Muzelle (western French Alps). *Quaternary Research*, *87*(3), 407-422. https://www.cambridge.org/core/journals/quaternary-research/article/one-thousand-seven-hundred-years-of-interaction-between-glacial-activity-and-flood-frequency-in-proglacial-lake-muzelle-western-french-alps/6F56B39299470BDDFDF20C80EFF4DAE3

Frauenfelder, R., Solheim, A., Isaksen, K., Romstad, B., Dyrrdal, A. V., Ekseth, K. H., ... & Hygen, H. O. (2017). Impacts of extreme weather events on transport infrastructure in Norway. *Nat. Hazards Earth Syst. Sci. Manuscript under review. Discussion started on*, *20*.https://pdfs.semanticscholar.org/2019/dcecb5f9cd34e7779b590202dd1e26829989.pdf

Givati, A., Gochis, D., Rummler, T., & Kunstmann, H. (2016). Comparing one-way and two-way coupled hydrometeorological forecasting systems for flood forecasting in the Mediterranean region. *Hydrology*, *3*(2), 19. https://www.mdpi.com/2306-5338/3/2/19/pdf

Goeldner-Gianella, L., Grancher, D., Robertsen, Ø., Anselme, B., Brunstein, D., & Lavigne, F. (2017). Perception of the risk of tsunami in a context of high-level risk assessment and management: the case of the fjord Lyngen in Norway. *Geoenvironmental Disasters*, *4*(1), 7. https://www.biomedcentral.com/openurl?doi=10.1186/s40677-017-0068-y

Gov.uk (2015). *Data Protection.* Retrieved From: https://www.gov.uk/data-protection

Graziella, D., Ingeborg, K., Monica, S., Nils-Kristian, O., Ragnar, E., Erik, J., & Hervé, C. (2015). Landslide early warning system and web tools for real-time scenarios and for distribution of warning messages in Norway. In *Engineering Geology for Society and Territory-Volume 2* (pp. 625-629). Springer, Cham.

Graziella, D., Ingeborg, K., Monica, S., Nils-Kristian, O., Ragnar, E., Erik, J., & Hervé, C. (2015). Landslide early warning system and web tools for real-time scenarios and for distribution of warning messages in Norway. In *Engineering Geology for Society and Territory-Volume 2* (pp. 625-629). Springer, Cham.https://link.springer.com/chapter/10.1007/978-3-319-09057-3_104

Graziella, D., Ingeborg, K., Monica, S., Nils-Kristian, O., Ragnar, E., Erik, J., & Hervé, C. (2015). Landslide early warning system and web tools for real-time scenarios and for distribution of warning messages in Norway. In *Engineering Geology for Society and Territory-Volume 2* (pp. 625-629). Springer, Cham. Retrieved from https://link.springer.com/chapter/10.1007/978-3-319-09057-3_104 [Retrieved on 20th October, 2019]

Gundersen, V., Kaltenborn, B. P., & Williams, D. R. (2016). A bridge over troubled water: A contextual analysis of social vulnerability to climate change in a riverine landscape in south-east Norway. *Norsk Geografisk Tidsskrift-Norwegian Journal of Geography*, *70*(4), 216-229.https://www.fs.usda.gov/treesearch/pubs/download/52968.pdf

Hailegeorgis, T. T., & Alfredsen, K. (2017). Regional flood frequency analysis and prediction in ungauged basins including estimation of major uncertainties for mid-Norway. *Journal of Hydrology: Regional Studies*, *9*, 104-126.https://www.sciencedirect.com/science/article/pii/S2214581816301768

Hailegeorgis, T. T., & Alfredsen, K. (2017). Regional flood frequency analysis and prediction in ungauged basins including estimation of major uncertainties for mid-Norway. *Journal of Hydrology: Regional Studies*, *9*, 104-126.https://www.sciencedirect.com/science/article/pii/S2214581816301768

Hapsari, R. I., & Zenurianto, M. (2016). View of flood disaster management in Indonesia and the key solutions. American Journal of Engineering Research, 5(3), 140-151. Retrieved from: http://www.ajer.org/papers/v5(03)/T050301400151.pdf

Hermanns, R. L., Oppikofer, T., Böhme, M., Dehls, J. F., Yugsi Molina, F. X., & Penna, I. M. (2016, June). Rock slope instabilities in Norway: First systematic hazard and risk classification of 22 unstable rock slopes from northern, western and southern Norway. In *Proceedings landslides and engineered slopes. Experience, theory and practice: proceedings of the 12th international symposium on landslides, Napoli, Italy* (pp. 12-19).https://www.researchgate.net/profile/Reginald_Hermanns/publication/303885045_Rock_slope_instabilities_in_Norway_First_systematic_hazard_and_risk_classification_of_22_unstable_rock_slopes_from_northern_western_and_southern_Norway/links/59e712c50f7e9b13acac6db1/Rock-slope-instabilities-in-Norway-First-systematic-hazard-and-risk-classification-of-22-unstable-rock-slopes-from-northern-western-and-southern-Norway.pdf

Hiljazi, S., & Curtis, T. (2018). Developing an Introductory Class in Business Intelligence (BI) Using MS Excel PowerPivot. *Association Supporting Computer Users in Education*.Retrieved From: https://files.eric.ed.gov/fulltext/ED592862.pdf

Hodgkins, G. A., Whitfield, P. H., Burn, D. H., Hannaford, J., Renard, B., Stahl, K., ... & Murphy, C. (2017). Climate-driven variability in the occurrence of major floods across North America and Europe. *Journal of Hydrology*, *552*, 704-717. https://www.sciencedirect.com/science/article/pii/S002216941730478X

Høgaas, F., & Longva, O. (2016). Mega deposits and erosive features related to the glacial lake Nedre Glomsjø outburst flood, southeastern Norway. *Quaternary Science Reviews*, *151*, 273-291.
https://www.researchgate.net/profile/Oddvar_Longva/publication/309212490_Mega_deposits_and_erosive_features_related_to_the_glacial_lake_Nedre_Glomsjo_outburst_flood_southeastern_Norway/links/582db52a08ae004f74bccc3e/Mega-deposits-and-erosive-

features-related-to-the-glacial-lake-Nedre-Glomsjo-outburst-flood-southeastern-Norway.pdf

https://www.ngi.no/eng/News/NGI-News/Urban-floods-a-rising-problem

Hungr, O., Clague, J., Morgenstern, N. R., VanDine, D., & Stadel, D. (2016). A review of landslide risk acceptability practices in various countries. *Landslides and Engineered Slopes. Experience, Theory and Practice, Rome*, 1121-1128. https://www.researchgate.net/profile/John_Clague/publication/303884882_A_review_of_landslide_risk_acceptability_practices_in_various_countries/links/579f831008aec29aed214477/A-review-of-landslide-risk-acceptability-practices-in-various-countries.pdf

Jones, L., Samman, E., & Vinck, P. (2018). Subjective measures of household resilience to climate variability and change: insights from a nationally representative survey of Tanzania. Ecology and Society, 23(1): 9). Retrieved from: http://eprints.lse.ac.uk/87638/1/Jones_Subjective%20Measures%20of%20Household%20Resilience.pdf

Judger, N. (2016). The thematic analysis of interview data: An approach used to examine the influence of the market on curricular provision in Mongolian higher education institutions. *Hillary Place Papers, 3rd edition, University of Leeds*.Retrieved From: http://hpp.education.leeds.ac.uk/wp-content/uploads/sites/131/2016/02/HPP2016-3-Jugder.pdf

Kalsnes, B., Nadim, F., Hermanns, R. L., Hygen, H. O., Petkovic, G., Dolva, B. K., ... & Høgvold, D. O. (2017). Landslide risk management in Norway. In *Slope Safety Preparedness for Impact of Climate Change* (pp. 215-251). CRC Press.https://www.taylorfrancis.com/books/e/9781315387789/chapters/10.1201/9781315387789-7

Kalsnes, B., Nadim, F., Hermanns, R. L., Hygen, H. O., Petkovic, G., Dolva, B. K., ... & Høgvold, D. O. (2017). Landslide risk management in Norway. In *Slope Safety Preparedness for Impact of Climate Change* (pp. 215-251). CRC Press. Retrieved from https://www.taylorfrancis.com/books/e/9781315387789/chapters/10.1201/9781315387789-7 [Retrieved on 20th October, 2019]

Kataria, B. (2015). Weather-Climate Forecasting System for Early Warning in Crop Protection. *Journal of engineering and technology*, *1*(5), 442-444. http://www.academia.edu/download/38565912/1.pdf

Kaufmann, M., Lewandowski, J., Chorynski, A., Wiering, M. A., Kaufmann, M., & Lewandowski, A. (2016). Shock events and flood risk management: a media analysis of the institutional long-term effects of flood events in the Netherlands and Poland. Retrieved from: https://repository.ubn.ru.nl/bitstream/handle/2066/162761/162761pub.pdf?sequence=1

Kennedy, A. M. (2017). Macro-social marketing research: philosophy, methodology and methods. *Journal of Macromarketing*, *37*(4), 347-355. Retrieved From: https://farapaper.com/wp-content/uploads/2019/11/Fardapaper-Macro-Social-Marketing-Research-Philosophy-Methodology-and-Methods.pdf

Knighton, J. O., Tsuda, O., Elliott, R., & Walter, M. T. (2018). Challenges to implementing bottom-up flood risk decision analysis frameworks: how strong are social networks of flooding professionals?. *Hydrology and Earth System Sciences*, *22*(11), 5657-5673. Retrieved from https://www.hydrol-earth-syst-sci.net/22/5657/2018/[Retrieved on 13th October, 2019]

Krøgli, I. K., Devoli, G., Colleuille, H., Boje, S., Sund, M., & Engen, I. K. (2018). The Norwegian forecasting and warning service for rainfall-and snowmelt-induced landslides. *Natural hazards and earth system sciences*, *18*(5), 1427-1450. Retrieved from https://www.nat-hazards-earth-syst-sci.net/18/1427/2018/nhess-18-1427-2018.pdf, retrieved 24 August 2018

Kulinkina, A. V., Shinee, E., Herrador, B. R. G., Nygård, K., & Schmoll, O. (2016). The siTuaTion of waTer-relaTed infecTious diseases in The pan-european region. *Copenhagen: WHO Regional Office for Europe*. http://www.euro.who.int/__data/assets/pdf_file/0019/322165/Situation-water-related-infectious-diseases.pdf?ua=1

Kundzewicz, Z. W. (Ed.). (2019). *Changes in flood risk in Europe*. CRC Press. https://books.google.co.in/books?hl=en&lr=&id=7uCsDwAAQBAJ&oi=fnd&pg=PP1&dq=trends+in+flood+in+norway&ots=w01lddI3Hm&sig=mHqcVv9OZFx6ROMpL4W7Fhe_V8c

Kvisvik, B. C., Paasche, Ø., & Dahl, S. O. (2015). Holocene cirque glacier activity in Rondane, southern Norway. *Geomorphology*, *246*, 433-444. https://www.sciencedirect.com/science/article/pii/S0169555X15300635

Law, M. (2017). R2P: Activating the International Community's Responsibility to Protect by Shifting Focus Away from Collective Action by the Security Council towards Early Warning and Prevention. King's Student L. Rev., 8, 88. Retrieved from: https://blogs.kcl.ac.uk/kslr/wp-content/blogs.dir/86/files/2017/01/8.1.6-Monique-Law-88-107.pdf

Lendering, K. T., Jonkman, S. N., & Kok, M. (2016). Effectiveness of emergency measures for flood prevention. *Journal of Flood Risk Management*, *9*(4), 320-334.https://s3.amazonaws.com/academia.edu.documents/44102515/Effectiveness_of_emergency_measures_for_20160325-18854-1jtk0ih.pdf?response-content-disposition=inline%3B%20filename%3DEffectiveness_of_emergency_measures_for.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20191213%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20191213T063657Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=e01646f90adf83912e595543a24455d87a10d8a9960a052bb4bcff8cf7bb80c0

Li, Y., Grimaldi, S., Walker, J. P., & Pauwels, V. (2016). Application of remote sensing data to constrain operational rainfall-driven flood forecasting: a review. *Remote Sensing*, *8*(6), 456. Retrieved from https://www.mdpi.com/2072-4292/8/6/456 [Retrieved on 13th October, 2019]

Lind, V., Jørgensen, G. H. M., Pongo, E., & Lombardi, G. (2018). Adapting Innovation in Grassland Management-Book of abstracts-20th meeting of the FAO-CIHEAM Mountain Pasture Network 9th–12th September 2018 in Ballstad, Lofoten, Norway. *NIBIO Bok*. https://nibio.brage.unit.no/nibio-xmlui/bitstream/handle/11250/2563784/NIBIO-Book-4-11.pdf?sequence=2

Liu, Z., Guo, S., Xiong, L., & Xu, C. Y. (2018). Hydrological uncertainty processor based on a copula function. *Hydrological sciences journal*, *63*(1), 74-86. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/02626667.2017.1410278[Retrieved on 13th October, 2019]

Lopez, M. G., Di Baldassarre, G., & Seibert, J. (2017). Impact of social preparedness on flood early warning systems. *Water Resources Research*, *53*(1), 522-534. https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2016WR019387%4010.1002/%28ISSN%291944-7973.SOCHYD1

Marks, D., & Lebel, L. (2016). Disaster governance and the scalar politics of incomplete decentralization: Fragmented and contested responses to the 2011 floods in Central Thailand. Habitat International, 52, 57-66. Retrieved from: https://s3.amazonaws.com/academia.edu.documents/43216498/Disaster_governance_and_the_scalar_politics_of_incomplete_-_Marks___Lebel.pdf?response-content-disposition=inline%3B%20filename%3DDisaster_governance_and_the_scalar_polit.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20191214%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20191214T042731Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=76cc719459ae1753abc7fa543ee8eb3aa14e0efa7ac0419213a24a8d5345ab2f

Matti, B., Dahlke, H. E., Dieppois, B., Lawler, D. M., & Lyon, S. W. (2017). Flood seasonality across Scandinavia—Evidence of a shifting hydrograph?. *Hydrological processes*, *31*(24), 4354-4370. https://onlinelibrary.wiley.com/doi/abs/10.1002/hyp.11365

Meyers, L. S., Gamst, G., & Guarino, A. J. (2016). *Applied multivariate research: Design and interpretation*. Sage publications. Retrieved From: http://library.mpib-berlin.mpg.de/toc/ze_2006_1176.pdf

Mohr, D. C., Riper, H., & Schueller, S. M. (2018). A solution-focused research approach to achieve an implementable revolution in digital mental health. *JAMA psychiatry*, *75*(2), 113-114. Retrieved From: https://www.researchgate.net/profile/David_Mohr3/publication/321789952_A_Solution-Focused_Research_Approach_to_Achieve_an_Implementable_Revolution_in_Digital_Mental_Health/links/5c066e3da6fdcc315f9bffa1/A-Solution-Focused-Research-Approach-to-Achieve-an-Implementable-Revolution-in-Digital-Mental-Health.pdf

Nepal, J., Chen, H. P., Gouldby, B., Simm, J., & Tarrant, O. (2015). State-based stochastic performance deterioration modelling of flood defence assets. *7th International Society for Structural Health Monitoring of Intelligent*

Infrastructure.https://www.researchgate.net/profile/Hua-Peng_Chen/publication/280100533_State-based_stochastic_performance_deterioration_modelling_of_flood_defence_assets/links/55a93dde08ae481aa7f97dbb.pdf

Newsinenglish.no (2018) Flash floods sweep through valleys Retrieved from https://www.newsinenglish.no/2018/10/14/flash-floods-sweeping-through-valleys/[Retrieved on 13th October, 2019]

Ngi.no (2017) Online . Available At : https://www.ngi.no/eng/News/NGI-News/Urban-floods-a-rising-problem

Norwaypost.no (2017). Online . Available At : http://www.norwaypost.no/weather/28538-flood-warning-for-the-south-of-norway

Nrdc.org (2019) *Flooding and Climate Change: Everything You Need to Know* Retrieved from https://www.nrdc.org/stories/flooding-and-climate-change-everything-you-need-know#consequences[Retrieved on 13th October, 2019]

Ntajal, J., Lamptey, B. L., Sogbedji, M. J., & Wilson-Bahun, K. K. (2017). Rainfall trends and flood frequency analyses in the lower Mono River basin in Togo, West Africa. *Int. J. Des. Ris. Red*, *23*, 93-103. http://www.ijoar.org/journals/IJOAR/papers/Rainfall_Tend_FLood_Frequency_Analysis_Ntajal_Edited_final.pdf

Nygård, H., Lundh Broen, M., Hustad, E., & Vassilakopoulou, P. (2018). Early Warning Systems in a Digitalisation Era: Key Characteristics and Directions for Future Research. In *Digital and social transformation for a better society-Proceedings of the Twelfth Mediterranean Conference on Information Systems (MCIS 2018)*.https://uia.brage.unit.no/uia-xmlui/bitstream/handle/11250/2598463/MCIS2018_EWS_Aura.pdf?sequence=2

Nygård, H., Lundh Broen, M., Hustad, E., & Vassilakopoulou, P. (2018). Early Warning Systems in a Digitalisation Era: Key Characteristics and Directions for Future Research. In *Digital and social transformation for a better society-Proceedings of the Twelfth Mediterranean Conference on Information Systems (MCIS 2018)*.https://uia.brage.unit.no/uia-xmlui/bitstream/handle/11250/2598463/MCIS2018_EWS_Aura.pdf?sequence=2

Ober, K. (2019). *The links between climate change, disasters, migration, and social resilience in Asia: A literature review* (No. 586). ADB Economics Working Paper Series. https://www.econstor.eu/bitstream/10419/203428/1/1669007286.pdf

OECD (2018) *OECD Conference on the Financial Management of Flood Risk. Building financial resilience in a changing climate*. Retrieved from *https://www.oecd.org/daf/fin/insurance/2016-Flood-Risk-Conference-Summary-of-Proceedings.pdf*, retrieved 27 August 2018

Oecd.org (2016) *SUMMARY OF PROCEEDINGS*Retrieved from https://www.oecd.org/daf/fin/insurance/2016-Flood-Risk-Conference-Summary-of-Proceedings.pdf[Retrieved on 13th October, 2019]

Oppikofer, T., Hermanns, R. L., Sandøy, G., Böhme, M., Jaboyedoff, M., Horton, P., ... & Fuchs, H. (2016). Quantification of casualties from potential rock-slope failures in Norway. *Landslides and Engineered Slopes: Experience, Theory and Practice*, 1537-1544.https://www.researchgate.net/profile/Reginald_Hermanns/publication/303885372_Quantification_of_casualties_from_potential_rock-slope_failures_in_Norway/links/59e714fe4585151e54658f3d/Quantification-of-casualties-from-potential-rock-slope-failures-in-Norway.pdf

Oppikofer, T., Hermanns, R. L., Sandøy, G., Böhme, M., Jaboyedoff, M., Horton, P., ... & Fuchs, H. (2016). Quantification of casualties from potential rock-slope failures in Norway. *Landslides and Engineered Slopes: Experience, Theory and Practice*, 1537-1544. Retrieved from https://www.researchgate.net/profile/Reginald_Hermanns/publication/303885372_Quantification_of_casualties_from_potential_rock-slope_failures_in_Norway/links/59e714fe4585151e54658f3d/Quantification-of-casualties-from-potential-rock-slope-failures-in-Norway.pdf [Retrieved on 20th October, 2019]

Pall, P., Tallaksen, L. M., & Stordal, F. (2019). A climatology of rain-on-snow events for Norway. *Journal of Climate*, *32*(20), 6995-7016. https://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-18-0529.1

Pall, P., Tallaksen, L. M., & Stordal, F. (2019). A climatology of rain-on-snow events for Norway. *Journal of Climate*, *32*(20), 6995-7016.

Pappenberger, F., Cloke, H. L., Parker, D. J., Wetterhall, F., Richardson, D. S., & Thielen, J. (2015). The monetary benefit of early flood warnings in Europe. *Environmental Science & Policy*, *51*, 278-291. [online] Retrieved from https://www.sciencedirect.com/science/article/pii/S1462901115000891 , retrieved 17 August 2018

Piciullo, L., Dahl, M. P., Devoli, G., Colleuille, H., & Calvello, M. (2017). Adapting the EDuMaP method to test the performance of the Norwegian early warning system for weather-induced landslides. *Natural Hazards and Earth System Sciences*, *17*(6), 817-831.https://www.nat-hazards-earth-syst-sci.net/17/817/2017/

Piciullo, L., Dahl, M. P., Devoli, G., Colleuille, H., & Calvello, M. (2017). Adapting the EDuMaP method to test the performance of the Norwegian early warning system for weather-induced landslides. *Natural Hazards and Earth System Sciences*, *17*(6), 817-831.https://www.nat-hazards-earth-syst-sci.net/17/817/2017/

Piciullo, L., Dahl, M. P., Devoli, G., Colleuille, H., & Calvello, M. (2017). Adapting the EDuMaP method to test the performance of the Norwegian early warning system for weather-induced landslides. *Natural Hazards and Earth System Sciences*, *17*(6), 817-831. https://www.nat-hazards-earth-syst-sci.net/17/817/2017/nhess-17-817-2017.pdf

Piciullo, L., Dahl, M. P., Devoli, G., Colleuille, H., & Calvello, M. (2017). Adapting the EDuMaP method to test the performance of the Norwegian early warning system for weather-induced landslides. *Natural Hazards and Earth System Sciences, 17*(6), 817-831.Retrieved from https://www.nat-hazards-earth-syst-sci.net/17/817/2017/ [Retrieved on 20th October, 2019]

Poff, N. L., Brown, C. M., Grantham, T. E., Matthews, J. H., Palmer, M. A., Spence, C. M., ... & Baeza, A. (2016). Sustainable water management under future uncertainty with eco-engineering decision scaling. Nature Climate Change, 6(1), 25-34. Retrieved from: https://agwaguide.org/docs/Poff_et_al_2015_NCC.pdf

politico.eu/article/politico-pro-sustainability-insights-circular-batteries-boost-chemicals-leaks-cop-update/

Qiu, L., Du, Z., Zhu, Q., & Fan, Y. (2017). An integrated flood management system based on linking environmental models and disaster-related data. *Environmental modelling &*

software, *91*, 111-126.http://www.irdrinternational.org/wp-content/uploads/2015/12/IJDRR-Fakhrudding-Nov-2015.pdf

Rahman, M. S., & Di, L. (2017). The state of the art of spaceborne remote sensing in flood management. *Natural Hazards*, *85*(2), 1223-1248.https://www.researchgate.net/profile/Md_Rahman254/publication/308956986_The_state_of_the_art_of_spaceborne_remote_sensing_in_flood_management/links/59dd14830f7e9b53c196d84d/The-state-of-the-art-of-spaceborne-remote-sensing-in-flood-management.pdf

Romanowicz, R. J., Bogdanowicz, E., Debele, S. E., Doroszkiewicz, J., Hisdal, H., Lawrence, D., ... & Wilson, D. (2016). Climate change impact on hydrological extremes: preliminary results from the Polish-Norwegian Project. *Acta Geophysica*, *64*(2), 477-509. https://link.springer.com/article/10.1515/acgeo-2016-0009

Romanowicz, R. J., Kundzewicz, Z. W., Meresa, H. K., Stoffel, M., Krysanova, V., & Doroszkiewicz, J. (2016). Projections of changes in flood hazard in two headwater catchments of the Vistula in the context of European-scale studies. In *Flood Risk in the Upper Vistula Basin* (pp. 341-359). Springer, Cham.https://link.springer.com/chapter/10.1007/978-3-319-41923-7_17

Sarstedt, M., Bengart, P., Shaltoni, A. M., & Lehmann, S. (2018). The use of sampling methods in advertising research: A gap between theory and practice. *International Journal of Advertising*, *37*(4), 650-663.Retrieved From: https://www.researchgate.net/profile/Marko_Sarstedt/publication/317905066_The_use_of_sampling_methods_in_advertising_research_A_gap_between_theory_and_practice/links/59f796cc458515547c24cbd5/The-use-of-sampling-methods-in-advertising-research-A-gap-between-theory-and-practice.pdf

Sättele, M., Bründl, M., & Straub, D. (2015). Quantifying the effectiveness of early warning systems for natural hazards. *Natural Hazards and Earth System Sciences Discussions*, *3*, 4479-4526.Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.942.456&rep=rep1&type=pdf [Retrieved on 20th October, 2019]

Sauquet, E., & Lang, M. (2017). Flood Regimes: Recent Development and Future under Climate Change. In *Floods* (pp. 299-309). Elsevier.https://www.sciencedirect.com/science/article/pii/B9781785482687500183

Sciencepolicy.colorado.edu (2017). Online . Available At : https://sciencepolicy.colorado.edu/admin/publication_files/resource-1807-climate_flood_norway_july05.pdf

Shafiai, S., & Khalid, M. S. (2016). Flood Disaster Management in Malaysia: A Review of Issues of Flood Disaster Relief during and Post-Disaster. In Int. Soft Sci. Conf (No. 1983, pp. 1-8). Retrieved from: https://www.researchgate.net/profile/Shazwani_Shafiai/publication/306387112_Flood_Disaster_Management_in_Malaysia_A_Review_of_Issues_of_Flood_Disaster_Relief_during_and_Post-Disaster/links/58468b0308ae2d21756c66ac/Flood-Disaster-Management-in-Malaysia-A-Review-of-Issues-of-Flood-Disaster-Relief-during-and-Post-Disaster.pdf

Sörensen, J., Persson, A., Sternudd, C., Aspegren, H., Nilsson, J., Nordström, J., ... & Larsson, R. (2016). Re-thinking urban flood management—Time for a regime shift. Water, 8(8), 332. Retrieved from: https://www.researchgate.net/profile/Shazwani_Shafiai/publication/306387112_Flood_Disaster_Management_in_Malaysia_A_Review_of_Issues_of_Flood_Disaster_Relief_during_and_Post-Disaster/links/58468b0308ae2d21756c66ac/Flood-Disaster-Management-in-Malaysia-A-Review-of-Issues-of-Flood-Disaster-Relief-during-and-Post-Disaster.pdf

Straus, M. A. (2017). The Conflict Tactics Scales and its critics: An evaluation and new data on validity and reliability. In *Physical violence in American families* (pp. 49-74). Routledge.Retrieved From: https://files.eric.ed.gov/fulltext/ED297030.pdf

Thiebes, B., & Glade, T. (2016, June). Landslide Early Warning Systems–fundamental concepts and innovative applications. In *Landslides and Engineered Slopes: Experience, Theory and Practice, edited by: Aversa, S., Cascini, L., Picarelli, L., and Scavia, C., Proceedings of the 12th International Symposium on Landslides, Napoli, Italy* (pp. 12-19).https://www.researchgate.net/profile/Benni_Thiebes/publication/296319407_Landslide_early_warning_systems_-_fundamental_concepts_and_innovative_applications/links/56d4330408aedf315fb7111d.pdf

Thiebes, B., & Glade, T. (2016, June). Landslide Early Warning Systems–fundamental concepts and innovative applications. In *Landslides and Engineered Slopes: Experience, Theory and Practice, edited by: Aversa, S., Cascini, L., Picarelli, L., and Scavia, C., Proceedings of the 12th International Symposium on Landslides, Napoli, Italy* (pp. 12-19). Retrieved from https://www.researchgate.net/profile/Benni_Thiebes/publication/296319407_Landslide_early_warning_systems_-_fundamental_concepts_and_innovative_applications/links/56d4330408aedf315fb7111d.pdf [Retrieved on 20th October, 2019]

Thorne, C. R., Lawson, E. C., Ozawa, C., Hamlin, S. L., & Smith, L. A. (2018). Overcoming uncertainty and barriers to adoption of Blue-Green Infrastructure for urban flood risk management. Journal of Flood Risk Management, 11, S960-S972. Retrieved from: https://onlinelibrary.wiley.com/doi/pdf/10.1111/jfr3.12218

Tight, M. (2016). Phenomenography: The development and application of an innovative research design in higher education research. *International Journal of Social Research Methodology*, *19*(3), 319-338. Retrieved From: https://www.tandfonline.com/doi/abs/10.1080/13645579.2015.1010284

Tiranti, D., Devoli, G., Cremonini, R., Sund, M., & Bo, S. (2017). Regional landslide forecasting in Piemonte (Italy) and in Norway: experiences from 2013 late spring. *Natural Hazards and Earth System Sciences Discussions*, 1-30.https://d-nb.info/1148111409/34

Torgersen, G., Bjerkholt, J. T., Kvaal, K., & Lindholm, O. G. (2015). Correlation between extreme rainfall and insurance claims due to urban flooding–case study Fredrikstad, Norway. *Journal of Urban and Environmental Engineering*, *9*(2), 127-138.https://www.redalyc.org/pdf/2832/283243518006.pdf

Torgersen, G., Rød, J. K., Kvaal, K., Bjerkholt, J. T., & Lindholm, O. G. (2017). Evaluating flood exposure for properties in Urban areas using a multivariate modelling technique. *Water*, *9*(5), 318. Torgersen, G., Rød, J. K., Kvaal, K., Bjerkholt, J. T., & Lindholm, O. G. (2017). Evaluating flood exposure for properties in Urban areas using a multivariate modelling technique. *Water*, *9*(5), 318.

Torgersen, G., Rød, J. K., Kvaal, K., Bjerkholt, J. T., & Lindholm, O. G. (2017). Evaluating flood exposure for properties in Urban areas using a multivariate modelling

technique. *Water*, *9*(5), 318. Retrieved from https://www.mdpi.com/2073-4441/9/5/318 [Retrieved on 13th October, 2019]

Tuffour, I. (2017). A critical overview of interpretative phenomenological analysis: a contemporary qualitative research approach. *Journal of Healthcare Communications*, *2*(4), 52. Retrieved From: http://repository.uwl.ac.uk/id/eprint/4082/1/a-critical-overview-of-interpretative-phenomenological-analysis-a-contemporary-qualitative-research-approach.pdf

Ui.adsabs.harvard.edu (2016). Online. Available At: https://ui.adsabs.harvard.edu/abs/2016EGUGA..1812822J/abstract

Uni.no (2016) Online. Available At: http://uni.no/media/manual_upload/WP_4-2016_Lillestoel_og_Rykkja.pdf

van Vliet, M., & Aerts, J. C. J. H. (2015). Adapting to climate change in urban water management: Flood management in the Rotterdam–Rijnmond area. In Understanding and managing urban water in transition (pp. 549-574). Springer, Dordrecht. Retrieved from: https://s3.amazonaws.com/academia.edu.documents/33695093/chapter_water_in_transition_before_copy_editing.pdf?response-content-disposition=inline%3B%20filename%3DAdaptation_to_climate_change_in_urban_wa.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20191214%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20191214T043211Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=1f1fdaea6d392ae55a8905d51ac05d46b278a454e7e23596a971c7e456f886da

Vanderhoven, E., Schellens, T., Vanderlinde, R., & Valcke, M. (2016). Developing educational materials about risks on social network sites: a design based research approach. *Educational technology research and development*, *64*(3), 459-480. Retrieved From: https://biblio.ugent.be/publication/6985885/file/7247886.pdf

Wang, C., & Zhang, X. (2019, October). An Empirical Study of the Effect of Phonetic Teaching on the Listening Ability of Marine College Students—Based on SPSS Software. In *2019 International Conference on Advanced Education, Service and Management* (Vol. 3, pp. 755-758). The Academy of Engineering and Education.Retrieved From: https://aeescience.org/uploads/ppapers/2019100701AESM2019/AESM107168.pdf

Westerberg, I. K., Wagener, T., Coxon, G., McMillan, H. K., Castellarin, A., Montanari, A., & Freer, J. (2016). Uncertainty in hydrological signatures for gauged and ungauged catchments. *Water Resources Research*, *52*(3), 1847-1865.Retrieved from https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2015WR017635 [Retrieved on 13th October, 2019]

Winit-Watjana, W. (2016). Research philosophy in pharmacy practice: necessity and relevance. *International Journal of Pharmacy Practice*, *24*(6), 428-436. Retrieved From: https://onlinelibrary.wiley.com/doi/abs/10.1111/ijpp.12281

Wulfmeyer, V., Turner, D. D., Baker, B., Banta, R., Behrendt, A., Bonin, T., ... & Hardesty, R. M. (2018). A new research approach for observing and characterizing land–atmosphere feedback. *Bulletin of the American Meteorological Society*, *99*(8), 1639-1667. Retrieved From: https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-17-0009.1

Yan, L., Xiong, L., Ruan, G., Xu, C. Y., Yan, P., & Liu, P. (2019). Reducing uncertainty of design floods of two-component mixture distributions by utilizing flood timescale to classify flood types in seasonally snow covered region. *Journal of Hydrology*, *574*, 588-608.https://www.sciencedirect.com/science/article/pii/S0022169419303968

Zahlsen, K., Kilaas, L., & Skjetne, P. (2018). *U.S. Patent No. 10,047,605*. Washington, DC: U.S. Patent and Trademark Office.Retrieved From: https://patentimages.storage.googleapis.com/76/21/28/534edeb2d7c77f/US10047605.pdf

Zhang, Q., Gu, X., Singh, V. P., Xiao, M., & Xu, C. Y. (2015). Flood frequency under the influence of trends in the Pearl River basin, China: changing patterns, causes and implications. *Hydrological processes*, *29*(6), 1406-1417. https://onlinelibrary.wiley.com/doi/abs/10.1002/hyp.10278

Appendices

Appendix 1: Timeframe

Main activities/ stages	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Topic Selection	●						
Data collection from secondary sources	●	●					
Creating layout		●					
Literature review		●	●	●			
Formation of the research Plan			●	●			
Selection of the Appropriate Research Techniques				●	●		
Primary data collection					●	●	
Analysis & Interpretation of Data Collection					●	●	
Findings of the Data						●	
Secondary Data Collection						●	
Conclusion of the Study						●	
Formation of Rough Draft						●	●
Submission of Final Work						●	●

Appendix 2: Interview transcript

Q1: What are the causes of floods in Norway?	
1st meteorologist	Rain cyclones are not general rainfall; rather it elongates heavy rainfall along with the great flow.
2nd meteorologist	In Norway, it is a common cause for flood occurrence and in this context, this meteorologist has pointed to the increasing temperature of Norway's weather.
3rd meteorologist	Climate change not only causes floods but also extracts all the humidity from air that leads to drought. While drought remains in the county, the existing water level becomes evaporated to a large extent and this excessive amount of water into the air ultimately shapes in the form of excessive rain.
Q2: How seasonal changes can raise the cause of flood?	
1st meteorologist	The natural hydrology is affected with the outcome of excessive snowfall and this has also degraded the climate of the earth. The high risk of snowmelt is addressed to the risk of frozen soil.
2nd meteorologist	In autumn of the recent years, the incidences of heavy rainfall have not been reported in Norway, but at the mid-time of summer, without any heavy rainfall, the flood has entered into the country.

3rd meteorologist	Due to the excessive level of snowfall in summer due to the increasing heat spreads out the threat of flood in Norway. Therefore, in the context of responding upon the impact of seasonal change, it has been analysed that seasonal change is equally responsible for the occurrence of the flood even in summer.
3: What preventive ways do you prefer to be undertaken by Norway?	
1st meteorologist	The warning technologies would help in detecting the detailed functionalities of the water that develops identification of the flow related to streamlining.
2nd meteorologist	Based on the proper measurement, the countrymen along the coastal areas would be warned so that in any type of external activities they are engaged in. Moreover, by measuring the depth of a rain cyclone, the government can take active steps for directing the falling rain underneath the soil.
3rd meteorologist	Based on the trading or transportation through the sea level, the country receives most of its earnings from the sea and for this reason, it is also necessary to detect the level of the sea every time to avoid the outcome of natural calamities. Therefore, the role of flood warning system is unavoidable as this could only be effective for reaching the report sea level at the environmental office of

	Norway to take proper action to save the country.
4. What is the significance of flood management practices that can be adopted under the determination of reducing the threat of flood?	
1st meteorologist	The invention of the HYDRA phase is impactful in the process of flood management. This is considered as one of the effective research programs for the purpose of flood prevention.
2nd meteorologist	Through the deployment of this management plan, the country has proceeded with maintaining strong relations with Finland.
3rd meteorologist	Undertaking this management system, in case of increasing water level, the excess flow of water used to be distributed to another basin and in this way, Norway has tried to reduce the threat of sea level due to the heavy rainfall.
5. What are the most dreadful floods you have gone through in recent years?	
1st meteorologist	The flood of 1789 is worth remembering for its demolition gesture towards the countrymen and the meteorologist has delineated the dreadful after effect of this year's flood.
2nd meteorologist	In 1789, the increase of temperature at a rapid pace has increased the level of water in the sea and this is known as the major cause

	of this year's flood occurrence. The rise of temperature is subjected to the increase of evaporation throughout the year.
3rd meteorologist	Large effect of the flood of 1995 and from the details of this participant; it gets known that this flood is also housed with dreadful effect upon the specific countrymen.
6. What is the significance of a flood forecasting system and how its functions are used for flood detection?	
1st meteorologist	This forecasting process is useful for the prevention of flood as, during the measurement of unfavourable forecasting, the coastal defensive processes are becoming strong under the surveillance of government.
2nd meteorologist	The advanced technology is appropriate for the detection of different hydrologic cycles at various temperatures. In case of uncertainty, the parameter within this technique denotes improper meteorological performance related to the sea level.
3rd meteorologist	The hydrological resemblances related to the abnormal precipitation can be measured. Besides this, the streamline flows can also be calculated through this technique that not only helps in developing defensive practice with respect to flood management.

7. What is the role of river basin management planning in the context of preventing Norway flood?	
1st meteorologist	. Due to the improper knowledge, the country has failed in detecting the cause of flood at the initial stage. If the pre-identification process would be adopted by the countrymen, the threat of flood at the eventual stage can be mitigated.
2nd meteorologist	Norway has proceeded to implement the HYDRA project in the basin areas of the rivers and at 145 basins, this program has been conducted by the government of the respective country.
3rd meteorologist	The water condition of each basin of Norway has been measured by the deployment of Hydra program and thus the government of the country's maintained synergic attitude for developing the capabilities of the river defence or coastal defence for the flood management activities.
8. What is the effect of riverine flood in the outcome of Norway flood?	
1st meteorologist	This flood has been caused for many reasons such as excessive rainfall in cyclones, seasonal change, ineffective river defence and ice melting.
2nd meteorologist	All these mediums for earning get diminished due to the outcome of the riverine flood. The

	excessive force of riverine flood not only destroys the houses of the coastal areas but also it demolishes the large buildings in the countryside.
3rd meteorologist	The larger industries get affected by this and as a result, the prevalent industrialism of the country becomes standstill
9. How river defences can be helpful in the process of flood management?	
1st meteorologist	Norway has failed to build a strong infrastructure for preventing a flood. In order to handle the devastating force of flood, Norway has used sandbags. The power or capability of this sandbag in the coastal areas is not enough to extract the excessive forces of water.
2nd meteorologist	The flood defence system has affected the road structure across the coastal areas and has also attenuated the flow of air from the riverside into the country.
3rd meteorologist	The overall analysis is centred on the ineffectiveness of the involved infrastructure due to the lack of potentiality of the Norway government regarding suitable flood management practices.
10. Is coastal defences potential in case of flood management?	

1st meteorologist	Coastal defence at the beach area is sufficiently substantial as this elongates the capability of handling the excess force of the sea. Through the help of scientific knowledge, the government of the country has decided to diminish the economical threat related to floods.
2nd meteorologist	The art of the coastal area has reinforced the areas of beach and thus, flood prevention ways can be practised by the government.
3rd meteorologist	Preventing it from the initial stage has minimised the formulation of excessive power under the force of water surge.
11. What are the impactful initiatives the government has taken as effective flood management projects?	
1st meteorologist	Norgenian Water has been used as the main actor for the establishment of the relationship between flood management by focusing on degrading environmental quality.
2nd meteorologist	Through the erection of these facilities, the country would become capable of delivering a suitable environment for its countrymen by preventing the forceful outcome of the flood.
3rd meteorologist	After detection of the damages at the coastal defence or river defence, this project has helped identify the prevalent gaps in the flood management system and take proper steps accordingly.

12. What are the potential techniques and models that are used for hydrograph techniques for early flood detection?	
1st meteorologist	Making this technique as one of the proactive systems for flood management, the country has enabled the establishment of flood-prevention techniques
2nd meteorologist	Following this technique, the government has decided to improve the infrastructure of the coastal areas so that the countrymen would remain secured during the outcome of forceful sea waves.
3rd meteorologist	The forceful flood is considered as the momentum of environmental abnormalities and the outbreak of this momentum can be avoided with the placement of local structure technique.
13. What are the methods adopted by the environment forecasting team to detect the water level in the sea?	
1st meteorologist	Making correlation diagrams with these models, the weather department of Norway would detect the direction of the hydrologic cycle so that the force of water level can be easily measured and calculated with this correlation diagram.
2nd meteorologist	Flood design is conducted by the coxal diagram and it is impactful for the detection of flood flow estimation.

3rd meteorologist	The time of peak flow of the water condition would also be measured by using this diagram and here lies the effectiveness of pursuing this model for the purpose of flood management.
14. What components are involved in the Early Warning procedures adopted by the UN?	
1st meteorologist	With the engagement of effective technologies, the flood forecasting system would become more authentic.
2nd meteorologist	The relevance of manpower in the forecasting system of UN as, without the manpower, the excellence of work cannot be proved by the country in case of flood managing.
3rd meteorologist	The infrastructure usage would be effective without the involvement of proper training to the community about the awareness of flood management.
15. Is it necessary to increase the awareness of the citizens, especially the people of coastal areas during the deployment of early warning procedures?	
1st meteorologist	Non-lining reservoirs the surface level of the catchment areas can be detected and thus, the power and quality of the rain can be detected by gathering the sample of the surface area.

2nd meteorologist	Through the adoption of the mentioned models, the weather department of Norway can take proper steps during the uncertainties of water flow by making a calculated hydrograph under the resolution for flood management.
3rd meteorologist	Quasi model is helpful for the absorption of rainfall by aligning with the sub-basin and thus, the excessive flow of water can be kept under control.
16. What are the different classification of Early warning systems and how they are impactful in flood management?	
1st meteorologist	Technology is one of the major aspects under EWS of UN. The technologies are used for identifying the hazards related to the flood and also help in calculating the depth of water along with streamline flow.
2nd meteorologist	The risk scenarios are also measured with the usage of these technologies and in this way, the UN has presented the active formulation of the warning system for flood management.
3rd meteorologist	Maintaining an institutional framework would help the country to develop the potentiality of EWS as all the flood managing practices have been implemented through the following legal requirements.

17. What gaps have been prevalent in the flood management practices arranged by Norway by contrasting to the flood requisites of international agencies?	
1st meteorologist	Without incurring a suitable infrastructure, the country would not withstand the outcome of a devastating flood. In case of making a strong flood gate, the country has not engaged advanced technologies and due to this reason, the power of the flood gate is considered to be more vulnerable with the comparison of the forceful impact of the flood.
2nd meteorologist	Based on the flood frequency, the country has failed to involve a substantial process for consolidating the flood prevention infrastructure.
3rd meteorologist	Due to the lack of skill, the country has not restrained the emergence of the flood.
18. What is the impact of risk knowledge in diminishing the risk subjected to flood?	
1st meteorologist	Monitoring activities are an integral part of risk knowledge as, through proper monitoring, the uncertain flow of water along with unfavourable weather conditions can be detected.
2nd meteorologist	. Considering the effectiveness of the warning system, the risk assessment practices would assist in identifying the possible risk from the uncertain report of weather forecasting.

3rd meteorologist	The risk can be identified from the data collection process related to the weather. The data transmission would help in detecting the inherited risk and with the emerged result; it facilitates the flood management practices with innovative flood prevention process.
19. What predictive uncertainty has been engaged in the flood management process of Norway?	
1st meteorologist	. Norway keeps using the old technologies for flood forecasting and based on this huge gap, the general people, especially the inhabitants around the coastal areas get no knowledge regarding the necessity of knowledge improvement.
2nd meteorologist	In case of any unfavourable weather forecast, the inhabitants do not take suitable precautions to protect their lives.
3rd meteorologist	Weather cannot be controlled, but with the increase of proper knowledge related to flood management, the country could reduce the life-threatening risk of the riverine flood.

20. Is there any gap in the training process for upcoming meteorologists due to which Norway has failed in making effective flood management practices?

Manager 1	The primary reason that creates hindrances in conducting their job in an effective manner.

Manager 2	meteorologist provides the view that lack of training can be an issue for the meteorologist
Manager 3	The third meteorologist has provided a lack of modern-day tools and techniques is an issue whereas an effective step of providing proper training is another issue

Q21. Do you believe that lack of critical infrastructure plays an important role in the flood?

Manager 1	Due to lack of proper effective management and political crisis affects overall performances of the country	
Manager 2	Proper coordination between Hydra and the Government of Norway can help in developing preventive measures.	
Manager 3	Effective managing this river basin can help the government to reduce the rate of intensity of flood that hits the shore.	