



Reducing risk of beach erosion in Maldives

Comparative case study of authority's adaptive capacity in Laamu atoll

Bodil Englund

2014

Environmental Science

Thesis for master's degree 30 credits

Lund University

Reducing risk of beach erosion in Maldives

Comparative case study of authority's adaptive capacity in Laamu atoll

Bodil Englund

2014

Thesis for master's degree 30 credits, Lund University

Internal supervisor: Jonas Åkerman, Associate prof., Department of Physical Geography and Ecosystem Science, Lund University

External supervisor: Mihad Mohamed, Program Analyst, UNDP Maldives

Abstract

The low-lying island nation Maldives is vulnerable to sea level rise and beach erosion. This study is a comparative case study investigating national, regional and local authorities risk reduction and adaptation work of beach erosion on two local islands and one resort island in Laamu atoll, Maldives. The aim of the study is to investigate if the authorities risk reduction works differ depending on if it is a resort island or a local island, if there are any gaps in the authorities' adaptive work and if they are prioritizing any specific kind of measures. In the study capacity analyses are carried out for each island based on Wamsler's theoretical and operational framework. The authorities' adaptation measures are mapped out and categorized based on the initial risk factors the measures are intended to reduce. Furthermore the interaction between the authorities and the resort operator and local people on the selected islands are also analyzed by comparing the result of a parallel study carried out by Borgudd (2014). The main method used in the study is a qualitative semi structured interview method where officials and councilors were interviewed at the three authority levels. By analyzing the capacity analyses it shows that the authorities' adaptation work for the local islands Maavah and Maamendhoo are similar compared to the resort island Six Senses Laamu. Compared to the investigated local islands authorities have taken fewer adaptation measures on the resort island. This may be because resort islands have to undertake and pay for their own protection measures. The authorities lack economic resources to prevent beach erosion on the two local islands. In general all authority levels need to improve their risk reduction work against beach erosion because they are now mostly focusing on hazard reduction and avoidance measures.

Key words: Maldives, beach erosion, disaster risk reduction, climate change adaptation, capacity analysis, authorities, climate change

Table of contents

| | |
|---|------------|
| Abstract | IV |
| Table of contents | V |
| List of abbreviations | VII |
| 1. Introduction | 1 |
| 1.1 Objectives of the study and research questions | 1 |
| 1.2 Environmental relevance | 2 |
| 1.3 Limitations..... | 2 |
| 1.4 Comparison with the study of Borgudd (2014)..... | 3 |
| 2. Background | 4 |
| 2.1 Republic of Maldives | 4 |
| 2.2 Study area: Laamu atoll..... | 4 |
| 2.2.1 Maavah | 5 |
| 2.2.2 Maamendhoo | 6 |
| 2.2.3 Six Senses Laamu..... | 6 |
| 2.3 Administrative levels..... | 6 |
| 2.3.1 National level | 6 |
| 2.3.2 Regional level..... | 7 |
| 2.3.3 Local level | 7 |
| 3. Theoretical and analytical framework | 8 |
| 3.1 Introduction | 8 |
| 3.2 Background to the theory | 8 |
| 3.2.1 Hazards, disasters and risk | 8 |
| 3.2.2 Disaster Risk Management..... | 9 |
| 3.2.3. Local communities´ and people´s role in risk reduction | 10 |
| 3.3 Operational framework of Wamsler´s theory | 11 |
| 3.3.1 Disaster Risk Reduction measures | 11 |
| 3.3.2. Mainstreaming..... | 12 |
| 3.4 How Wamsler´s framework is used in this study | 13 |
| 3.4.1 Capacity analysis..... | 13 |
| 3.4.2 Mainstreaming..... | 14 |
| 4. Method | 15 |
| 4.1 Comparative case study | 15 |
| 4.1 Pre-study..... | 15 |
| 4.3 Qualitative semi structured interviews | 15 |
| 4.3.1 Selection of interviewed authorities | 16 |
| 4.3.2 Selection of study area..... | 17 |
| 4.3.3 Wamsler´s theoretical and operational framework..... | 17 |
| 5. Analysis | 18 |
| 5.1 How the national authorities´ work to prevent beach erosion | 18 |
| 5.1.1 Ministry of Environment and Energy..... | 18 |
| 5.1.2 Environmental Protection Agency | 18 |
| 5.1.3 Ministry of Housing and Infrastructure | 19 |
| 5.1.4 Ministry of Tourism and the tourist sector | 19 |
| 5.1.5 The central government´s land reclamation project | 20 |
| 5.1.6 In case of a natural hazard | 20 |

| | |
|---|--------------|
| 5.2 Laamu atoll council’s risk reduction work to prevent beach erosion | 20 |
| 5.3 Results of the comparative case study | 21 |
| 5.3.1 Capacity analysis for Maavah | 21 |
| 5.3.2 Capacity analysis for Maamendhoo | 23 |
| 5.3.3 Capacity analysis for Six Senses Laamu | 26 |
| 5.4 Mainstreaming..... | 28 |
| 5.4.1 Mainstreaming strategies - national authorities..... | 28 |
| 5.4.2 Mainstreaming strategies - Laamu atoll council..... | 30 |
| | 30 |
| 5.4.3 Mainstreaming strategies - Maavah and Maamendhoo island councils | 30 |
| 5.4 Interaction between the authorities and local people/resorts | 31 |
| 5.4.1 Responsibility of authorities..... | 31 |
| 5.4.2 Responsibility of local people and resorts | 33 |
| 5.4.3 Hindering or supporting?..... | 34 |
| 5.4.4 Complementing or not complementing each other’s adaptive work? | 35 |
| 5.4.5 Adaptive help from authorities | 36 |
| 5.4.6 How authorities in Maldives inform about their current work | 37 |
| 6. Discussion | 38 |
| 6.1 Capacity analyses for Maavah and Maamendhoo | 38 |
| 6.2 Capacity analysis for Six Senses Laamu | 39 |
| 6.3 Differences and similarities between authorities risk reduction work on Maamendhoo, Maavah and Six Senses Laamu | 39 |
| 6.4 Mainstreaming strategies | 41 |
| 6.5 Interaction between local people/resort islands and authorities adaptive work..... | 41 |
| 6.6 Evaluation of the method..... | 43 |
| 6.7 Environmental relevance | 44 |
| 7. Conclusions | 45 |
| Acknowledgements..... | 46 |
| References | 47 |
| Appendix 1-8..... | 50-62 |

List of abbreviations

DRM - Disaster Risk Management

EIA - Environmental Impact Assessments

EPA - Environmental Protection Agency

LECReD - Low Emission Climate Resilient Development (project by UNDP in Laamu atoll)

MaIC - Maamendhoo Island Council

MEE - Ministry of Environment and Energy

MHI - Ministry of Housing and Infrastructure

MNDF - Maldivian National Defense Force

MT - Ministry of Tourism

MvIC - Maavah Island Council

NDMC - National Disaster Management Center

SSL - Six Senses Laamu

UNDP - United Nations Development Programme

UNISDR - United Nation Office for Disaster Risk Reduction

1. Introduction

The number of disasters and other climate related impacts has increased the last decades and has caused a rise in hazard events and accelerating human and economic losses around the world (UNISDR, 2012a). Disasters only occur when natural hazards are combined with vulnerable conditions. This means that if a community has the capacity or resources to withstand a natural hazard it is less vulnerable and the disaster may not become that severe. Changing climatic conditions has led to an increase in current vulnerable conditions of people and systems (UNISDR, 2012a) and since the climate is estimated to further change in the future the number of disasters is predicted to increase (Blodgett and Keller, 2008).

Therefore it is an increasing necessity for institutions to adapt and reduce risk in order to prevent disasters to occur. Disaster risk management (DRM) is a general term for work related to the reduction of risks for disasters undertaken by individuals and institutions, both before, during and after a disaster (Wamsler, 2014). The impact of hazards is very dependent on urban planning practice and governance processes. Many institutions worldwide are today struggling to find ways to incorporate risk reduction and climate adaptation into their daily work. It is therefore of great importance that institutions find effective and comprehensive working structures in how to reduce risk and adapt to the above describe situation through the whole disaster cycle.

One country that is vulnerable to climate change is the island country Maldives (Karthikheyan, 2010). It is the lowest lying country in the world where over 80 % of the land area is located less than 1 meter above mean high tide level (UNDP, 2013). Due to the country's low elevation it is highly vulnerable to sea level rise and beach erosion. Result of a study shows that around 97 % of all islands are exposed to beach erosion (Shaig, 2006). It is therefore of interest to investigate how authorities in Maldives are reducing risk and adapt to beach erosion and further if this work differ between resort and local islands. This study is a comparative case study in which capacity analyses are carried out for the islands Maamendhoo, Maavah and Six Senses in Laamu atoll, Maldives. Risk reduction measures and mainstreaming strategies are mapped out, analyzed and compared in accordance to the theoretical and operational framework of Wamsler (2014). Further is a joint analysis carried out with the study result of Borgudd (2014) who is investigating the local peoples' adaptive capacities on the same islands as in this study. No similar study has been found about how the authorities work to reduce risk and adapt to beach erosion in the Maldives and what the authorities' capacities are. This study therefore fills an academic gap within the field of DRM.

1.1 Objectives of the study and research questions

The main aim of the study is to analyze how local, regional and national authorities have adapted in the past, currently adapt and plan to adapt in the future to issues regarding beach erosion on three different islands in Laamu atoll (the local islands Maavah and Maamendhoo and the resort island Six Senses) by carrying out capacity analyses. The study investigates if the authorities' measures differ depending on if it is a resort island or a local island, if there are any gaps in the authorities' adaptive work and if they are prioritizing any specific kind of measures. The aim also includes how authorities work to reduce risk of beach erosion in their daily work, so called mainstreaming. Wamsler's theoretical and operational framework is used to analyze the above mentioned aim. National and regional authorities work to reduce risk to beach erosion is also compiled and analyzed.

Further the study aims to investigate the interaction between authorities and one resort's/local people's adaptive work in Maldives. The study is investigating a) how authorities perceive one resort's/local people's adaptation work against erosion, b) if the adaptive measures taken by authorities are hindered or supported by one resort/local people c) if the adaptive measures taken

by authorities are complimenting one resort's/local people's adaptive work and d) if the authorities are assisting with the adaptive help that one resort/local people are requesting. This is done by comparing the result of a parallel study carried out by Borgudd (2014) which is analyzing the adaptive measures of local people and one resort operator in Laamu atoll, Maldives.

Based on these analyzes the study aims to identifies strategies and propose measures how the authorities can improve their current adaptive work.

The main research question is:

- How do local, regional and national authorities work to reduce risk to beach erosion and how does their adaptive work differ between one resort island and two local islands in Laamu atoll?

In support to answer the main research question the following questions will be answered in the study:

- Based on the operational framework of Wamsler, are there any gaps or weaknesses in the authorities' adaptive work regarding beach erosion?
- By comparing the result from Borgudd (2014), how does the authorities' adaptive work interact with local peoples'/resort's adaptive work regarding beach erosion?

1.2 Environmental relevance

The number of disasters and other climate related impacts has increased the last decades and has caused accelerating human and economic losses around the world (UNISDR, 2012a). Since the climate is estimated to further change in the future the number of disasters is predicted to increase (Blodgett and Keller, 2008). It is therefore required that institutions can reduce current and future risk in urban planning and further development in the society in a structured and sustainable way (Wamsler, 2014). The framework of Wamsler, used in this study, offer an effective tool for institutions, so that they in a comprehensive and practical way can work with risk reduction (RR) and climate change adaptation (CCA). To further improve the institutions work, it is essential to take into account local people's adaptive capacities which also are covered in the framework of Wamsler. It makes the framework useful in a very useful tool dealing with an acute and important complex problem.

Maldives is the lowest lying country in the world where over 80 % of the land area is located less than 1 meter above mean high tide level (UNDP, 2013). It makes it vulnerable to sea level rise and beach erosion. Because of the country's exposed situation it is important that institutions analysis their own adaptive capacity regarding erosion issues, identify opportunities for improvements and incorporating risk reduction regarding beach erosion into their daily work.

1.3 Limitations

A basic risk assessment includes a capacity analysis (ISO, 2009) but this has not been done in this study due to budget and time limitations.

In Wamsler's theoretical and analytical framework institutions refers to city authorities and other governmental or non-governmental organizations working in the field of urban planning (Wamsler, 2014). This includes, among others, authorities at national, regional and local level, NGOs and the private sector. However, this study only investigates national, regional and local authorities' risk reduction work against beach erosion. Further this study does not investigate how the cooperation between different authority levels are and no capacity analyses are carried out at national and regional authorities due to time and budget limitations.

1.4 Comparison with the study of Borgudd (2014)

The field study in Maldives was carried out during nine weeks in March and April in 2014 and is a joint study with Julia Borgudd. This means that the interviews with both authorities on different levels (during both the pre-study and the main study), local people on Maamendhoo and Maavah, and the resort Six Senses Laamu, and how they adapt to beach erosion were conducted together. The results from the interviews with the Maldivian authorities on national, regional (Laamu atoll council) and local (Island councils on Maavah and Maamendhoo) level are presented in this study, while the results from the interviews with local people on Maamendhoo and Maavah and the resort Six Senses Laamu are presented in the study of Borgudd (2014). The interview guides were compiled and revised together as more information about the situation was gathered from the interviews.

The operational framework of Wamsler (2014) is being used in both of the studies, see chapter 3, as an analytical tool to carry out capacity analyses of the adaptive capacities of authorities and local people/one resort, and how well their work complement each other regarding problems related to beach erosion. The theoretical chapter is shared in both of the studies, since the same theory of Wamsler is being used.

Both of the studies aim to compare each other's result to investigate and analyze the interaction between local people and authorities in Maldives, see section *1.1 Objectives of the study and research questions*. Information from interviews in this study is compiled and compared with information from interviews from Borgudd's study (2014). The comparative result and a following discussion are therefore shared in both studies. In this study the interaction between local people and authorities is presented in section *5.4 Interaction between the authorities and local people/resorts* and the following discussion is presented in section *6.5 Interaction between local people/resort islands and authorities adaptive work*.

The reports of both of the studies stand alone. The results from the capacity analyses in the study of Borgudd (2014) are attached to appendix 8 in order to assist the reader.

2. Background

2.1 Republic of Maldives

Maldives is an island nation located in the Indian Ocean consisting of 26 atolls and around 1190 small islands, see figure 1. An atoll is a group of islands and sand banks formed on coral reefs situated upon peaks of a submarine volcano ridge (Abdulla, et al, 2007). An atoll is often ring shaped. The climate in Maldives is tropical dominated by two monsoon seasons, the dry northeast monsoon runs from approximately December to the beginning of May and the wet southwest monsoon with strong winds and storms runs from mid-May to November (MMS, 2014a). The ocean currents change direction when the monsoons shift because of change in wind direction. This causes natural movement of soil and sand material around islands in Maldives.

Maldives is the lowest lying country in the world where over 80 % of the land area is located less than 1 meter above mean high tide level (UNDP, 2013). Because the country's low elevation it is highly vulnerable to beach erosion and sea level rise. More than 70 % of all important infrastructures, and 42 % of the population is settled within 100 m of the coastline (UNDP, 2008). Result of a study shows that around 97 % of all islands are exposed to beach erosion (Shaig, 2006).

Maldives has around 320 000 inhabitants (2010) and its capital is Malé (UNdata, 2014).

The country has a well-developed tourist industry since the climate and the white sandy beaches attract many international visitors. There are mainly three different types of islands in the country: local islands, resort islands and uninhabited islands (UNDP, 2013). The number of local islands is around 200 and that is where local people mostly live. An average local island has a population of 900 people. Resort islands are self-contained and only intended for the tourist industry, and are around 105 in number. One resort is allowed on one resort island. The rest of the islands are generally uninhabited. Even though inhabitants are allowed to run tourist facilities on local islands since 2009 resort islands and local islands are much separated.

2.2 Study area: Laamu atoll

The field study of this comparative investigation is carried out in the Laamu atoll. The three islands being compared are Maamendhoo, Maavah and Six Senses, see location in figure 2. The atoll comprises of a ring of coral islands and is the second largest atoll in the country in terms of



Figure 1. Map of Maldives' location in the Indian Ocean and how the atolls are spread from north to south. Laamu atoll is here called Hadhdhunmathee atoll (Biosphere exhibition, 2014).

land area (UNDP, 2013). The largest island in Maldives, Gan, is located here and the atoll capital is the island Fonadhoo. In total Laamu atoll consists of 73 islands where 12 are inhabited, one resort island is privately leased to operate the tourist resort Six Senses Laamu and the rest are uninhabited. Maavah and Maamendhoo are two islands of the 12 inhabited islands. Totally approximately 12 000 people live in the atoll. A survey indicates that the Laamu atoll is one of the poorest atolls in Maldives. Fishery and agriculture are the two main industries that employ most people in the atoll. All the islands in the atoll are exposed to beach erosion and experience regular flooding. Lately islands and communities report an increase in the rate of erosion.

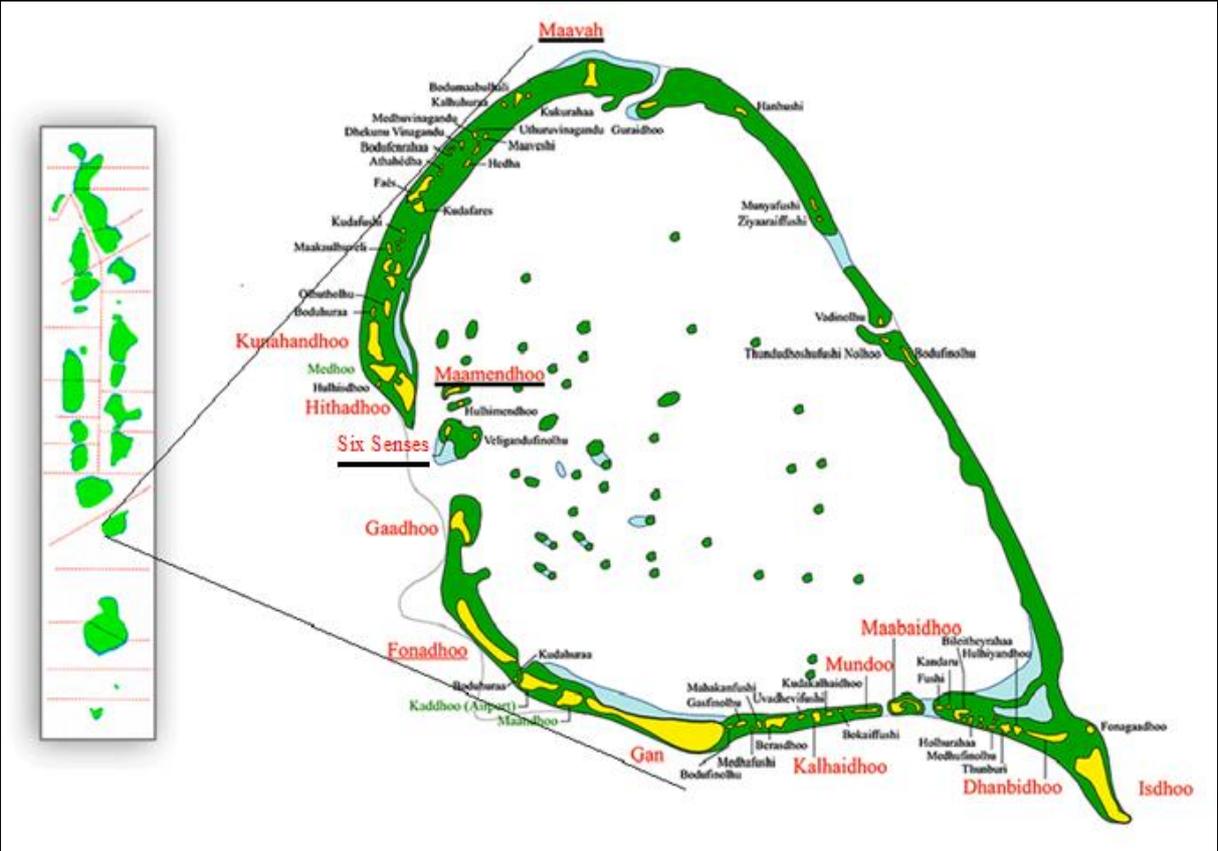


Figure 2. Map of Laamu atoll. Maamendhoo, Maavah and Six Senses are underlined with black lines. Green fields are coral reefs and yellow fields are islands. The map is turned and does not display correct northerly direction (LGA, 2014).

2.2.1 Maavah

The island of Maavah is overpopulated with a population of around 1900 people (LAC, 2014a). Almost the whole island is exploited with houses except the palm forest in the western part of the island, see appendix 2. Maavah is exposed to erosion on the island’s northwestern and southwestern parts (MvIC, 2014; own observation). The island councilors state that the erosion occurs when the monsoons shift. A big area of sand and soil has moved to the northern part of the island but is not moving back again when the monsoon change. So far no residential houses, infrastructure or public buildings and services are affected by beach erosion (MvIC, 2014). The island councilors say that it might happen in the future. At some places houses are only 5 meters from the shoreline. One house is even closer. On the island the locals take washing water from wells and collect rain water for drinking water. Because of salt intrusion quality of the washing water has got degraded.

The previous island chief gave away land close to the beach against the regulation to build houses and boats in 2007 (MvIC, 2014). This is why, according to the island councilors, many

trees close to the beach side are cut down and some houses are located close to the shoreline. The councilors say the island chief gave away the land to attract people's votes.

2.2.2 Maamendhoo

The population of Maamendhoo is officially around 1300 people but only around 900 people lives there permanently (MaIC, 2014). The island is exposed to erosion and the most affected areas are the southwestern and northern parts of the island (MaIC, 2014, own observation). For example houses close to the police station are situated around 5 meters from the coastline, see appendix 4. According to a calculation by the island council that area has eroded around 60 centimeters per year since 1999 (MaIC, 2014). So far no residential houses, electricity cables or public buildings and services are affected by beach erosion. When it is high tide in August and September the sea level reach house walls and roads. The councilors say that beach erosion has been noticed for at least 30 years and has increased since the harbor was built on the island in 2009. The local people on Maamendhoo use ground water for washing and showering. According to the councilors some wells located close to the sea taste salty because of salt intrusion into the ground water. The councilors experience that the salt intrusion has increased in pace with increased erosion.

2.2.3 Six Senses Laamu

The resort Six Senses Laamu is the only resort island in Laamu atoll and was opened in 2010 (SSL, 2014). The resort has three jetties with overwater villas and a restaurant on poles standing on the reef in the water, see appendix 6. On the island there are villas for the tourists and other resort and staff buildings.

The island is experiencing severe erosion on the north western and north eastern parts (SSL, 2014). One of the staff states that the erosion started when the resort was built. The beach on the affected sides started to disappear continuously and the natural sand movement around the island stopped. In a report from 2011, Beach management plan 2011, it is concluded that the shape of the island has changed at least since the 70s (CDE Consulting, 2011). At some places as much as 70 meters. Since the resort opened they have closed down seven villas because the water has come too close or has demolished them (SSL, 2014). The beach close to the resort kitchen has also been affected were the water was right up to the house wall before measures were taken.

2.3 Administrative levels

The Maldivians voted for the first time in a democratic election in 2008 and Mohammed Nasheed became president (BBC, 2013). Before this election the country was ruled by a dictator for thirty years. During Nasheed's presidency a Decentralization Act was adopted in 2011 in order to strengthen citizen's influence in governmental processes and promote democracy at local level (The Government of Maldives, 2009). In the Act more authorial responsibility is allocated to atolls and islands, and the objective is that each level shall bear its own costs (Decentralization Act, 2010). Current government system is divided into three authority levels: national ministries and agencies, atoll councils (regional) and island/city councils (local). All island and city councils are accountable to an atoll council (CLGF, 2012). There are two city councils, 66 island councils and 20 atoll councils in Maldives.

2.3.1 National level

The majority of all ministries and the other governmental agencies are sited in Malé (UNDP, 2014). Each ministry is responsible to coordinate, plan and develop laws and regulations within the ministry's respective sector work. A ministry may have underlying agencies responsible to handle more specific assignment. Maldives has an independent body called LGA (Local Government Authority) looking after the whole government process from local level up to national level.

2.3.2 Regional level

Atoll councils are elected by people living in the atoll every third year (Decentralization Act, 2010). The number of members in the council depends on the size of the atoll population. The councils' main task is to continuously develop the atolls' fields of responsibilities, implement national laws and regulations and do this within the atoll budget. The councils' coordinate the island councils within the atoll and follow up and monitor the function of their work. Atoll councils are responsible for the development of development plans for respective atoll. The atoll office is situated in the atoll capital.

2.3.3 Local level

Every inhabited island has its own island council elected every third year (Decentralization Act, 2010). Islands with more than 25 000 citizens have so called city councils. The councils comprise of five, seven or nine councilors elected by the local people on that particular island depending on the island's population. The island council is responsible for the administration and development of the island community, and make decisions in order to favor this. Some examples of facilities the island council is legally forced to provide to the inhabitants are water, electricity, sewage system, roads, primary health care and schools. When it comes to erosion the council shall:

Take necessary measures to alleviate the land erosion problem and maintain the jetty and the breakwater of the island (Decentralization Act, 2010, paragraph 24d).

They are also responsible for development of land use and development plans in consultation with the public and the implementation of national and regional laws, policies and guidelines.

3. Theoretical and analytical framework

3.1 Introduction

This theoretical chapter provides the reader with an overview and understanding of Wamsler's theory (Wamsler, 2014) which is the framework used to analyse the result in this study and the study of Borgudd (2014). Both of these studies are based on this theory developed by Wamsler (2014), and is used as a theoretical and operational framework to make capacity analyses on *how local people and one resort operator* (Borgudd, 2014) and *authorities* (this study) reduce risk to the natural hazard beach erosion in Maldives. The theory of Wamsler offer an effective tool for institutions, so that they in a comprehensive and practical way can work with risk reduction (RR) and climate change adaptation (CCA) (Wamsler, 2014). Wamsler has developed four different risk reduction and adaptation measures, see part 3.3.1, so that institutions can develop a more proactive approach in their preparations before, during and after natural hazards occurs. The adaptation measures refer to the adaptive capacity that people and institutions have and the adaptive capacity therefore becomes obvious in the measures that are taken. According to Wamsler institutions cannot reduce the potential impact of natural hazards in a comprehensive way without knowledge of the institutions' adaptive capacities. In order to improve the institutions work Wamsler also highlights that these need to get a better understanding of peoples adaptive capacities and how people themselves may reduce the effects of natural hazards. In this way institutions may improve their knowledge about what local people are requesting from the institutions and in turn what their needs are. With this knowledge institutions may therefore develop their risk reduction work so that it complement and support the adaptive capacity of local people.

Wamsler also highlights the need for institutions to institutionalize (mainstream) risk reduction and adaptation in a systematic way into urban planning in order to achieve a sustainable change, see part 3.3.2 (Wamsler, 2014). The investigated Maldivian authorities' mainstreaming strategies are also compiled and analyzed in this study.

3.2 Background to the theory

This section provides a background description of the theory and gives the reader an understanding of the following section 3.3 *Operational framework of Wamsler's theory*.

3.2.1 Hazards, disasters and risk

Around the world natural hazards are a common phenomenon in people's daily life (Wamsler, 2014). Natural hazards can be divided into two different types: climatic hazards and non-climatic hazards. Some examples of climatic hazards are storms, floods, sea level rise and droughts. Volcanic eruption and earthquakes are examples of non-climatic hazards. A natural hazard can also trigger a so-called secondary hazard, which is a hazard that has been caused by a preceding natural event/hazard. Examples of secondary hazards are landslides caused by rain and beach erosion enhanced by sea level rise and more frequent storm surge and wave action.

Disasters only occur when natural hazards are combined with vulnerable conditions; that is when people or a system is affected by a disruption and in turn do not have the ability to cope with the human, material, environmental or economic losses and impacts, by using its own resources (UNISDR, 2009). *Disaster risk (R)* is the probability that this disruption may occur, and is based on the interaction between *natural hazards (H)* and *vulnerable conditions (V)* (Wamsler, 2014). This relationship can be explained by the equation: $R = H \times V$. This means that if a

community has the capacity or resources to withstand the hazard, and therefore is less vulnerable, the disaster may not be that severe.

Changing climatic conditions have been observed the last decades and have caused a rise in hazard events (UNISDR, 2012b). This has caused an increase in current vulnerable conditions of people and systems (V) since changes in climate are something that people are not used to handle. The increase in hazard events and vulnerable conditions has in turn increased the number of disasters. This has also been the case with Maldives, which has observed increased precipitation intensity and higher temperatures (MMS, 2014b).

When a disaster occurs it is a product of previous developments in an area, and can be the root cause that increases the level of risk (Wamsler, 2014). An example is if a country or a region has lacking democratic processes and this can lead to social, economic and political marginalization. As a consequence, it can be difficult for local people and institutions to use efficient responding and adaptive measures when a hazard occurs, and in turn create a disaster.

Whether a hazard will result in a disaster is determined by four risk factors according to Wamsler (2014). These are:

1. The type, magnitude, time span and intensity of current hazards and potential hazards in the future.
2. Conditions of the location. In other words how sensitive the location is to withstand current hazards and potential hazards in the future.
3. The existence of usable structures and mechanisms that can *respond* to current hazards and potential hazards in the future; and
4. The existence of usable structures and mechanisms that can *recover* from current hazards and potential hazards in the future.

3.2.2 Disaster Risk Management

Disaster risk management (DRM) is a general term for work related to the reduction of risks for disasters undertaken by individuals and institutions, both before, during and after a disaster. (Wamsler, 2014). DRM can be illustrated in a so called disaster cycle (University of Copenhagen, 2014) which describes its three phases and how the phases interlink with DRM, see figure 3. The first phase in the disaster cycle is the *response phase* during and directly after a disaster (Wamsler, 2014). The second phase is the *recovery phase*, where work is implemented to restore peoples' former living conditions. The third phase is called *development work-phase*. This phase aims to improve living conditions for people in the long-term, and do include more aspects than reducing risk from disasters, for example reducing poverty, unemployment, and improve governance structures. This phase continues until a new disaster happens (if a disaster happens). DRM intend to reduce risk in all these three phases and rebuild and develop a society after a disaster. DRM consists of the three different processes; 1) disaster response, 2) disaster recovery and 3) disaster risk reduction (DRR). Disaster response is measures taken to reduce risk during the response phase like saving lives and providing temporary living (UNIDSR, 2009). Disaster recovery are measures taken to reduce risk during the recovery phase for instance reconstruct former buildings and restore civic functions like roads, hospitals and schools. Disaster risk reduction are measures taken during all the three phases, see figure 3 (Wamsler, 2014). This means that DRR needs to be integrated into the processes of response, recovery, and also development work.

Disaster risk reduction (DRR) and climate change adaptation (CCA) are two areas of knowledge which both aim to reduce the number of incidences and the intensity of disasters (Wamsler, 2014). The differences between the two fields are that climate change adaptation only involves risk reduction to climatic disasters while disaster risk reduction both involves climatic and non-climatic disasters. The access to adequate knowledge and tools regarding DRR and CCA are often lacking amongst authorities, aid organisations and planners (Carmin *et al.*, 2012; UNISDR, 2012a; Wamsler, 2009). According to Wamsler it is crucial that both DRR and CCA

are essential parts of urban planning and other related government processes, not only after a disaster (disaster recovery) but also before (development work) and during a disaster (disaster response) (Wamsler, 2014). This is one of the reasons why Wamsler developed this theory. With a successful adaptive work to reduce risk and vulnerability, disasters would not be that severe and reduce the importance of disaster response and disaster recovery.

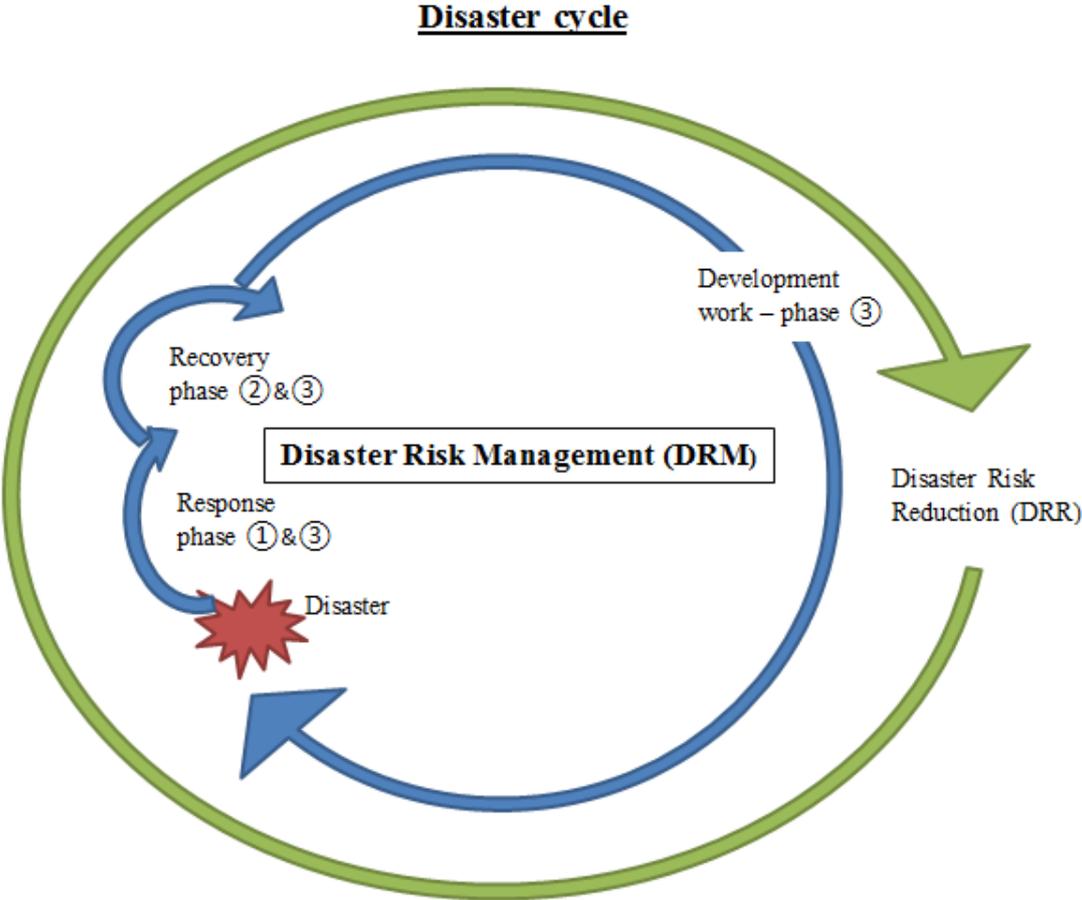


Figure 3. The figure shows how DRM is related to the disaster cycle. The disaster cycle has three phases after a disaster has occurred and to achieve sustainable risk reduction DRR need to be implemented into all phases (University of Copenhagen, 2014).

3.2.3. Local communities’ and people’s role in risk reduction

Local people have a big role in reducing risk from hazards since their adaptation work and performance have a great effect when it comes to minimizing the damages when a natural hazard occurs (Wamsler, 2013). In many poor countries there is a need to compensate for lacking governmental risk reduction work. It leaves individuals to take their own initiatives in order to reduce and adapt to disaster risk (Wamsler, 2014).

When institutions are planning for risk reduction the focus is often on physical “hard” measures like a sea wall to protect from sea swells (Wamsler, 2014). These measures are often based on directives that have a top-down approach that does not take into consideration local people’s adaptive capacity. Top-down measures can create a false sense of security among locals. It can result in a situation where local people do not become involved, since they believe institutions are responsible for risk reduction.

There are rarely any documentation about what people themselves are doing to reduce and adapt their own risk to hazards (used capacities, see part 3.3.1) and what they can do but do not currently do (unused capacities, see part 3.3.1) (Carmin *et al.*, 2012; Satterthwaite *et al.*, 2007; UNISDR, 2012c; Wamsler, 2014). There are hardly any methods or tools to involve local people directly. People's exposure and vulnerability to natural hazards are mostly not considered in authorities work (Wamsler, 2014). Local people may not have the impression that they are supported in their work with risk reduction and they may lack information about what they can do to protect themselves and what their responsibilities are.

3.3 Operational framework of Wamsler's theory

In this section the operational framework of Wamsler is explained and how the framework is used in this study and in the study of Borgudd (2014) to analyze the risk reduction and adaptation measures local people, one resort and authorities in Maldives use and plan to use.

3.3.1 Disaster Risk Reduction measures

Disaster risk reduction and climate change adaptation include four different kinds of measures that have been developed by Wamsler (2014). They can be planned and undertaken by institutions and/or local people and/or communities before a hazard strikes. This may make people and/or the society less vulnerable and more resilient to withstand a hazard. The four measures are built upon the risk factors mentioned earlier, see part 3.2.1, which needs to address current and future hazards, and also current vulnerabilities that makes it hard for a location to withstand, respond and recover from hazard impacts. Knowledge about all four risk factors is crucial for institutions to know when analysing risk and to come up with good and comprehensive measures to reduce the identified risk in an efficient and extensive way. When institutions want to start the work with reducing risk and adapt to a changing climate the first step is to do a risk assessment (Wamsler, 2014). A capacity analysis is a part of every elementary risk assessment (UNISDR, 2012b). Wamsler's four risk reduction and adaptation measures are:

1) Hazard reduction and avoidance - intend to increase the capacity to reduce or avoid the level of and/or frequency of current and future hazards that can affect institutions, local people and/or communities (Wamsler, 2014). Local people can for example move from a threatened area to avoid the hazard and institutions can build physical measures, for example a sea wall, to reduce the impact from hazards.

2) Vulnerability reduction - intend to increase the capacity to reduce the current and/or future vulnerabilities of institutions, local people and communities with the intention to better resist potential future disasters (Wamsler, 2014). For example that individuals stay in the exposed area and try to take measures to improve the situation, for example through building houses at higher elevation or increase the drainage of rainwater in a flood prone area.

3) Preparedness for response - intend to increase the capacity to set up good and well organized response mechanisms and structures in a society so that institutions, local people and communities may handle a future disaster in an effective way during and directly after it has occurred (Wamsler, 2014). Preparedness for response measures may for instance be that a country or area have an early warning system if a storm is approaching or that local authorities have standard routines how to act during a disaster occurs.

4) Preparedness for recovery - intend to increase the capacity to make sure that recovery mechanisms and structures in a society are easily available so that institutions, local people and communities rapidly can recover after a future disaster event (Wamsler, 2014). Examples of preparedness for recovery measures may be that households have insured their property and authorities give advisory service for reconstruction.

The risk reduction and adaptation measures can be divided into two different contexts: used and unused capacities (Wamsler, 2014). *Used capacity* refers to the adaptive measures that local people, communities and institutions currently take to reduce their risk. The capacity becomes obvious in the risk reduction and adaptation measures that are taken, for example the existence of a sea wall to protect from sea level rise. *Unused capacity*, on the other hand, refers to adaptive measures that local people, communities and institutions *may* take to reduce their risk, but that they currently are not doing. In other words, the capacity to do something to reduce the risk is there, but is not (yet) used. An example may be the existence of a community centre which could be used as an emergency shelter. Together *used* and *unused capacity* are called *adaptive capacity*.

In this study and in the study of Borguud (2104) the operational framework of Wamsler is further developed by adding the context of *lacking capacity* and *planned measures*. Lacking capacity refers to measures and capacities local people and institutions do not have. The value of including this context is because it becomes more obvious what local people and institutions can improve and/or what is a limitation in their work. Planned measures are added to differentiate between measures that have been done and the measures that are planned to be undertaken. This gives a wider picture on how the situation looks like and how institutions and local people plan to adapt in the future. By adding, *lacking capacity* and *planned measures*, the analyze becomes more comprehensive.

3.3.2. Mainstreaming

It is of great importance for institutions to actively reduce risk in their work in order to minimize disaster occurrence and to build resilient communities (Wamsler, 2014). To be able to achieve this, Wamsler consider risk reduction and adaptation to be mainstreamed into all kinds of institutional sector work in all three phases of the disaster cycle, see figure 3. Wamsler means that it should be a requirement for relevant institutions to make risk reduction as an integral part of their routine work and in for example urban planning. Mainstreaming is to look at structures and working methods that already exist and try to modify and build on these existing structures. It does not mean a complete change of the core work and responsibilities of an institution, but viewing them from a different perspective and to do relevant changes in the daily work. It is not only institutions that need to mainstream risk reduction. There is also a need for the mainstreaming of risk reduction in all types of sector work such as, donors, community associations, educational system and academia, private companies, as well as authorities at all levels, in order to achieve a disaster-resilient society. According to Wamsler institutions mainstreaming approaches can be divided into five mainstreaming strategies and one integration strategy.

Mainstreaming strategies and their purpose:

- *Integration strategy (add-on risk reduction or adaptation)* - integration of a specific activity or programme that clearly intend to reduce risk, but do not change the implementing institution's core work.
- *Programmatic mainstreaming* – modification of an institution's programme and/or project work to increase the programmes ability to reduce risk and reduce the possibility of the programmes activities to increase risk.
- *Organizational mainstreaming* – take risk reduction and adaptation into consideration at institutional level by integrating it into routines, organizational management, processes, laws and rules.
- *Internal mainstreaming* – changes in an organization's work to reduce its own risk from impacts related to disasters and climate change so that no buildings, staff or important documents get affected.

- *Inter-organizational mainstreaming* – increased cooperation regarding risk reduction and climate adaptation between all kinds of implementing sectors like authorities, businesses, NGOs and communities to improve and harmonize their work.
- *Educational mainstreaming* – increased cooperation between research/educational bodies and implementing risk reduction sectors to reduce the distance between science/education and practice.

The strategies are strengthening and complementing each other (Wamsler, 2014). If the six strategies are combined into an institutions work it leads to a sustainable change in their work for risk reduction.

3.4 How Wamsler´s framework is used in this study

In this section it is explained how this study and the study of Borgudd (2014) use the theory of Wamsler.

3.4.1 Capacity analysis

In both studies capacity analyses are performed, this study is compiling the four risk reduction measures of authorities and Borgudd (2014) for local people and one resort. The measures are divided and analysed into past and existing measures (used capacities), planned measures, measures that can be used (unused capacities) and absent measures (lacking capacities). The knowledge from the capacity analysis is used to come up with new potential risk reduction measures or to build upon existing ones to reduce risk in an efficient and comprehensive way.

Wamsler means that an effective risk reduction work by institutions, communities and inhabitants needs to be both flexible and inclusive:

- 1) *Flexibility* means that there is more than one measure that can address each risk factor (Wamsler, 2014). If one measure is not functioning it is good if other measures exist that can be used instead.
- 2) *Inclusiveness* means that all the four potential risk reduction and adaptation measures are used to guarantee that every risk factor is taken into consideration.

To widen the analysis both studies further categorize each of the four adaptation measures according to their thematic focus; physical, environmental, social/cultural, economic, or political/institutional (Wamsler, 2014). This is part of Wamsler´s theory, since flexibility also means that there are different types of measures with different thematic focus that address each risk factor. A social measure may for example be how people in a community warn each other before a storm or help each other after the storm. An example of an economic measure may be that households have an insurance that cover the cost of property damage. Categorizing the measures according to their thematic focus makes it easier to make a distinction whether the measures only are focused on specific categories. For example if individuals or institutions only use physical and social measures, and disregard environmental or economic measures. Each measure is colour coded in the analysis, see section 5, depending on its thematic focus. Physical measures are dark grey, environmental measures are green, social/cultural measures are red, economic measures are blue and political/institutional measures are orange.

Analysing the results according to this approach make it possible to find out if any measures are lacking and accordingly determine if the adaptation work among institutions and individuals are adequate or not (Wamsler, 2014).

To get a better understanding of peoples used and unused capacities an in-depth analysis of these risk reduction and adaptation measures are crucial (Wamsler 2014). In this way institutions will improve their knowledge about what local people are requesting from the institutions and in

turn what their needs may be. In this way the institutions may improve their relations with the civil society. This analysis may make institutions scaling up, encouraging current coping strategies, and/or proposing new or improved strategies for individuals and communities, where they are required. There is no “one solution fits all”, because different factors that contribute to risk may vary within or between cities, settlements and households.

The mapping of the four risk reduction measures and their categorization in this study and in the study of Borgudd (2014) are gathered in matrices to make the capacity analyses more comprehensible. The matrices for this study are presented in section 5.3 and the matrices for the study of Borgudd (2014) are presented in appendix 8.

3.4.2 Mainstreaming

The mainstreaming strategies of the authorities work with risk reduction in Maldives, as described in section 5.4, are compiled in this study and are divided into local, regional and national authority levels. The strategies are presented in tables in order to illustrate if there is any differences between the different authority levels in their mainstreaming of risk reduction.

4. Method

4.1 Comparative case study

This study is carried out as a field study in the Maldives during nine weeks, in March and April in 2014. In the study a comparative case study has been performed to investigate how local, regional and national authorities adapt to problems related to beach erosion on the three islands Maamendhoo, Maavah and Six Senses Laamu in Laamu atoll. In order to simplify the result capacity analyses have been compiled in matrices for each island and it has been investigated if there are any gaps in the authorities' adaptive work. Further the authorities' work to reduce risk of beach erosion in their daily work, so called mainstreaming, are compiled and analyzed. The operational and theoretical framework used to analyze the results is developed by Wamsler (2014), see chapter 3. An overview of the adaptive work done by national and regional authorities is compiled and presented in the study, but no capacity analysis has been done regarding these two authority levels.

Further a comparison is made with the result from Borgudd (2014), who has done comparative analyses regarding local people and one resort operator in Laamu atoll. The purpose of comparing the result is to illustrate the interaction between the authorities and local people/resort.

The study consists of two parts, one part where general information was gathered, here called pre-study, and a second part where the main investigation was carried through, here called main study.

4.1 Pre-study

The pre-study was carried out in Malé where officials at ministries, agencies and NGOs were interviewed. The main objective of the pre-study was to gather background information for the main study. Requested information was to get an overview of how the administrative levels are organized and which mandate/responsibility they have to manage beach erosion issues. The pre-study was also the background to the selection of islands to investigate in the main study. Totally 13 officials were interviewed during nine interviews at ministries and agencies in the pre-study; Ministry of Environment and Energy; National Disaster Management Centre (NDMC); Maldivian Meteorological Service (MMS); UNDP (United Nations Development Programme) Maldives; Local Governance Agency (LGA) and Maldivian Red Crescent. During the pre-study the external supervisor Mihad Mohamed at UNDP helped with contact details to relevant officials at ministries and agencies.

4.3 Qualitative semi structured interviews

A qualitative semi structured interview method was used to collect empirical data as the source to all research questions in this study. It was used in both the pre-study and in the main study. In a semi structure interview questions are asked using a predetermined interview guide (Esaiasson, *et al.*, 2007). The method was chosen because it aims to represent the respondent's own knowledge, experiences and thoughts in a specific topic (Dalen, 2007). In the interviews opened and semi structured questions were asked. In open questions the respondent was freely answering with its own words. On the semi structured questions the respondent got two or more answering alternatives to choose from and after this selection the respondent added with its own words, see appendix 7.

In the main study officials and councilors at national, regional and local authorities has been interviewed. The interview guide used in the main study was developed with help from information gathered in the pre-study. The questions are mainly examples of risk reduction and

adaptation measures, interaction between local people/authorities and mainstreaming strategies according to the theory of Wamlser (2014) adapted to Maldivian conditions, see appendix 7. Some questions were also asked to obtain a deeper understanding of each authority's role in their erosion prevention work. Before the interview guide was used the external supervisor examined the questions and gave comments for further development. The interview guide was updated and modified during the whole main study depending on which authority was interviewed. Based on experiences from the interviews one larger revision of the interview guide was done after interviewing the two atoll councilors to improve it further. All questions regarding interaction between local people and authorities have not been asked to all interviewed authorities. This means that some information is lacking within this part. The individual interviews took around one to three hours. The respondents' knowledge in English varied a lot among the authority levels which has led to difficulties in interpretation of some answers. All interviews were recorded and transcribed before the compiling of the result started.

The information gathered through the interviews is the main contribution to the result this study is based on. The result is also complemented with information from the interviews in the pre-study, provided documents by interviewed persons, websites and through own observations. Field observations were made on Maamendhoo and Maavah by tours on the islands to get an own perception of the erosion situation and the visible protection measures. An email was sent to EPA after leaving Maldives to complement the information of what national authorities have done on the selected islands. The information is added to the interview answers.

4.3.1 Selection of interviewed authorities

In the main study nine interviews were carried out involving fifteen persons. The following authorities were interviewed at respective authority level:

National level

- One interview with one official at the Environmental Protection Agency.
- One interview with one official at the Ministry of Tourism.
- One interview with two officials at the planning section at Ministry of Housing and Infrastructure.
- One interview with one official at the Ministry of Environmental and Energy.
- One interview with one official at the engineering section at Ministry of Housing and Infrastructure.

Regional level

- One interview with one present councilor of the Laamu atoll council.
- One interview with one previous councilor of the Laamu atoll council.

Local level

- One interview with five councilors of the Maamendhoo island council.
- One interview with two councilors of the Maavah island council.

Firstly the atoll councilors in Laamu atoll were interviewed on Fonadhoo, followed by the two island councils on Maamendhoo and Maavah. The five interviews at national level were conducted at the end of the study in Malé. The interviews were completed in this order because the atoll councilors provided information as a background to the selection of which islands to choose for the comparative analyses. The national authorities were interviewed at the end of the main study in order to use the regional and local data to develop the interview guides for the national authorities.

When the decision was made to investigate Laamu atoll and the three islands it was natural to select and interview councilors of each council. Resort islands do not have any local council and is under the responsibility of Ministry of Tourism. Therefore Ministry of Tourism is one of the

interviewed national authorities. The three national authorities Environmental Protection Agency, Ministry of Housing and Infrastructure and Ministry of Environment and Energy were selected because these authorities' are main actors' handling erosion issues in Maldives.

4.3.2 Selection of study area

In total there are around 200 local islands and 105 resort islands in Maldives (UNDP, 2013). In this study one resort island and two local islands were selected in order to get a proportional number of islands representing the island composition of the country.

The selection of islands in the Laamu atoll was based on information gathered in the pre-study. It was chosen because all islands in the atoll are exposed to beach erosion and local communities report a rapid increase in the rate of erosion (UNDP, 2013). Other factors considered are that UNDP recently has started a project called LECReD (Low Emission Climate Resilient Development) there and could help with information about the atoll. Interviewed official at LGA could also provide a contact person, the civil servant at Laamu atoll council, who assisted with accommodation and contact details. Access to daily public ferry was also important to enable us independent transportation within the atoll.

When arriving to Laamu atoll only one out of three islands was selected beforehand. The selected island was Six Senses Laamu because there is only one resort island in Laamu atoll and it is affected by erosion. Maavah and Maamendhoo were selected after consultation with one atoll councilor. The decision is based on factors like population, size and erosion situation. Both islands are of small size which is characteristic to the Maldivian islands. An average local island in Maldives has a population of 900 people (UNDP, 2013) and the islands were selected trying to reflect this. The population of Maavah is around 1900 people and around 900 people live on Maamendhoo (LAC, 2014a). Both islands are also exposed to erosion.

4.3.3 Wamsler's theoretical and operational framework

In this study Wamsler's theoretical and operational framework is used to analyze the empirical material coming out of the performed interviews. The theory of Wamsler is used in this study because it is the result of more than ten years of research in different countries and organizations within the field. The main part of her research is available in the newly published book, *Cities, Disaster Risk and Adaptation*. The analytical framework is meant to provide an effective tool for institutions, so that they in a comprehensive and structural way can work with risk reduction (RR) and climate change adaptation (CCA), see chapter 3 (Wamsler, 2014). It is therefore interesting to apply this analysis tool in the context of Maldives.

5. Analysis

This section presents the results regarding what the authorities do to prevent beach erosion at national, regional and local level. Firstly the actions by national authorities are described in section 5.1. Thereafter actions taken by the Laamu atoll council is described in section 5.2. Finally the results from the three different islands are compiled and described in section 5.3. The comparative study is visualized in three matrices. The national, regional and local authority's mainstreaming strategies are presented in tables in section 5.4. In the last section 5.6 it is compared how the authorities and local people on Maavah and Maamendhoo and the resort Six Senses Laamu perceive each other's adaptive work.

5.1 How the national authorities' work to prevent beach erosion

5.1.1 Ministry of Environment and Energy

Ministry of Environmental and Energy (MEE) is the leading ministry dealing with beach erosion issues and have the main responsibility to coordinate the adaptive work among Maldivian authorities (MEE, 2014). The main authorities they are in cooperation with are the Environmental Protection Agency (EPA), Ministry of Housing and Infrastructure (MHI) and Ministry of Tourism (MT) (MHI, 2014b). MEE is responsible for the national planning, develop policies regarding erosion and implement erosion projects (EPA, 2014; MEE, 2014). To accomplish this MEE is seeking funding from the government and from international funds (MEE, 2014). In MEE there is one climate change department and one environmental department. The environmental department has a separate coastal zone unit doing the implementation of projects.

The environmental ministry, together with Environmental Protection Agency (EPA), Ministry of Housing and Infrastructure (MHI) and other stakeholders, annually presents a priority list of which islands that are in need of coastal protection measures (MEE, 2014; EPA, 2014). The islands are chosen after certain criteria's like severity of the erosion, population and how far buildings are located from the coast. The parliament decides which islands that will get support (EPA, 2014). According to the interviewed official at EPA the parliament often decide to support islands not on the priority list in order to obtain political goodwill. How many islands the government can help annually depends on the economic resources, generally not more than one or two.

It is regulated in Maldivian law that it is prohibited to take sand from inhabited islands (MIC, 2014b). Coral mining is also prohibited.

5.1.2 Environmental Protection Agency

The Environmental Protection Agency (EPA) is the environmental regulatory body and is an agency under MEE (EPA, 2014). EPA gives technical information and assistance to MEE and decision makers when they formulate project and structures. Regarding beach erosion EPA is in authority to monitor the erosion situation and evaluate the changes on local and resort islands. At the moment the monitoring programme is not in operation because of lack of economic resources. EPA also do technical surveys in which EPA investigate the erosion situation on affected local and resort islands. What kind of survey EPA does depends on the requesting island's needs. Reports from these surveys may be used by the island council to get funding for beach protection projects from donor agencies or CSRs projects from resorts. The resort islands frequently hire private consultants to speed up the process since EPA has limited resources in time and funding.

MEE and EPA perform environmental awareness campaigns every year in different parts of the country. Beach erosion is one topic covered and information regarding proposed prevention measures and expected results are presented. The participants are community NGOs, environmental groups, school children and island officials.

If somebody, for example a local person, authority or resort operator, wants to implement physical erosion protection along the shoreline they need to execute an Environmental Impact Assessment (EIA) and get a permit from EPA (EPA, 2014). Otherwise the actor gets fined (MIC, 2014b). A resort first needs to get permission from Ministry of Tourism and then EPA (MT, 2014). This rule is under the EIA regulations which EPA is in custody of (EPA, 2014). It is often expensive to do an EIA because of consultant and equipment costs. In case of emergency an EIA and permission is not needed for a temporary solution, but the actor still has to inform EPA before the measure is undertaken.

5.1.3 Ministry of Housing and Infrastructure

Ministry of Housing and Infrastructure (MHI) is responsible to implement governmental construction works which include coastal protection measures on local islands (EPA, 2014). Sometimes coastal protection works are done in combination with other infrastructure projects, for example construction of land reclamation when a harbor is built. MHI give MEE technical advice regarding beach erosion (MHI, 2014b). The ministry has among others a planning section and an engineering section. The engineering section is implementing the governmental construction works (MHI, 2014a) and the planning section is developing Land use plan and Development plan guidelines. All atoll and island councils have to follow these guidelines in their physical planning and development work.

The Land use planning guidelines regulate how allocation of land is handled and was put into place in 2005 (MHI, 2014b). One rule in the guideline is to keep a 20 meter buffer zone from the high tide coast line. In this way it is not allowed to construct buildings within this buffer zone and in turn preserve coastal vegetation. There are some exceptions, for example if an island does not have any adequate space MHI might give approval to build closer to the coast. Another exception is if there are existing hard structures in place that may protect the coast from erosion, it is allowed. One example is a harbor. Many islands have buildings less than 20 meters away from the beach because they were built before the regulations were put into place. MHI has the responsibility to approve the islands' land use plans and make sure they follow the regulations. Even if the island councils are responsible to develop their own land use plan MHI sometimes does it because many islands do not have technical capacity to do it (MHI, 2014b). When MHI carry out an island's land use plan they do it in cooperation with the island council and the local community.

5.1.4 Ministry of Tourism and the tourist sector

Ministry of Tourism is the regulative authority for the tourism sector which includes all resort islands (MT, 2014). The ministry is the leaseholder of private islands and has mandate to develop the tourist sector and maintain tourist facility standards. When it comes to beach erosion the ministry gives out guidelines and regulations on what can be done along the coastline on resort islands.

Resort operators are responsible to maintain their island's shoreline. If there is an erosion problem the resort has to address it and they have to pay for the measure by themselves (EPA, 2014). The regulation *Environment protection and preservation regulations for the Tourism sector* control the development of resort islands (MT, 2014). Resort islands have stricter setback regulations compared to local islands. A resort island can only build upon 20 % of the total land area and the buffer zone is 30 meters (MHI, 2014b). Resort can build bungalows and other constructions closer if certain criteria's are fulfilled for example if it is built more than five meters from the vegetation line. Removal of vegetation close to the shoreline is restricted (MT, 2014). The ministry also regulates how to build. Buildings in the water have to be able to withstand erosion. The building is not allowed to block the beach movements and has therefore to stand on stilts or columns. If a resort wants to take any coastal protection measures like beach replenishment or breakwaters they have to get approval from EPA (MHI, 2014a). The ministry

sends out inspectors at least once a year doing regular visits on the resort islands to observe if the ministry's guidelines are followed and erosion will be reported.

5.1.5 The central government's land reclamation project

Maldivian central government is currently working on reducing the number of inhabited islands and to concentrate the population on fewer islands (MMS, 2014b). The government is planning to enlarge six islands by land reclamation and try to attract people moving there by offering better facilities and more spacious living (MHI, 2014a). The government is doing this for both social and environmental reasons. One reason is that many local islands are overpopulated with limited space for further development. It is also expensive and inefficient for the government to provide all inhabited islands facilities like school, health center, harbor and sewage system (LAC, 2014a). Protection against beach erosion is another reason. Several islands are in need of coastal protection measures and it is easier and less expensive to protect fewer islands than many.

5.1.6 In case of a natural hazard

Maldives has a national warning system in operation that announce alarms if both climatic and non-climatic hazards occur (MMS, 2014b). Sea swells and storms are hazards related to beach erosion. Maldivian Meteorological Service (MMS) is the responsible agency announcing the alarms. The warning system has three criteria levels (white, yellow and red) set out for a number of hazards. Depending on which criteria level that is reached different stages of information is provided. When the highest, criteria level red, is reached MMS directly announce warnings to the public and relevant institutions. MMS send an automatic warning message to 97 stakeholders, including National Disaster Management Center (NDMC), police, Maldivian National Defense Force (MNDF), atoll councils and other concerned ministries and agencies. When an atoll council receive the warning it is responsible to further communicate it to inhabited islands in their atoll. Ministry of Tourism communicates the warning to resort islands (MT, 2014). MMS broadcast the warning parallel in TV and public media at the same time to inform the public and they also have phone lines where people directly can ask questions (MMS, 2014b). Police, NDMC and MNDF give support in acute situations caused by natural hazards. This can be expanded to also include damage related to beach erosion (LAC, 2014a).

5.2 Laamu atoll council's risk reduction work to prevent beach erosion

On a regional level Laamu atoll council has not taken many measures regarding beach erosion. When the council receives the category three warning from MSS it further communicates it by phone and fax to all resort and local islands in the atoll (LAC, 2014a). The council has also during the last mandate period arranged workshops for local people about environmental issues, including beach erosion, on all islands every year (LAC, 2014b). In an acute erosion event the atoll council can ask MNDF and the police for help and they can come to ease the situation (LAC, 2014a). This has only been done in flood events earlier. Temporary accommodation can also be provided if needed.

In the future Laamu atoll council plans to document areas that are exposed to erosion in the atoll council's new development plan (LAC, 2014a). Laamu atoll council does not have a land use plan at the moment but MHI's planning section helps the council to develop one. The land use plan will include the 20 meter buffer zone that is prescribed by law and it will be kept free from further exploitation (LAC, 2014a). Another example is that UNDP started a project in Laamu atoll called LECReD (Low Emission Climate Resilient Development) in April 2014 (LAC, 2014a). Within the project Laamu atoll council will get help to develop a climate strategy for Laamu atoll and it will include risk reduction to erosion (UNDP, 2013). Together with UNDP the new council also wants to continue the awareness raising and plan to hold a campaign on the local islands during 2014 and 2015 about different subjects including beach erosion (LAC, 2014a).

The two interviewed officials representing Laamu atoll council says that they are lacking facilities, funds and educated staff to take the measures needed to protect the local islands in the atoll (LAC, 2014a). It is possible to give comments about beach erosion protection measures in an EIA process for any coastal construction (LAC, 2014a). The atoll council has not been able to give any comments and participate in any EIA meetings because they are held in Malé and the council does not have enough financial capacity to cover the travel costs. The council cannot give comments without attending the meetings.

5.3 Results of the comparative case study

In this section is the capacity analyses carried out for Maavah, Maamendhoo and Six Senses Laamu presented in matrices. Each measure is colour coded depending on its thematic focus. Physical measures are dark grey, environmental measures are green, social/cultural measures are red, economic measures are blue and political/institutional measures are orange.

5.3.1 Capacity analysis for Maavah

The matrix below shows the capacity analysis for Maavah presenting all measures taken by national, regional and local authorities.

Matrix 1. The matrix presents all erosion protection measures taken on Maavah. In the matrix Maavah island council is shortened to MvIC.

| | Used capacity | Planned measures | Unused capacity | Lacking capacity |
|---------------------------------------|--|---|-----------------|--|
| Hazard reduction and avoidance | <ul style="list-style-type: none"> -MHI constructed land reclamation on Maavah when building a harbor in 1997 (MvIC, 2014). -MvIC follows national regulation; setback of 20 meters from the coastline (MvIC, 2014). -In 2012 and 2013 MvIC requested the government to reclaim affected areas and to build revetments (MvIC, 2014). -Land exploitation is not allowed on Maavah without permission (MvIC, 2014). -MvIC does not take any sand and no corals from reefs (MvIC, 2014). -The government built a sea wall made of sand/cement bags app. 5-10 years ago to protect an area against beach erosion. It is now swept away by the sea (LAC, 2014a). -Tree plantation on Maavah during the government initiative “Million Tree Programme” in 1996 (LAC, 2014a; RRCAP, 2002). -MvIC has asked the atoll council for help to construct revetments (LAC, 2014b). | <ul style="list-style-type: none"> -MvIC plans to protect a palm forest as an environmental protection area (MvIC, 2014). -MvIC plans to buy coconut palms from locals to prevent them to get cut down (MvIC, 2014). -MvIC plans to arrange an awareness campaign about environmental issues, including how to prevent beach erosion (MvIC, 2014). -Possible land reclamation by MHI if sand gets left after finishing the ongoing harbor project (MvIC, 2014). | | <ul style="list-style-type: none"> -Due to overpopulation there is no area left to build houses (MvIC, 2014). |

| | | | | |
|----------------------------------|---|--|--|---|
| Vulnerability reduction | | | | |
| Preparedness for response | -MvIC uses megaphones to inform local people when a heavy storm is approaching (MvIC, 2014). | | -MvIC can provide temporary accommodation if needed (MvIC, 2014). -If people get affected under a storm MvIC would assist them to protect their households but this has not been done yet (MvIC, 2014). | -MvIC does not have facilities to take precautions to reduce the impact of beach erosion when a storm emerge (MvIC, 2014). |
| Preparedness for recovery | | | -If beach erosion would occur in a storm event MvIC would report it to NDMC (MvIC, 2014). -MvIC would ask the national government for help if the council is not able to support (MvIC, 2014). | -MvIC does not have the financial capacity to repair damages to beach erosion (MvIC, 2014). |
| Other measures | -MvIC tries unofficially to raise awareness among local people about erosion problems (MvIC, 2014). -A survey including beach erosion was carried out by EPA in 2011 (MvIC, 2014; EPA, 2014). -MEE carried out a beach erosion survey for whole Maavah between 2006-2008 (LAC, 2014a; EPA, 2014). - Maavah is on MEE's priority list for erosion protection support (EPA, 2014). | | | -Maavah island does not have an operating NGO that could work with beach erosion protection (MvIC, 2014). -MvIC does not have enough financial resources and knowledge to protect the island against beach erosion (MvIC, 2014). |

Used capacity

There are thirteen measures taken (used capacity) on Maavah regarding beach erosion, see matrix 1. A majority of these are hazard reduction and avoidance measures, but also one preparedness for response measure and four measures under the category other measures. The measures' thematic foci are all represented except economic measures. One measure taken by MHI is when the ministry built a harbor and enlarged the island by constructing land reclamation in 1997. The project was financed by the government (MvIC, 2014). In 2014 a reconstruction of the harbor was undertaken (EPA, 2014; MvIC, 2014). EPA carried out a survey in 2011 before a reconstruction of the harbor started in 2014 to investigate among other things how the construction could affect the erosion situation. According to the councilors the island council has not received the conclusion of the survey (MvIC, 2014). Maavah is one of the islands on MEEs and EPAs priority list for islands in need of erosion protection.

Maavah island council has requested the government for help to reclaim certain parts of the island and to build revetments, both in 2012 and in 2013 (MvIC, 2014). The government has not replied to any requests but the councilor said they will keep on asking until they get an answer. The council has also asked the atoll council for help to construct revetments since they do not have financial capacity to do it. The atoll council plans to include that Maavah is exposed to erosion and that they need revetments in the atoll development plan (LAC, 2014a). MHI is currently helping the island council to develop their land use plan and national regulations like a

buffer zone on 20 meters from the coastline will be followed (MvIC, 2014). To avoid damages on buildings in the future no land exploitation is allowed on the island without permission from MHI.

Planned measures

There are four planned measures on Maavah and all of them are hazard reduction and avoidance measures. Two of the planned measures concern preservation of trees since the island councilors think further erosion can be prevented this way (MvIC, 2014). The island council plans to protect the palm forest on the island's western part as an environmental protection area. The second tree preservation measure is to buy coconut palms from local people to prevent them to get cut down. The council will finance it on its own and plan to start the project in 2015 – 2016. Both the environmental protection area and the bought trees will be protected in the development plan. Another planned measure is that the island council plans to arrange is an awareness campaign about environmental issues for locals where erosion aspects will be included (MvIC, 2014). The information will cover how erosion is caused and how it can be prevented. The campaign will be financed by the council and is highlighted in the development plan. If there is a surplus of sand available after finishing the ongoing harbor project MHI plan to construct land reclamation on the northern side of the harbor (MHI, 2014b).

Unused capacity

During the study four unused measures have been identified and categorized. Two of them are preparedness for response measures and two are preparedness for recovery measures. One example of a preparedness for response measure is that Maavah island council can provide temporary accommodation if needed but it has not been done yet (MvIC, 2014). One example of an unused preparedness for recovery measure is that Maavah island council would request the government for help if a local person would ask for assistance and had to reject because of limited funding (MvIC, 2014).

Maavah island council does not have any prepared measures if damages from beach erosion are caused in a storm event, not before, during and after a storm (MvIC, 2014). According to the councilors it is because houses and infrastructure have not been damaged by erosion in previous storms. If it happens in the future the council would act as it does during a flooding event, described as follows: when the storm warning reaches the staff at the council they inform the locals by using megaphones. If any damages occurs during and after the storm the council, police and/or MNDF will come and help the affected people depending on the severity of the damages. After the storm the people report the damages to the council, which further reports it to NDMC.

Lacking capacity

Four lacking capacities has been detected in the study of Maavah's capacity analysis. One is that the island council does not have an operating NGO that could work with beach erosion protection (MvIC, 2014). The other lacking capacities are that the island council does not have enough financial resources to protect the island, repair damages and take precautions to reduce the impact of beach erosion. Knowledge of how to protect the island is also lacking.

5.3.2 Capacity analysis for Maamendhoo

The matrix below shows the capacity analysis for Maamendhoo presenting all measures taken by national, regional and local authorities.

Matrix 2. The matrix presents all erosion protection measures taken on Maamendhoo. In the matrix Maamendhoo island council is shortened to MaIC.

| | Used capacity | Planned measures | Unused capacity | Lacking capacity |
|---------------------------------------|---|---|--|---|
| Hazard reduction and avoidance | <p>-MHI constructed land reclamation on Maamendhoo in 2009 (MaIC, 2014).</p> <p>-MaIC follows national setback regulation in their physical planning (MaIC, 2014).</p> <p>-Tree plantation programme by the council in 2012 (MaIC, 2014; LAC, 2014b).</p> <p>-MaIC has forbidden to plant palm trees close to the coast to reduce size of land chunks lost to erosion (MaIC, 2014).</p> <p>-MaIC has included revetments and their cost in the development plan (MaIC, 2014).</p> <p>-MaIC does not take sand from the beach and no corals from reefs (MaIC, 2014).</p> <p>-MaIC has asked the atoll council for help to construct revetments (LAC, 2014b).</p> | <p>-MaIC plans to plant trees to protect the coastline as soon as their economy allows (MaIC, 2014).</p> <p>-Laamu atoll council will write that Maamendhoo needs revetments in the atoll development plan (LAC, 2014a).</p> | | <p>-MaIC does not have financial capacity to take physical measures to protect from beach erosion (MaIC, 2014).</p> |
| Vulnerability reduction | | | | |
| Preparedness for response | <p>-MaIC uses loudspeakers and mosques to inform locals when a heavy storm is approaching (MaIC, 2014).</p> | | <p>-MaIC plans to arrange two training sessions in DRM. Erosion is not included (MaIC, 2014).</p> <p>-MaIC can provide temporary accommodation if needed (MaIC, 2014).</p> | |
| Preparedness for recovery | | | <p>-MaIC plans to arrange two training sections in DRM. Erosion is not included (MaIC, 2014).</p> | <p>-MaIC does not have financial capacity to buy insurance for the council office to protect from natural hazards (MaIC, 2014).</p> |
| Other measures | <p>-Two erosion surveys have been carried out by MEE and EPA on Maamendhoo in 2008 (MHI 2014a) and 2012 (EPA, 2014b).</p> <p>-MaIC has requested EPA and MEE for help to protect the island from erosion (MaIC, 2014).</p> <p>-EPA carried out an EIA for the harbor project in 2008. Beach erosion aspects were included (MaIC, 2014; MHI, 2014a).</p> | <p>-MaIC plans to monitor the development of erosion after protection measures by the government have been taken (MaIC, 2014).</p> <p>-MaIC plans to carry out an awareness campaign including beach erosion (MaIC, 2014).</p> <p>-MaIC plans to start a cooperative society. The income will be used in the council's budget (MaIC, 2014).</p> | <p>-Maamendhoo have three operating NGO:s. None of them work with beach erosion protection (MaIC, 2014).</p> | <p>-MaIC does not have enough financial resources to protect the island against beach erosion (MaIC, 2014).</p> <p>-MaIC does not have enough staff and education to protect the island against beach erosion (MaIC, 2014).</p> |

| | | | | |
|--|--|--|--|--|
| | <p>-MaIC has applied to EPA to hire one more staff in order to do erosion protection activities (MaIC, 2014).</p> <p>-MaIC has asked the government if the council can build a resort on a nearby island and then rent it to a tourist company to increase funds (MaIC, 2014).</p> <p>- Maamendhoo is on MEEs and EPAs priority list for erosion protection support (EPA, 2014).</p> | | | |
|--|--|--|--|--|

Used capacity

Fourteen measures have been taken on Maamendhoo regarding beach erosion. Seven of them are hazard avoidance and reduction measures, one preparedness for response measure and the rest other measures, see matrix 2. The measures thematic foci are all represented except social measures.

One physical measure is the land reclamation MHI constructed when a harbor was built on Maamendhoo in 2009 (MaIC, 2014; MHI, 2014a). It is located on northeastern part of the harbor, see map in appendix 4, to both address the lack of land and replace previously eroded areas on the island. EPA carried out an EIA for the harbor project in 2008 and beach erosion aspects were included in the assessment (MEE, 2014; MHI, 2014a). According to one official at MHI the erosion recommendations were followed (MHI, 2014a). After the harbor construction the island council experienced that the erosion increased and asked MEE and EPA for help to in 2012 and 2013 (MaIC, 2014). In the council's request a report with photos was sent to show the development of the erosion and that the island is suffering due to it. In combination with the report the council also has requested for an environmental survey and asked for money for erosion protection measures. The council wants to use the result of the survey to determine what kind of protection measures are best for Maamendhoo. The islands councilors say that the requested ministries have not replied the council or visit the island. On the other hand one official at MHI says that the island council asked the government for help and that one official from MEE went to the island and carried out an erosion survey (MHI, 2014a).

Maamendhoo island council has taken two environmental measures regarding tree plantation. In 2012 the council arranged a tree plantation programme in order to protect the coastline (MaIC, 2014). The council, in cooperation with the local schoolchildren, planted a local tree species on the island. The programme did not cost anything because the council got the saplings for free. Unfortunately the trees died. The island council has also forbidden individuals to plant and grow palm trees close to the coastline. The council has decided this because they think that when a palm tree is toppling into the sea caused by erosion a large area of land will disappear as a result.

The island council has included revetments and what it would cost to build it in their development plan (MaIC, 2014). The council does not have financial capacity to build it on their own and has asked the government and atoll council for help. So far they have not got any budget for it. The councilors are aware that it might become too expensive to construct revetments on Maamendhoo in relation to the island's small population. The councilors say that it might be better if the government builds houses on Gan and Fonnadhoo. Then the Maamendhoo people can move there and the government can protect those islands instead. One councilor expressed:

If you should spend money it is better to spend it in a good way (Island councilor, MaIC, 2014).

Maamendhoo island council does not have a land use plan yet and has recently requested MHI for help to develop one (MaIC, 2014). Even though the council does not have this the councilors says that they follow national setback regulation not to build closer than 20 meters from the coastline in their physical planning.

The island council has asked MEE and EPA if locals can take their own physical measures like putting sandbags along the coast (MaIC, 2014). The EPA has not answered and if the locals do anything they get fined if they do not have permission.

Planned measures

There are five planned measures on Maamendhoo, two hazard avoidance and reduction measures and three other measures. One hazard avoidance and reduction measure is that the island council plans to carry out a new tree plantation program (MaIC, 2014). Before it is possible, the councilors mean, the office needs to hire more staff and find more funding because the people working there now do not have time and resources. This time the council plans to buy smaller tree plants. The council has applied in their budget request to EPA to hire one more staff in order to do erosion protection activities and among other things. One example of another measure is that Maamedhoo island council plans to carry out an awareness campaign for the locals regarding disaster management, including beach erosion.

Unused capacity

During the study four unused measures have been found and categorized. One detected unused measure is that the council plans to arrange two training sessions during 2014 (MaIC, 2014). The first session will be held with the council, 15 local volunteers and representatives from Red Crescent, MNF and NDMC on Maamendhoo. Later the council will hold a larger training session which includes all local people on the island. The aim is to train them to manage natural disasters, but aspects relating to beach erosion are not yet included. Depending on what to include in the training sessions this measure can be both a preparedness for response measure and a preparedness for recovery measure. One example of a preparedness for response measure is that the island council can provide temporary accommodation if houses get damaged in a storm event. This was done during the tsunami. On Maamendhoo there are three NGOs operating, but none of them are working with beach erosion.

Maamendhoo island council does not have any prepared measures if damages to beach erosion are caused in a storm event, not before, during and after a storm (MaIC, 2014). When a category three storm hits the island, the council informs the locals by using loudspeakers and mosques. If the power breaks down they use loudspeakers with batteries. If damages due to continuous erosion or through storm event the council will go and check the harm and report it to the government.

Lacking capacity

Several lacking capacities has been observed during the study on Maamendhoo. The Maamanedhoo island council express that they do not have enough financial resources, staff and education to protect the island against beach erosion (MaIC, 2014). The council is not capable to buy insurance for the council office or take physical measures to protect the island. To improve the economic situation the council has a couple of plans and ideas. For example the island council has asked the government if they can build a resort on a nearby island and then rent it to a tourist company. The council also plans to start a cooperative society on the island. The income will be used in the council's budget.

5.3.3 Capacity analysis for Six Senses Laamu

The matrix below shows the capacity analysis for Six Senses Laamu presenting all measures taken by national, regional and local authorities.

Matrix 3. The matrix presents all erosion protection measures taken by authorities on Six Senses Laamu. Six Senses Laamu is shortened to SSL.

| | Used capacity | Planned measures | Unused capacity | Lacking capacity |
|---------------------------------------|--|--|-----------------|------------------|
| Hazard reduction and avoidance | -EPA has given permission to construct artificial reefs in 2013 (EPA, 2014). -MT has given SSL permission to build a temporary sea wall made of sandbags (MT, 2014). -EPA has given permission to install seven geotubes on SSL (SSL, 2014a). -EPA has hired the consultant firm Seamarc to install three geotubes (SSL, 2014). -EPA has given SSL permission to do beach nourishment (SSL, 2014). | -If the installed geotubes are successful, SSL has permission to install four more geotubes (SSL, 2014). | | |
| Vulnerability reduction | | | | |
| Preparedness for response | -MT is calling and emailing SSL when a storm is approaching (SSL, 2014). -Atoll council is calling SSL when a storm is approaching (SSL, 2014). | | | |
| Preparedness for recovery | | | | |
| Other measures | -EPA receives monitoring reports from SSL and further communicates it to the central government (SSL, 2014). -MEE and MT are giving report and improvements of what the SSL can do in their protection work regarding erosion (SSL, 2014). | | | |

Used capacity

The authorities in Maldives are involved in nine measures taken on Six Senses Laamu, five of them are hazard reduction and avoidance measures, two of them are preparedness for response measures and two are under the category other measure, see matrix 3. The hazard reduction and avoidance measures are permissions from national authorities to construct physical measures, except one.

The Ministry of Tourism (MT) gave Six Senses Laamu permission to build a temporary sea wall made of sandbags during the construction phase of the resort (MT, 2014). According to the official at the resort the sea wall is still there and has a management program for it.

Six Senses Laamu contacted EPA because the resort needed help with the erosion development (SSL, 2014). In turn EPA put the resort in contact with the consultant firm Seamarc. Initially the firm did a survey on the island and wrote a report about the erosion situation and proposed improvements of what can be done to reduce the erosion. The cost for the survey was 10 000 dollars. Then Seamarc together with the resort came up with a four step action plan and submitted it to EPA which they approved. Taken measures within this action plan are three geotubes installed by Seamarc in October 2013, see top left photo in appendix 5. They are at an experimental stage and test if that can be a solution. If the installed geotubes are successful Six

Senses has permission to install four more geotubes. One geotube costs around 8000 dollars and the resort pays Seamarc and the installation of them on their own. EPA has also given permission to do beach nourishment by pumping sand through cables from a boat from a near lying sandbank.

Laamu atoll council is in contact with Six Senses two times per month. The atoll council comes to the resort island to see how the situation is on the resort (SSL, 2014). The atoll council assist the resort by for example reporting to the central government that the resort have problem with beach erosion.

Planned measures

The only identified planned measure is that if the installed geotubes are successful Six Senses has permission and plan to install four more, seven in total (SSL, 2014).

Unused capacity

No unused capacity has been identified.

Lacking capacity

No lacking capacity has been identified.

Other measures

Two political/institutional measures under the category other measure has been found on Six Senses Laamu. EPA receives monitoring reports from Six Senses and further communicates it to the central government (SSL, 2014). MEE and MT are giving report and improvements of what the resort can do in their protection work regarding erosion.

5.4 Mainstreaming

5.4.1 Mainstreaming strategies - national authorities

Mainstreaming strategies at national level are presented in table 1 below.

Table 1. The table presents national authorities mainstreaming strategies.

| |
|---|
| <p>Integration strategy (add-on risk reduction or adaptation)</p> <ul style="list-style-type: none"> MHI has recently started to put, for example revetments or geo bags, to protect the coastline of land reclamations (MHI, 2014a). |
| <p>Programmatic mainstreaming</p> <ul style="list-style-type: none"> When the harbor on Maamendhoo was built an EIA was carried out by MHI and beach erosion impacts were taken into consideration (MaIC, 2014). EPA has a national coastal zone monitoring programme with 20 sites distributed across the country. Currently no measurements are done because of lacking financial resources (EPA, 2014). When MHI construct buildings or infrastructure the ministry ensures that the constructors are qualified and that they follow recommended erosion construction codes (MHI, 2014a). When MHI carry out the National land reclamation programme the lowest land reclamation boundary is 1.5 meters above mean sea level (MHI, 2014a). On some islands it is 2 meters. MHI is currently evaluating the different methods they use for beach replenishment and beach erosion measures (MHI, 2014a). MHI use to have sand cement bags revetments and is now tested, as a pilot project, to use concrete blocks. MT has a well-developed warning system within the ministry to warn resorts when a category three storm is approaching (MT, 2014). |
| <p>Organizational mainstreaming</p> <ul style="list-style-type: none"> MT, in collaboration with UNDP, has an ongoing project called Maldives Tourism Adaptation Project (TAP) (MT, 2014; UNDP, 2014). The project aims to identify the tourism sector’s adaptive capacity to climate change and use the knowledge to develop regulation and |

guidelines.

- The EIA guidelines have recently been revised to include monitoring of erosion development one year after something has been built in a coastal area and compare the result with previous measurements (MHI, 2014a).
- MHI has a post focusing on beach erosion in the ministry's annual budget (MHI, 2014a) and EPA has a post for monitoring of beach erosion in the agency's annual budget (EPA, 2014).
- EPA is currently developing coastal development guidelines as a part of the EIA process for all coastal activities (EPA, 2014). The guidelines will include how to design coastal protection measures for example what kind of structures and materials to use.
- EPA has a coastal zone management unit working with beach erosion (EPA, 2014).
- EPA is establishing a GIS database with information about the erosion situation and which measures that are taken on the islands in Maldives (EPA, 2014).
- EPA has recently revised two regulations with beach erosion components, the EIA regulation and Dredging and reclamation regulation (EPA, 2014). The EIA regulation now has the flexibility allowing temporary measures to be taken without doing an EIA. Dredging and reclamation regulation now include borrow restrictions in coastal areas to minimize erosion.
- MHI revised the Land use plan guidelines in 2005 to include a 20 meter buffer zone from the high tide coast line (MHI, 2014b).
- UNDP, in cooperation with MEE and MHI, are currently revising the Land use plan guidelines to include adaptation to a changed climate as a part of the project Integrating Climate Change into Risk Resilient Island Planning (ICCR) (MHI, 2014b). Changes that may be considered are specific location for important infrastructure and to build houses close to the coast on higher elevation.
- It is prohibited by Maldivian law to do coral mining and to take sand from inhabited islands (MvIC, 2014).
- MEE has a separate coastal zone unit implementing erosion projects (EPA, 2014).
- MT is continuously revising existing regulations almost every two years. In 2014 MT is revising the environmental guidelines *Environment protection and preservation regulations for the Tourism sector* to improve erosion components.
- MT is reviewing the building code for house construction on resort islands (MT, 2014). The codes are changed to adapt to a changing climate including withstanding erosion.
- All new staff at EPA is given training in coastal zone management (EPA, 2014).
- The staff in the planning section at MHI has during their time at the ministry taken courses where beach erosion issues and climate change adaptation have been incorporated (MHI, 2014b).
- The planning staff at MT is educated in how to reduce risk to beach erosion (MT, 2014). They have attended workshops and governmental programs.

Internal mainstreaming

-

Inter-organizational mainstreaming

- National early warning system for heavy storms and other natural hazards (MMS, 2014b). MMS has the task to inform responsible stakeholders.
- Good communication between authority levels when MMS gives out category three warnings (MIC, 2014a; MIC, 2014b; LAC, 2014a; MMS, 2014; MT, 2014).
- UNDP cooperates with MEE and MHI in how to integrate climate change adaptation into the planning process through the project ICCR (Integrating Climate Change into Risk Resilient Island planning) (UNDP, 2014).
- EPA gives presentations about their current work or the result of a technical survey on request from schools, NGOs or governmental authorities (EPA, 2014).

Educational mainstreaming

- The Ministry of Education has incorporated knowledge about disaster and hazard risk in schoolchildren's curriculum (MMS, 2014b). School children grade 1-7 are educated in environmental studies in school, including how to minimize risk of beach erosion (MvIC,

2014).

- EPA cooperates with different universities abroad, for example with a university in New Zealand regarding the monitoring program (EPA, 2014).

5.4.2 Mainstreaming strategies - Laamu atoll council

Mainstreaming strategies at regional level taken by Laamu atoll council are presented in table 3 below.

Table 3. The table presents Laamu atoll council's mainstreaming strategies.

| |
|---|
| <p>Integration strategy (add-on risk reduction or adaptation)</p> <ul style="list-style-type: none"> • The previous atoll council arranged workshops about environmental issues, including beach erosion, for the local people every year on all the islands in Laamu atoll (LAC, 2014b). • Laamu atoll council is planning to carry out an awareness campaign to make people aware of erosion problems and what people can do if something happens (LAC, 2014a). |
| <p>Programmatic mainstreaming</p> <ul style="list-style-type: none"> • In the previous atoll development plan coastal erosion protection measures like revetments for Maavah was mentioned (LAC, 2014b). Laamu atoll council will write that Maavah is exposed to erosion and needs revetments in the new development plan too (LAC, 2014a). • Laamu atoll council is revising the old atoll development plan and will highlight beach erosion problems in the new one (LAC 2014a). Before the revising started the council visited all the islands to listen to what the communities and island councils need and want. |
| <p>Organizational mainstreaming</p> <ul style="list-style-type: none"> • Laamu atoll council will in their revision of the development plan change routines so that beach erosion aspects come into consideration (LAC, 2014a). • Laamu atoll council will develop a climate strategy with the help of UNDP during the Low Emission Climate Resilient Development project, LECReD, see section 5.2 (LAC, 2014a). |
| <p>Internal mainstreaming</p> <p>-</p> |
| <p>Inter-organizational mainstreaming</p> <ul style="list-style-type: none"> • Cooperation between Laamu atoll council and UNDP during the development process of Laamu atoll climate strategy (LAC, 2014a). |
| <p>Educational mainstreaming</p> <p>-</p> |

5.4.3 Mainstreaming strategies - Maavah and Maamendhoo island councils

Mainstreaming strategies at local level taken by Maavah and Maamendhoo island councils are presented in table 3 below.

Table 3. The table presents local authorities mainstreaming strategies.

| |
|---|
| <p>Integration strategy (add-on risk reduction or adaptation)</p> <p>-</p> |
| <p>Programmatic mainstreaming</p> <ul style="list-style-type: none"> • All exploration of new land on Maavah is stopped in the land use plan. The island council needs to ask MHI for permission to be able to explore new land (MvIC, 2014). • An environmental awareness campaign including beach erosion is highlighted in Maavah's development plan (MvIC, 2014). • Maamendhoo and Maavah island councils are following national rules and regulations regarding coastal protection in their urban planning (MvIC, 2014; MaIC, 2014). |

| |
|--|
| <ul style="list-style-type: none"> • Maavah island council is following national rules by reporting people taking sand from inhabited islands and corals from the reef (MaIC, 2014). • The president of Maavah island council has attended courses in sustainable development and environmental issues, including beach erosion (MvIC, 2014). • Maamendhoo council staff has participated in a workshop for the LECReD project (Low Emission Climate Resilient Development), see section 5.2 (MaIC, 2014). |
| <p>Organizational mainstreaming</p> <ul style="list-style-type: none"> • Maavah island council is reviewing their development plan in 2014 and will request government and experts to get better knowledge and technical information regarding beach erosion protection (MvIC, 2014). • Maamendhoo island council has included revetments and their cost in the development plan (MaIC, 2014). • Laamu atoll council plans to write that Maamendhoo needs revetments in the atoll development plan (LAC, 2014a). • Maamendhoo island council has applied to EPA to hire one more staff in order to do erosion protection activities (MaIC, 2014). |
| <p>Internal mainstreaming</p> <p>-</p> |
| <p>Inter-organizational mainstreaming</p> <ul style="list-style-type: none"> • School children on Maamendhoo have helped the island council to plant trees to protect the coast from erosion (MaIC, 2014). • Maamendhoo island council uses political party’s loudspeaker systems to warn locals if for example a heavy storm is on its way to hit Maamendhoo (MaIC, 2014). • Maamendhoo island council has asked the atoll council for help to construct revetments (LAC, 2014b). |
| <p>Educational mainstreaming</p> <p>-</p> |

No one of the authorities in the study use any internal mainstreaming strategy, see table 1, 2 and 3. On the question if the own authority organization ever have considered its own risk of beach erosion all of the interviewed persons answered no. One atoll councilor means it is because the office is far away from the coastline (LAC, 2014a). Almost no authorities at any level have insurance for their office buildings and equipment. Only the interviewed at Ministry of Tourism and Ministry of Housing and Infrastructure think their buildings have some sort of coverage. Some authorities are interested in having insurance, some are not. For example Maavah island council is not interested to buy insurance because they do not consider that the beach erosion issue is main problem the island is facing (MIC, 2014b). Maamandhoo island council is on the other hand interested to have insurance but is not able to buy one because of lacking financial capacity.

5.4 Interaction between the authorities and local people/resorts

This section deals with research question number three in this study and the study of Borgudd (2014). The authorities perspective are gathered through interviews with officials and councils at all authority levels, and the local people’s and the resort’s perspectives through interviews with people at Maamendhoo and Maavah and staff at Six Senses Laamu.

5.4.1 Responsibility of authorities

The first analysis deals with the perception and opinion of the local people and staff of the resort Six Senses. What do they think that authorities should do against beach erosion problems and how does this compare with the opinion of the authorities?

Local people on both Maavah and Maamendhoo think that the responsibility of the national authorities are to take protection measures against erosion, for example making barriers and

putting big bags around the island, and they further think that the authorities have resources to do this (Maamendhoo, 2014; Maavah, 2014). People on Maamendhoo want the government to give financial support, which they currently are not doing (Maamendhoo, 2014). MEE has the main responsibility for the national planning regarding erosion and they take the initiative if coastal protection measures need to be done (EPA, 2014; MEE, 2014). In turn it is MHI that does the physical work to build the coastal protection measures, and also initiate the EIA (MHI, 2014a). EPA is responsible to investigate if the EIA regulations are followed. They also have a priority list of which islands that are in need of erosion protection (EPA, 2014). The MEE's official thinks that they have enough knowledge about erosion, but the financial resources are lacking and that is the key problem preventing them from doing their work in a proper way (MEE, 2014). MHI think that they are short of staff (MHI, 2014a and 2014b). The engineering section does not have any coastal engineer at the moment (MHI, 2014a). It is difficult to keep the staff because the private sector and other actors pay more than MHI can.

Local people on Maamendhoo also think that MEE and EPA should hold awareness programs about the situation (Maamendhoo, 2014), while people on Maavah think this is something the island and atoll council should do (Maavah, 2014). People on both islands want to have more information about erosion and how it can be prevented by building good protection, and also about how different measures affect different parts of the island (negative side effects). Local people can then manage it better on their own. Laamu atoll council has carried out awareness campaigns on different islands in Laamu atoll during the last mandate period (LAC, 2014b). The awareness campaign was about environmental issues including beach erosion. MEE and EPA has also carried out awareness campaigns in different parts of the Maldives to community NGO:s, school children, environmental groups and island officials (MEE, 2014; EPA, 2014). Unfortunately it is not known if this has been done on Maamendhoo or on Maavah. Both Maamendhoo and Maavah island council plan to carry out environmental awareness campaigns to local people that include erosion (MaIC, 2014; MvIC, 2014). Maavah island council says that they currently try to make people aware of the erosion problems but that they not officially are working with it (MvIC, 2014).

On Maavah people think that the national authorities have the responsibility to make laws and guidelines that people should follow (Maavah, 2014). For example not to take sand or not to cut down trees. In Maldives it is MEE that develops policies regarding erosion and implementation of erosion projects (EPA, 2014, MEE, 2014). MHI are in turn responsible for the development and implementation of land use plans and development plans guidelines (MHI, 2014a). When MHI develop plans they do consultations with the locals and try to include and implement their opinions. MHI and island councils have to consult with the island community like women's committee, island council, NGOs, education health and power utilities during the development plan process.

Local people on Maavah think that the island council will not do anything to prevent erosion if they are not interested (Maavah, 2014). That is why it is important with laws and guidelines that the island council need to follow and that it is the island council's responsibility to enforce the laws. For example by contacting the police who will fine if people take sand from the beach or corals from the lagoon. The island council on Maavah also think that this is their responsibility (MvIC, 2014), but this process can be more effective than what it is today, according to some locals (Maavah, 2014). Although some people think that it starts with the island council and that it is the island council that needs to ask for help to the national authorities, otherwise nothing will happen. In sum local people on Maavah want the authorities to have better coordination between each other, so that the work becomes more effective.

People on both Maamendhoo and Maavah consider that the island council has a responsibility to protect the beach from erosion (Maamendhoo, 2014; Maavah, 2014). For example to construct barriers and to carry out proper monitoring of beaches and investigate which sites that are commonly eroded. They should also investigate which houses that are affected and make people aware of the situation. Both Maamendhoo island council and Laamu atoll council state that their

responsibility is to work for and to take measures to reduce the erosion (LAC, 2014a; MaIC, 2014). This therefore harmonize with the perception of what local people think they should do, even if they do not have financial resources to implement these measures and need support from the government. Laamu atoll council has mentioned erosion measures in the previous atoll development plan and has sent it to the government for implementation (LAC, 2014a).

Maamendhoo island council thinks they do not cooperate yet with people in the local community regarding erosion measures (MaIC, 2014). Still, local school children helped the council to plant trees in 2012. If the council asks the locals for support they are sure they will help.

People on Maavah also want the island and atoll councils to do a survey around the island to find out how fragile the environment is and to monitor which houses that are affected to erosion (Maavah, 2014). EPA is responsible for monitoring erosion changes, but has not done this on Maavah. EPA has carried out a survey on Maavah that includes beach erosion (MvIC, 2014; EPA, 2014). Sometimes EPA gives presentations about their current work or the result of a technical survey on request from schools, NGOs or governmental authorities (EPA, 2014). It seems like this has not been the case on Maavah, since people in general do not have information about this survey.

On both Maamendhoo and Maavah none of the respondents believe that the authorities are doing enough to prevent erosion (Maamendhoo, 2014; Maavah, 2014). Some persons on Maamendhoo do not even trust politicians, since they have not done anything the last 4-5 years. On Maavah people say that the central government does not take any measure to prevent erosion. Although people on both Maamendhoo and Maavah understand that national authorities do not have enough resources to help all of the 200 inhabited islands in Maldives, since nearly all islands have the same situation with erosion.

Staffs on Six Senses think that the responsibility of the national authorities is to make surveys and help them with monitoring the erosion situation (SSL, 2014), which EPA also has responsibility for (EPA, 2014). Further the resort's opinion is that the responsibility of the authorities is to give financial support to the resort (SSL, 2014). The Ministry of Tourism is responsible for the development and implementation of regulations and guidelines for the tourist sector including beach erosion regulations (MT, 2014). The ministry also approves resort operators' development plans before the resort is built and when it is constructed they make sure the regulations are followed. If not the resort is not allowed to open. Since the atoll and island council do not have any responsibility when it comes to resorts, no question was asked to the resort about the responsibility that the atoll and island council have. On Six Senses they could not say whether the national authorities are doing enough to prevent erosion, since they need to evaluate whether the measures they have helped them with are satisfying (SSL, 2014). If they need more help in the future they will ask for it.

5.4.2 Responsibility of local people and resorts

The opinion of national, regional and local authorities regarding the responsibilities that the local people and resorts should have to take precautions against beach erosion is here presented and compared with what local people on Maavah and Maamendhoo and staff at Six Senses think about their own responsibility.

According to MEE and EPA the local people are responsible to report to their respective island and atoll councils if they are exposed, and then the councils should report upwards to the national authorities (MEE, 2014; EPA, 2014). MHI thinks that locals have a social responsibility to be aware of how erosion occurs and follow national regulations (MHI, 2014a). One official at EPA thinks locals do not have more responsibility than report to the authorities (EPA, 2014). According to the official it is the authorities at all levels that have the responsibility to take coastal protections on the islands. EPA does not think the locals live up to their responsibilities since they almost do not get any reports. This is probably because the locals do not have knowledge of who they should report to, and then contact the local councils in the first place.

The regional and local authorities have different views of how much responsibility local people have to prevent their island from beaches erosion. One atoll councilor and the island councilors on Maamendhoo think the locals have more responsibility than national authorities (LAC, 2014b; MaIC, 2014). They think locals should follow national regulations and that they also should protect their property and themselves as much as they can by for example enhancing their house foundations. The island councilors at Maavah island council think the locals should follow national regulations and tell the council or the police if they see someone breaking these regulations (MvIC, 2014). The second atoll councilor thinks the locals have responsibility to prevent from beach erosion but that the authorities have the main responsibility (LAC, 2014a). According to the regional and local authorities the local people do not fully live up to their responsibilities because a few still take sand from beaches and corals from the reef and some houses have weak constructions. One councilor at Laamu atoll council believes everyone has responsibility to prevent erosion, both authorities and citizens, but means that most of the responsibility lies with the authorities (LAC, 2014b).

In accordance with the atoll councilors perception, the local people on Maamendhoo and Maavah think that everybody have responsibility to prevent erosion (Maamendhoo, 2014; Maavah, 2014). They also agree with the authorities that their responsibility is to follow national regulations like not take sand from the inhabited islands and corals from the reef. One person on Maamendhoo states that people have the responsibility to tell each other what to do and not to do in order to prevent erosion and that locals should take away the garbage from the beach (Maamendhoo, 2014). On the other hand one person on Maavah thinks people should not clean the beach from garbage since the person think it will worsen the erosion situation (Maavah, 2014). Even though some of the interviewed on Maavah think local people have responsibility to take precautions for beach erosion, some people say that they are busy with other things and do not have the time to take precautions.

Resort islands need to apply to EPA for permission to take physical measures (EPA, 2014.) One official at MT think that resort companies have to make sure they do not break the tourist sector's regulations regarding beach erosion (MT, 2014). The official thinks the resorts live up to their responsibilities very well. It is only occasionally that resort operators do not follow guidelines and regulations because many of the operators are from abroad and is not aware of all national regulation of Maldives. The staff at Six Senses does not mention anything about following regulations, they mean that they are responsible to protect their island because they are dependent on a good looking beach to attract guests to the resort (SSL, 2014).

5.4.3 Hindering or supporting?

The opinion from the authority level regarding if local people and resorts are hindering or supporting the authorities work regarding beach erosion is presented here. The interviewed officials and councilor's answers are compared with opinions from local people on Maavah and Maamendhoo and staff on Six Senses Laamu regarding if the authorities are hindering or supporting their work.

Local people do not believe that the authorities are supporting their work, instead they think they are hindered by laws (Maamendhoo, 2014; Maavah, 2014). According to the interviewed locals it was easier to get permission to take physical measures before the island council was established in 2011 than it is now. The reason is the EIA regulations. Before any physical measure is undertaken along the coast an EIA has to be carried out. The problem is that people do not have any money for doing an EIA. EPA expressed during the interview that they get complaints from island councils, resort and locals since they are perceived stopping the development when an EIA is needed in all type of development projects (EPA, 2014). Occasionally EPA also meets resistance because people are afraid of changes.

When the construction of the harbor on Maavah was carried out in 2009 people said that they could express their opinion about it (Maavah, 2014). One person said that MHI did not follow the recommendations, since they changed their work. When the EIA was done MHI said the harbor

would not damage and increase erosion, but according to some people the erosion became worse after the harbor was built. People only think that authorities are supporting if houses are damaged.

Comparing the different authorities opinion regarding if local people are hindering or supporting the authorities work, all of the authorities say local people are generally supporting them. According to MEE, locals are not hindering the ministry because MEE is working for the benefit of them (MEE, 2014). The locals participate in meetings and have their opinion about MEEs erosion projects. Even if they do not agree about MEEs project this is not an obstacle according to the interviewed official. The same opinion is found among one official at MHI since local people show up during community consultations in the EIA process and are interested of what is best for their island (MHI, 2014b). MHI means that local islands often have a high level of community sense. If there are people giving resistance the island councils would stop them or explain to them how things should work. MHI also tries to meet the locals' views and needs. One common problem is often lack of land, and locals prefer to have bigger residential lots but do not complain because of their strong community sense, one MHI official means. People know it is done for their benefit. Maamendhoo and Maavah council experience that most people are supporting them and appreciate what the councils do regarding their work with erosion (MaIC, 2014; MvIC, 2014). One reason is that the locals follow the regulations not to take any sand from the beach and not cut down any trees. There are a few people hindering the councils' adaptive work by not follow the rules and if so they are reported to the police. One council also said that some locals refuse to follow the council's decisions due to the councilors' political affiliations.

The staff at Six Senses are of the opinion that the authorities are supporting the measures the resort takes against erosion (SSL, 2014). The official at MT states there is no hindrance against the ministry's work because it will harm the resorts financially (MT, 2014). All resort properties are insured but if the resort operators do something against the guidelines and regulations the insurance does not cover potential damages.

5.4.4 Complementing or not complementing each other's adaptive work?

This section is comparing the different matrixes from the capacity analyses regarding both what local people, Six Senses Laamu and authorities are doing to reduce risk against erosion (see section 5.3 and appendix 8). This is done to see how they are complementing each other's adaptive work.

The Maldivian authorities are sometimes complementing local people's and Six Senses Laamu's risk reduction initiatives and sometimes not. One example where they are complementing each other is that one local person on Maamendhoo expresses that he would move from the island if support is given from the central government (Maamendhoo, 2014). This is complementing the authorities work because the central government is currently working on reducing the number of inhabited islands (MMS, 2014b) by enlarging six islands through land reclamation (MHI, 2014a). The government tries to attract people moving there by offering better facilities and more spacious living. Another example is that local people on Maamendhoo have planted trees that have been initiated by both the previous government and the island council (Maamendhoo, 2014). Six Senses Laamu's risk reduction work is complementing the authorities risk reduction work because the resort operator has taken several measures within all categories except preparedness for response. The authorities have not taken any vulnerability reduction measures or preparedness for recovery measures at all on Six Senses Laamu. They are also complementing each other's work since the authorities are giving Six Senses permission to take all measures the resort is asking for. Comparing the result from the capacity analyses regarding both Maavah and Maamendhoo it shows that local people take more measures when it comes to preparedness for response measures compared to what authorities do. On Maavah, local people also have one vulnerability reduction measure and one preparedness for recovery measure while the authorities do not have any of these measures. This shows that local people are complementing the authorities gaps/weaknesses in their adaptive work.

There are cases when local people are not complementing the authorities' adaptive work regarding beach erosion. For example that it is regulated in Maldivian law that no one is allowed to take sand from beaches on inhabited islands and take corals from reefs (MvIC, 2014). The regulation is followed by most people, but few people still take sand and corals. Another example is that Maamendhoo island council has forbidden the planting of palm trees close to the coast to reduce size of land chunks lost to erosion (MaIC, 2014), but the locals do this anyway. By comparing the authorities' capacity analysis and the local people's capacity analysis for Maamendhoo it appears that none of them have taken any used measure in the categories vulnerability reduction and preparedness for recovery. This shows that their risk reduction work do not complement each other and therefore the authorities needs to develop these kind of measures more than others.

5.4.5 Adaptive help from authorities

One local person on Maamendhoo has asked Maamendhoo island council to put sandbags on the beach to protect a house (Maamendhoo, 2014). Since the island council does not have enough economic resources they send a letter to EPA regarding this matter and asked for permission two years ago (MaIC, 2014). The agency has not yet replied. The official at EPA experience that the agency has the knowledge but has limitations in staff, funding and equipment (EPA, 2014) which can explain why Maamendhoo island council has not got any reply. The councils on both Maamendhoo and Maavah express they cannot accomplish their mandate in accordance to the Decentralization Act because they experience the power are still centralized. Both Maavah and Maamendhoo island councils also think they do not have enough resources and knowledge to protect the island against beach erosion (MaIC, 2014; MvIC, 2014). More educated staff is also required to implement the erosion protection measures and so that they can develop their own land use plans.

On Maavah people have asked for help to refill sand (land reclamation) after the construction of the harbor, but this has not been approved according to the interviewed (Maavah, 2014). One example where people have got help from the authorities is when a sand/cement bag revetment was built on Maavah in 2008 and financial support was given from the government. According to a local person on Maavah the central government has granted people money for damage on property and they have sent a letter to find out how many houses on the island that are affected by the erosion. People that have not asked for help said that if they will face damage, they will first contact the island council, who will contact further to national authorities. This corresponds to what EPA is saying, since they are mostly in contact with the island councils instead of local people (EPA, 2014).

Six Senses has asked for help to EPA to do a survey about the erosion situation, which EPA also have done (SSL, 2014). EPA has also helped Six Senses to get in contact with the consult firm Seamarc that have helped the resort to install geotubes. The national authorities share their ideas with the resort. MT and MEE are for example giving reports and information about improvements that the resort can do. According to the official at the MT they are in most cases able to give help if a resort is asking for it, since they do not lack financial capacity to do their job regarding beach erosion (MT, 2014). The person means that the ministry is able to produce good practice, guidelines and prepare for incidences. Within the ministry they have expertise and consultants available for the resorts to seek for help to get technical advice and solutions for that specific island. But the ministry does not have capacity to visit resort islands as often as they wish.

The resort has cooperated with the previous atoll councilor by phone twice/month. The atoll councilor has also visited the island to see how the situation regarding erosion is on the resort island. The atoll council assist the resort by for example reporting to the central government that the resort have problem with beach erosion (SSL, 2014). The current atoll councilor says that Six Senses has never asked the atoll council for help regarding erosion (LAC, 2014b). But the current councilor have only had his post a short period of time, which means that they may continue help

the resort with these matters in the future. Although, both of the councilors do not think the atoll council is able to give help to limit damage due to beach erosion if a resort asks for it because they do not have enough budget (LAC, 2014a; LAC, 2014b).

The general perception among people on both Maamendhoo and Maavah is that they will get help from national authorities in the future if the erosion damages houses and harm people (Maamendhoo, 2014; Maavah, 2014). Some people were not sure exactly what kind of help they will get, or if they will get help from national authorities, but their hope is that they will get help from authorities in the future. People on Maavah say that since the national authorities helped during the tsunami, they believe that they will receive help again if the erosion gets severe (Maavah, 2014). Although some people on Maavah think that they will only get help from the island council and not national authorities. One person on Maamendhoo has a different opinion and says that it is only the government that can do something, and not the island council, since there are lacking economic resources (Maamendhoo, 2014).

Unfortunately the question regarding if the resort think they will get any help in the future from authorities was not asked to Six Senses.

5.4.6 How authorities in Maldives inform about their current work

This section describes how authorities inform about their work to local people and the measures they are planning to do.

According to the two island councils they think they have not done anything of prevent beach erosion and they have therefore not informed about their work in any way (MaIC, 2014; MvIC, 2014). If they inform about their work in the future they will inform on Facebook, and on a note board outside the island council building. They have informed about the harbor this way. In the future Maavah island council plans to carry out a tree project (MvIC, 2014). Then the council plans to publish it before the project and arrange activities around it.

MEE does not inform the local people about their current work to reduce risk to beach erosion more than the awareness campaign and putting up information on their website about ongoing projects (MEE, 2014). The projects are also published in local media and magazines where the project is carried out. MHI and EPA does not inform about their work regarding erosion to local people (MHI, 2014b; EPA, 2014).

The national authorities do not contact resorts about measures. Since resorts have the main responsibility to take measures against beach erosion Six Senses hire a consultant firm for implementation of measures (SSL, 2014). Authorities contact the resort about other issues. Before a new regulation is adopted the Ministry of Tourism invites resort operators to take part in consultation meetings where they discuss and give comments about it (MT, 2014). If guidelines or regulations regarding the tourist sector is revised MT publish this on their website and if there are major changes the ministry tries to communicate by email to the general manager or responsible staff within adequate sector.

6. Discussion

The main research question; *How do local, regional and national authorities work to reduce risk of beach erosion and how does their adaptive work differ between resort islands and local islands in Laamu atoll?* and the first sub question; *Are there any gaps or weaknesses in the authorities' adaptive work regarding beach erosion based on the operational framework of Wamsler?* This is discussed in the sections 6.1-6.4. The second sub question; *By comparing the result from Borgudd (2014), how does the local and regional authorities' adaptive work interacts with local peoples' adaptive work regarding beach erosion?* This is discussed in section 6.5.

6.1 Capacity analyses for Maavah and Maamendhoo

The capacity analyses of the national, regional and local authorities' adaptation work for Maavah and Maamendhoo are similar. Therefore are they analyzed together in this discussion.

There are gaps in the authorities risk reduction work regarding beach erosion on both islands. There are no vulnerability reduction measures taken, planned to be taken or identified unused capacity on Maavah or Maamendhoo. There are no preparedness for recovery measures taken or planned to be taken on the islands either. According to the theory of Wamsler (2014) is the inclusiveness in the authorities work therefore low.

All the different authorities prioritize hazard reduction and avoidance measures on the islands. On Maamendhoo, the authorities have taken seven hazard reduction and avoidance measures and plan to take additional two in a close future. On Maavah the authorities have taken eight hazard reduction and avoidance measures and plan to take additional four. All of the hazard reduction and avoidance measures on both islands are physical, environmental or political/institutional, but no economic and social/cultural measures are done. Only one preparedness for response measure is taken on the islands, and that is when the island councils inform the locals when a heavy storm is approaching. The rest of the used capacity and planned measures are under the category other measures where their thematic foci vary between the islands. Maamendhoo has more other measures than Maavah and are political/institutional or economical. On Maavah are they social/cultural or political/institutional. The flexibility among the taken and planned measures is high within the category hazard reduction and avoidance because there are many measures that can compensate if one measure is not functioning. The flexibility is low or not existent in the other categories except the category other measures.

The national authorities are treating Maamendhoo and Maavah in similar ways. They have carried out erosion surveys and built land reclamations on the islands, and both islands are on MEEs and EPAs erosion priority list. Maavah got land reclamation earlier than Maamendhoo and national authorities have taken two more measures on Maavah compared to Maamendhoo. This may be due to that Maavah has higher population or that they consider the island exposed to a higher risk for erosion. In addition to this it does not appear that national authorities are prioritizing any of the local islands to any greater extent.

Laamu atoll council has not taken any measures on Maavah and Maamendhoo. The council plans to report that Maavah and Mamendhoo need revetments in the atoll development plan.

On local level the island councils give the impression that they do their best with the available resources to adapt to the erosion problems. The local authorities are not adapting to the investigated local islands in exactly the same way. The local authority on Maamendhoo is trying to improve the council's economic situation more than Maavah. Both Maavah and Maamendhoo island councils have taken or plan to take environmental measures regarding tree plantation and tree preservation but is tackling the issue differently. Maavah island council plans to protect the palm forest on the island and plan to buy palm trees from locals to prevent them from being cut down. Maamendhoo island council on the other hand has forbidden to plant new palm trees close

to the coast because they think that potentially a too large piece of land may get eroded when a palm tree tipples into the sea. The reason why they handle the palm tree issue differently is probably because they are experiencing trees' ability to protect from erosion in different ways.

Why all the authority levels together are lacking in their risk reduction work on the investigated local islands can be the reason of many things. One contributing factor may be that the decentralization of power to regional and local authorities was carried out only three years ago, in 2011. The regional and local authorities have their responsibilities and shall bear their own costs, but it is obvious that they do not have the resources to carry out their tasks. That is probably one reason why the regional authority has not taken any measures on Maavah and Maamdhoo. National level has a lot of knowledge and experience of how to prevent beach erosion. Both regional and local authorities express that they do not have enough trained staff and economic resources to take beach erosion protection measures. This shows that the resources are not distributed well enough between national authorities and lower authority levels. National authorities are struggling trying to help the exposed islands in Maldives. The national authorities have to select the most affected islands which to help because they cannot help everyone due to lacking financial resources. Even if both Maamdhoo and Maavah are on MEE's priority list it may take a long time before they get help since there are political aspects in the selection procedure too.

6.2 Capacity analysis for Six Senses Laamu

The capacity analysis for Six Senses Laamu shows that there are gaps in the authorities' adaptation work because the authorities have not taken any vulnerability reduction and preparedness for recovery measures. According to the theory of Wamsler (2014) is the inclusiveness of the categories therefore low. There are five hazard reduction and avoidance measures taken on Six Senses Laamu and they are all permissions from national authorities to construct physical measures. The preparedness for response measures are two political/institutional measures. Since there are more than one measure taken within each category the flexibility within the measures are there. The flexibility is rather low within the preparedness for response category because it only has two protection measures.

Why the authorities have taken fewer adaptation measures and no unused and lacking capacities on Six Senses Laamu compared to the investigated local islands can be explained by different things. One reason may be that the resort islands have to undertake and pay for their own protection measures. It makes the authorities less involved in the resorts' erosion protection work. Another possible reason is that the interviewed official on MT did not know in detail of what authorities have done specifically on Six Senses Laamu. Information has been complemented from other interviews carried out in this study. Therefore, more measures may exist. In order to improve the variability of the study it would have been good to interview a staff at the resort about the authorities' measures taken there. MT has strict guidelines for resorts operators how to construct and where to minimize erosion. This kind of prevention is not covered in the capacity analysis because that is not a specific measure on Six Senses. That is a general mainstreaming strategy for the whole tourist sector.

6.3 Differences and similarities between authorities' risk reduction work on Maamdhoo, Maavah and Six Senses Laamu

By analyzing the result of this comparative case study it can be concluded that the capacity analyses for Maavah and Maamdhoo are quite similar in comparison to the capacity analysis for Six Senses Laamu. One large difference though is that only one planned measure and no unused and lacking capacities have been identified as taken by authorities for Six Senses Laamu. On both Maavah and Maamdhoo several planned measures, unused and lacking capacities have been identified. National authorities have taken five hazard reduction and avoidance measures on Six

Senses Laamu where they have given permission to the resort to take physical measures to protect from erosion. One measure was not approved. This shows that the authorities are not taking any protection measure on the resort island itself compared to what authorities do on local islands. National authorities have taken two hazard reduction and avoidance measures on Maavah and one on Maamendhoo. Resort islands are independent to take their own erosion protection measures and pay for them on their own.

A similarity between the local islands capacity analyses and the resort's capacity analysis are that the authorities have not taken or plan to take any vulnerability reduction or preparedness for recovery measures on the three islands. This may be due to that the local authorities on Maavah and Maamendhoo are lacking economic resources, for example to buy insurance and to repair damages to erosion. Since no lacking capacities have been identified on Six Senses it is difficult to draw any conclusions why the authorities do not have taken any of these measures.

By comparing the result from the capacity analyses it is obvious that the operator of Six Senses Laamu has much more economic resources to protect the resort island from erosion than the authorities have on Maavah and Maamendhoo. Many of the measures the island councils has taken or plan to take on the local islands are relatively cheap or do not cost anything. The measures taken on Six Senses by the resort operator are expensive physical measures where the national authorities only have given permission. One physical measure on respective local island taken by national authorities are the land reclamations and they have been taken in combination with construction of the islands harbors. Many of the national measures taken on the local islands are taken in combination with development work. This has probably been done to make it more cost effective. According to previous studies authorities has a tendency to focus on physical measures when reducing risk (Wamsler, 2014; Carmin et al., 2012). Then they only tackle a small part of what is necessary and then the root cause of the problem is ignored. The authorities in Maldives focus on different types of measures, probably because of lacking resources. If the authorities had more money more physical measures would probably be taken because that is the trend the interview answers have pointed at.

In general all authority levels in Maldives need to improve their risk reduction work against beach erosion because they are now mostly focusing on hazard reduction and avoidance measures. They are probably doing it because they see erosion as something continuously happening and that is not related to large acute situations for example storms. If the local islands had experienced damages due to beach erosion the measures in the capacity analyses may also include measures during and in the aftermath of a critical situation. Six Senses Laamu on the other hand has experienced damages on houses caused by erosion but the protection measures are then taken by the resort operator and not by authorities. These measures are therefore not included in the capacity analysis.

In order to improve risk reduction work regarding beach erosion on Six Senses Laamu it is good if the authorities take measures within the categories vulnerability reduction and preparedness for recovery. Since the authorities in Maldives do not take "direct" measures in the tourist sector (give permission to physical measures and regulate the sector) they can adjust the national regulations. One example is that MT can change the distance a building is allowed to be built from the vegetation line, now it is 5 meters. MT can also require that resort operators shall develop a plan how to handle extreme erosion events like a heavy storm. The plan should include measures before, during and after erosion occurs. LAC and the island councils can increase the cooperation with Six Senses and for example prepare temporary accommodation within the atoll.

The authorities risk reduction work on Maamendhoo and Maavah can be improved and several things can be done. They generally are lacking preparing measures and routines if damages would appear in the future. All authority levels need to develop vulnerability reduction, preparedness for response and preparedness for recovery measures. Since some of the authorities express that they are lacking economic resources to adapt to erosion they should focus more on

”soft measures” like education, stricter regulations and vegetation preservation. These are cheaper than physical measures.

The cooperation between the authority levels need to be improved so that their adaptation work will complement each other. Noted in the capacity analyses is that the authorities have unused capacities on Maamendhoo and Maavah and the authorities may further develop them to include beach erosion. It eases the authorities work because unused capacities are structures that already exists but not yet are used. For example MNDF and NDMC may include relief and recovery operations to also cover damages due to beach erosion. At local level the councils may have storage of sandbags to fill and put in exposed areas if a heavy storm is approaching. The atoll council may for example coordinate the island council’s protection work and arrange workshops for the island councilors so they can share experiences, such as plantation of palm trees. The communication between authority levels also needs to be improved because both Maavah and Maamendhoo island councils means that national authorities do not answer their requests when they ask for help. It is very important that the local councils get information on what the national authorities plan for their island in order to adapt their work after their time plan.

6.4 Mainstreaming strategies

According to the compilation of the national authorities' work regarding erosion, it appears that they are well aware of the beach erosion problem and are actively working with the question. By analysing the three authority levels mainstreaming strategies it turns out that national authorities are mainstreaming erosion protection into their work well. All mainstreaming strategies are used by the national authorities except internal mainstreaming. The category with most strategies at national level is organisational mainstreaming and many of them are revision of guidelines and regulations. It is good to have a strong and well-founded legislations when planning and developing infrastructure and buildings. But the laws only become efficient if regional and local authorities have capacity to implement them. Currently none of either Laamu atoll council or Maammedhoo and Maavah island councils is developing their land use plans by themselves. They get help from MHI because they are lacking both educated staff and economic resources. This is something that needs to be improved at regional and local level otherwise the legislations are not as efficient as they could be. The regional and local authorities do also have several mainstreaming strategies in each category except under internal mainstreaming and educational mainstreaming. The impression is that they do the best they can with the resources they have. No internal mainstreaming strategies are used by any of the authority levels. It is probably due to that the offices are located at the protected capital island, and are far away from the coastline.

6.5 Interaction between local people/resort islands and authorities adaptive work

This section discusses the most important and interesting results regarding the interaction between authorities and local people/resorts. A general conclusion that can be drawn regarding the interaction between authorities and Six Senses is that they are supporting each other’s work with erosion, they are complementing each other’s work and the authorities are assisting with the resources the resort is requesting. In general the interaction between authorities and local people show a more complex result. Local people do not think that the authorities are supporting them in their adaptation work while the authorities experience that the locals are supporting them in their work, with some exceptions. The locals think that the authorities have not done enough to prevent from erosion. By comparing their capacity analyzes the local people are complementing the authorities gaps/weaknesses in their adaptation work to a certain extent. In general the local people do not get the help they are requesting for from the authorities.

The authorities have different views of what the local people’s responsibility are to prevent beach erosion. One official at EPA thinks locals do not have more responsibility than reporting to

the authorities if they are exposed to erosion, while Maamendhoo island council thinks locals should follow national regulations and that they also should protect their property and themselves from erosion. This shows that the authorities do not have a joint approach regarding the locals responsibility and in turn makes it hard for local people to relate to. Since the authorities have different perceptions it hinders the authorities work to make it in line with the locals adaptive work, and it also result in a situation where the different authorities work are not complementing each other. Local people have a responsibility to tell both what they are doing to prevent erosion and what they are requesting from the authorities, but the problem is that their requests are not always answered. One example is when a local person on Maamendhoo wanted to put sandbags on the beach, but when the authorities did not answer this request. Authorities therefore need to have better knowledge about what local people themselves are doing and what they are requesting to make the authorities adaptive work more effective. One suggestion how the authorities may improve the situation is to come up with a common responsibility distribution between local people and authorities, and informing about it during for example awareness campaigns. Local people are requesting for more information regarding how they can protect themselves and how they can prevent erosion to occur. This can also be included in an awareness campaign to encourage people to take own measures against erosion. Some campaigns have been carried out but it seems like it has not reached locals on Maavah and Maamendhoo. It is important that these measures correspond to what local people actually can do, since they are lacking financial resources. Therefore they need to focus on “soft measures” like planting trees.

Local people also have different views of what the responsibility is regarding different authorities. Some people say that it is the island council’s responsibility to contact the national authorities, otherwise nothing will happen. Other people say that the island council will not do anything if they are not interested, and that the national authorities have to implement laws and guidelines that the island councils shall follow. Local people are very dependent on the authorities and think that they are not doing enough to prevent erosion. That is why it is important for the authorities to communicate what the authorities’ responsibility is.

Regarding communication between national authorities and Six Senses/local people, the information from the interviews shows that Six Senses have a close relationship with national authorities like MT and EPA. To compare with the local people they have not a close relationship with the national authorities, but have instead a closer relationship with the island councils. Local people do not communicate directly with the authorities, but go through the island councils if they need help. But the island councils do not have a close relationship with the national authorities either since they do not answer their requests. The reason for this can be because the resorts have more money to pay for the services that national authorities can give. Another reason may be because the tourism sector brings in much money to the public treasury the authorities have a greater interest in supporting them. The tourist sector is one of Maldives highest source of income since it contributes 27 % to the country’s GDP (UNDP, 2013). A suggestion is that national authorities should pay as much attention to local islands as they give to resort islands.

The decentralization of Maldives in 2011 and regional and local authorities are therefore not used to deal with these questions. Both local people and regional and local authorities have high expectations that the national authorities shall solve the problem. This shows that a top-down approach exists in Maldives and that national authorities need to have better collaboration with both regional and local authorities and give them tools and encourage them how to deal with the erosion problems better. Maavah island council thinks that the collaboration with national authorities needs to be improved.

The capacity analyses that have been done in this study can be more comprehensive if a risk assessment on the different islands is carried out. The risk assessment would give information about how vulnerable the islands are to beach erosion. This would give a better understanding if the measures the resort, local people and authorities are taking are enough now and in the future.

The EIA regulation is for a good purpose, to protect the environment in various development projects. In the context of erosion protection it has divided the different stakeholders who want to

take physical protection measures to prevent further erosion. The winning stakeholders are the ones who can afford to pay for the measures, which in this case is Six Senses. The losing stakeholders are the ones that do not have financial resources which in this case are the regional and local authorities, and the local people. Recently the government has revised the regulations to allow stakeholders to take temporary measures along the coast in an acute situation without permission. This is a way for the authorities to meet the division the EIA regulation causes. In this joint study no examples have been found where the changed regulation has been used. In order to even out the differences between the stakeholders local and regional authorities need to improve their economy. As expressed in the interviews the island councils have more urgent problems to handle than erosion and all resources cannot be spent on erosion protection. Therefore one solution may be to focus more on cheap measures like awareness raising, strengthen regulations and protect the coast with vegetation.

The main problem to implement measures on local islands is that all the authorities and also local people express that they are lacking financial resources. By comparing with the tourist sector both MT and Six Senses express that they have financial resources.

Even though the authorities have taken more adaptation measures on the local islands than on the resort island it is noted that the tourist sector has stricter regulations regarding beach erosion compared to the rest of the society. For example the tourist sector does regulate how to build houses so that they can withstand erosion, the land use plan has a wider buffer zone and only 20 % of the land area is allowed to be build upon on a resort island. Inspectors from the MT visit each resort island at least once a year. Many local islands are overpopulated with houses already within the buffer zone for local islands. The tourism sector is the largest source of income in Maldives and contributes to approximately 27 % of the country's GDP (UNDP, 2013). The tourist sector is dependent on beautiful white sandy beaches since that are what Maldives is famous for. That may be a reason why the tourist regulations are stricter.

6.6 Evaluation of the method

The theory of Wamsler has been good as an analytical tool in this study in order to map out and compare the islands adaptive capacity. To improve the study, the framework of Wamsler has been further developed by adding planned measures and lacking capacity in the capacity analyses. Planned measures were added because this aspect it is important to be aware of when the authorities, after having carried out the capacity analyses, shall develop new measures to complement existing and planned measures. For example, if only planned physical measures are under the category hazard reduction and avoidance, measures with other thematic foci would be developed in order to widen the flexibility of the category. When doing a capacity analyses, however, it is good to keep in mind that all the planned measures might not become realized. The parameter lacking capacity was also missing in the capacity analyses and was added in the study. It is important to include this because it explains why some measures are not taken and it provides a broader view of what capacities that are perceived missing in the current risk reduction work, if there are any. When compiling the result some measures did not fit into any of the risk reduction and adaptation measures. These measures were put in a fifth category – *other measures*. Some of them were put there because information was lacking about the measure or it did not fit in under any other risk reduction measure. Maybe more categories need to be added in the theory of Wamsler, for example awareness raising and risk assessment.

Some weaknesses have been identified during the semi structured interviews. The reliability in the study can therefore have become undermined. One is that during the interviews leading questions has occasionally been asked when the respondent has not understood the question or when she or he did not develop the answer. Even if it is not good for the objectivity of the study it was sometimes a must, otherwise no answer at all would have been given. Another weakness is that the interview guides were mostly only sent out to national authorities one day before the

interviews were carried out. It would have been good if the interview guide were send out earlier before the interview so the respondent could have been better prepared with information about the investigated islands. Then they would have been able to do research beforehand and to give more precise answers of what they have done on the islands. Some questions have also been missed to ask during the interviews. This has resulted in that it is difficult to compare the answers in the second part of the study, section 5.4 *Interaction between the authorities and local people/resorts*.

In order to improve the results further it would have been of advantage to interview an official at the erosion unit at the MEE and test the interview guides before the interviews were carried out. Due to lack of time this was not possible.

The decision to have a broad aim, including all three authority levels, was taken in order to perform a comprehensive study of the authority levels adaptation work. This has led to that the result is on a general basis rather than with a deep focus. Even if the result from the three compared islands is of a general nature it is possible to draw the conclusion that the current situation between local and resort islands are similar in whole Maldives, of course with some local differences.

6.7 Environmental relevance

This study shows that Maldives already is vulnerable to beach erosion, and the country likely will be more vulnerable to sea level rise and beach erosion in the future. This put the Maldivian authorities in a situation where risk reduction and climate adaptation work is of high importance. This study reveals that there are gaps in the authorities risk reduction work according to Wamsler's theory. Even if this is a small study it gives a hint of what the authorities are in need to improve. The capacity analyses give a good overview of which measures authorities have undertaken on the investigated islands. If the Maldivian authorities would carry out a similar study on a larger scale with more islands and more people from the civil society they may then get a better overview of the authorities adaptation work. With a good overview it is easier to find weaknesses and gaps, and from there priorities improvements in a structured and cost efficient way.

7. Conclusions

In the following bullet points below are the main conclusions drawn from this study presented:

- The capacity analyses of the national, regional and local authorities' adaptation work for Maavah and Maamendhoo are similar. There are gaps in all authority levels' risk reduction work regarding beach erosion because they have not taken or plan to take any vulnerability reduction measures and preparedness for recovery measures on the two islands. The inclusiveness in their risk reduction and adaptation work is therefore low. All the different authorities prioritize hazard reduction and avoidance measures on Maavah and Maamendhoo. There are also differences in the authorities work between the islands.
- All three authority levels experience lacking economic resources to prevent beach erosion on Maamendhoo and Maavah. Regional and local authorities express that they do not have enough trained staff. One contributing factor why all authority levels are lacking in their risk reduction work, may be due to the recent decentralization of power to regional and local authorities.
- The capacity analysis for Six Senses Laamu shows that there are gaps in the authorities adaptation work because the authorities have not taken any vulnerability reduction and preparedness for recovery measures. The inclusiveness of the categories therefore low. In similarity with the local islands the authorities are prioritizing hazard reduction and avoidance measures. Compared to the investigated local islands authorities have taken fewer adaptation measures here and no unused and lacking capacities on Six Senses Laamu. This may be because resort islands have to undertake and pay for their own protection measures.
- Even though the authorities have taken more adaptation measures on the local islands than on the resort island it is noted that the tourist sector has stricter regulations regarding beach erosion compared to the rest of the society. This can be explained by the fact that the tourism sector is the largest source of income in Maldives.
- In general all authority levels in Maldives need to improve their risk reduction work against beach erosion because they are now mostly focusing on hazard reduction and avoidance measures. To get a more comprehensive approach the authorities need to focus on vulnerability reduction and preparedness for recovery measures.
- The three authority levels mainstream erosion protection into their work well. But to make the strategies efficient regional and local authorities need to improve their capacity to implement them.
- A general conclusion that may be drawn regarding the interaction between authorities and Six Senses is that they are supporting each other's work with erosion, they are complementing also each other measures and the authorities are assisting with the resources the resort is requesting. In general the interaction between authorities and local people show a more complex picture and result. By comparing their capacity analyzes the local people are complementing the authorities gaps/weaknesses in their adaptation work to a certain extent. The local people do not in general get the help they are requesting from the authorities.

Acknowledgements

To do this study in Maldives has been an extraordinary experience. Maldivians are genuinely kind people and has helped me and Julia in our studies in a way I could never imagine. I want to thank Swedish International Cooperation Agency's (SIDA) for the Minor Field Study scholarship. Without the scholarship this field trip would not has been possible. I would like to express a special thanks to my external supervisor Mihad Mohamed, program analyst, for all help in Maldives. There are many people who have helped me during my stay and I am very thankful for that. I would like to express my gratefulness to Habeeb, Ali Shareef, Ali Shifaaz with friends, Mohamed Ali, Moosa Ibrahim, Afhif Abdul Ghanee, Hussain Nizam and Ahmed Shukury. I would also like to thank Johanna Alkan Olsson and my Swedish supervisor Jonas Åkerman, associate prof., for all help I received conducting the study.

References

- Abdulla, N., Ahmed, S., Amjad, A., Lubna, M., Mohamed, S. A., Sheen, M., Simad, S., 2007. *Maldives National Adaptation Plan for Action, Republic of Maldives*. Ministry of Environment, Energy and Water. Link to source: <http://unfccc.int/resource/docs/napa/mdv01.pdf>
- BBC, 2013. *Maldives Profile – Timeline*. Link to source: <http://www.bbc.com/news/world-south-asia-12653969> Date: 2014-08-02.
- Biosphere exhibition, 2014. *Biosphere exhibition. Maps. Maldives*. Link to source: <http://www.biosphere-expeditions.org/1-week-projects/scuba-diving-voluntourism-holiday-working-on-coral-reefs-whale-sharks-of-the-maldives-archip.html> Date: 2014-07-12.
- Blodgett, R. H. and Keller, E. A., 2008. *Natural hazards - earth's processes as hazards, disasters and catastrophes*. Second edition. Upper Saddle River, NJ 07458. USA: Pearson education, Inc.
- Borgudd, J., 2014. *Reducing risk of erosion in Maldives. Comparative case study of local people's and resort's adaptive capacity in Laamu atoll*. Master thesis. Centre for Environmental and Climate research. Lund University. Lund.
- Carmin, J., Nadkarni, N., Rhie, C., 2012. *Progress and challenges in urban climate adaptation planning: results of a global survey*. Massachusetts Institute of Technology. Department of Urban Studies and Planning. Link to source: <http://web.mit.edu/jcarmin/www/urbanadapt/Urban%20Adaptation%20Report%20FINAL.pdf>
- CDE Consulting, 2011. *Beach management plan 2011, Six Senses Laamu, Laamu Atoll Maldives. An appraisal of the beach conditions and medium-term management options*. CDE Consultancy. Maldives.
- CLGF, 2012. *Country profile: Maldives. The local government system in Maldives*. Commonwealth Local Government Forum. Link to source: <http://www.clgf.org.uk/userfiles/1/files/Maldives%20local%20government%20profile%202011-12.pdf>
- Dalen, 2007. *Intervju som metod*. Malmö: Gleerups Utbildning AB.
- Decentralization Act, 2010. *Act on decentralization of the administrative divisions of the Maldives*. Ministry of Home Affairs. Link to source: <http://www.shareefweb.com/documents/LocalGovReforms/MaldivesDraftlaw®ulations/Draft%20Translation%20of%20decentralisation%20ActMaldives.pdf>
- Esaiasson, P., Giljam, M., Oscarsson, H., Wängnerud, L., 2007. *Metodpraktikan - konsten att studera samhälle, individ och marknad*. Third edition. Stockholm: Norstedts Juridik AB.
- Huq, S., Pelling, M., Reid, H., Romeo Lanko, P., Satterthwaite, D., 2007. *Adapting to climate change in urban areas: the possibilities and constraints in low- and middle- income nations*. Human settlements Discussion Paper Series. Theme: Climate change and cities. London, UK: IIED.
- ISO, 2009. *ISO 31000 Risk management: principles and guidelines*. First edition. Geneva: International Organization for Standardization.
- Karthikheyian, T.C., 2010. *Environmental challenges for Maldives*. South Asian Survey. Vol. 17:3, 343-351.
- LGA, 2014. *Local Government Authority*. Link to source: <http://lga.gov.mv/en/councils> Date: 2014-07-12.
- MMS, 2014a. *Climate of Maldives*. Maldivian Meteorological Service. Link to source: http://www.meteorology.gov.mv/met/?holdc=left_topnavi_details&bindc=372de59e40cd1024223255d84da97af5&target=0&seek=Kecfmyk Date: 2014-07-12.

- RRCAP, 2002. *Maldives: State of the Environment 2002*. Regional Resource Centre for Asia and the Pacific. Link to source: http://www.rrcap.ait.asia/pub/soe/maldives_biodiversity.pdf Date: 2014-07-22.
- Shaiq, A., 2006. *Climate change vulnerability and adaptation assessment of the Maldives land and beaches*. Centre of Disaster studies. James Cook University. Townsville, Australia.
- Six Senses, 2014. *Welcome*. Link to source: <http://www.sixsenses.com/resorts/laamu/destination> Date: 2014-08-03.
- The Government of Maldives, 2009. *Strengthening Local Governance in Maldives*. President's Office & Ministry of Home Affairs. Link to source: <http://www.maldivespartnershipforum.gov.mv/pdf/Local%20Governance.pdf>
- UNdata, 2014. *Maldives*. UN - A world of information Link to source: <http://data.un.org/CountryProfile.aspx?crName=MALDIVES#Summary> Date: 2014-07-12.
- UNDP, 2008. *Integrating Climate Change Risks into Resilient Island Planning in the Maldives*. Project document. UNDP Maldives.
- UNDP, 2013. *Low emission climate resilient development (LECReD)*. Joint programme document. UNDP Maldives.
- UNDP, 2014. *TAP: Increasing Climate Change Resilience of Maldives through Adaptation in the Tourism Sector - Background*. Link to source: http://www.mv.undp.org/content/maldives/en/home/operations/projects/environment_and_energy/tourism-adaptation-to-climate-change.html Date: 2014-08-03.
- UNISDR, 2009. *Terminology: disaster risk reduction*. Geneva. Link to source: http://www.inpe.br/crs/geodesastres/conteudo/artigos/UNISDR_Terminology_on_Disaster_Risk_Reduction_2009.pdf
- UNISDR , 2012a. *2012 - disasters in numbers*. Geneva. Link to source: http://www.preventionweb.net/files/31685_factsheet2012.pdf
- UNISDR, 2012b. *Making Cities Resilient report 2012: my city is getting ready! A global snapshot of how local governments reduce disaster risk*. Second edition. Geneva. Link to source: http://www.unisdr.org/files/28240_rcreport.pdf
- UNISDR, 2012c. *How to make cities more resilient: a handbook for local government leaders. A contribution to the global campaign 2010-2015 "Making cities resilient"*. Geneva. Link to source: http://www.unisdr.org/files/26462_handbookfinalonlineversion.pdf
- University of Copenhagen, 2014. *Master of Disaster Management Programme*. Link to source: www.mdma.cu.dk/masters_programme/ Date: 2014-07-08.
- Wamsler, C., 2009. *Operational framework for integrating risk reduction and climate change adaptation into urban development*. Brookes World Poverty Institute. Working Paper Series. No. 101. Manchester, UK.
- Wamsler, C., 2013. *Anpassning i städer*. In: Rummukainen, M., *15 nedslag i klimatforskningen - Dåtid, nutid, framtid*. Center for environmental and climate research. Lund University.
- Wamsler, C., 2014. *Cities, Disaster Risk and Adaptation*. Routledge. London, UK and New York, US.

Interviews

- EPA, 2014. Interview with one official at Environmental Protection Agency. Date: 2014-04-27.
- LAC, 2014a. Interview with one councilor of Laamu Atoll Council. Date: 2014-04-06 and 2014-04-08.
- LAC, 2014b. Interview with one previous councilor of Laamu Atoll Council. Date: 2014-04-08.
- MaIC, 2014a. Interview with five councilors of Maamendhoo Island Council. Date: 2014-04-10.
- MEE, 2014. Interview with one official at Ministry of Environment and Energy. Date: 2014-04-22.
- MvIC, 2014b. Interview with two councilors of Maavah Island council. Date: 2014-04-15 and 2014-04-16.

MHI, 2014a. Interview with one official at Ministry of Housing and Infrastructure, engineering section. Date: 2014-04-27.

MHI, 2014b. Interview with two officials at Ministry of Housing and Infrastructure, planning section. Date: 2014-04-22.

MMS, 2014b. Interview with three officials at Maldivian Meteorological Service. Date: 2014-03-05.

MT, 2014. Interview with one official at Ministry of Tourism. Date: 2014-04-21.

UNDP, 2014. Interview with one official at UNDP Maldives. Date: 2014-03-02.

Complimenting information from interviews from the study of Borgudd (2014)

SSL, 2014. Interview with two resort engineers on Six Senses Laamu. Date: 2014-04-11.

Maamendhoo, 2014. Interviews with five local persons on Maamendhoo. Date: 2014-04-14 and 2014-04-16.

Maavah, 2014. Interviews with four local persons on Maavah. Date: 2014-04-12, 2014-04-13 and 2014-04-14.

Appendix 1

Photos of Maavah



Visualization of how close a house wall is the coastline.



Erosion on the western part of Maavah.



Thrown garbage by the locals along the coast in order to protect from erosion.



A palm tree soon tipping into the sea.

Appendix 3

Photos of Maamendhoo



Erosion on the northeast side of Maamendhoo (Englund, 2014).



Plantation of new palm trees by locals on Maamendhoo (Englund, 2014).



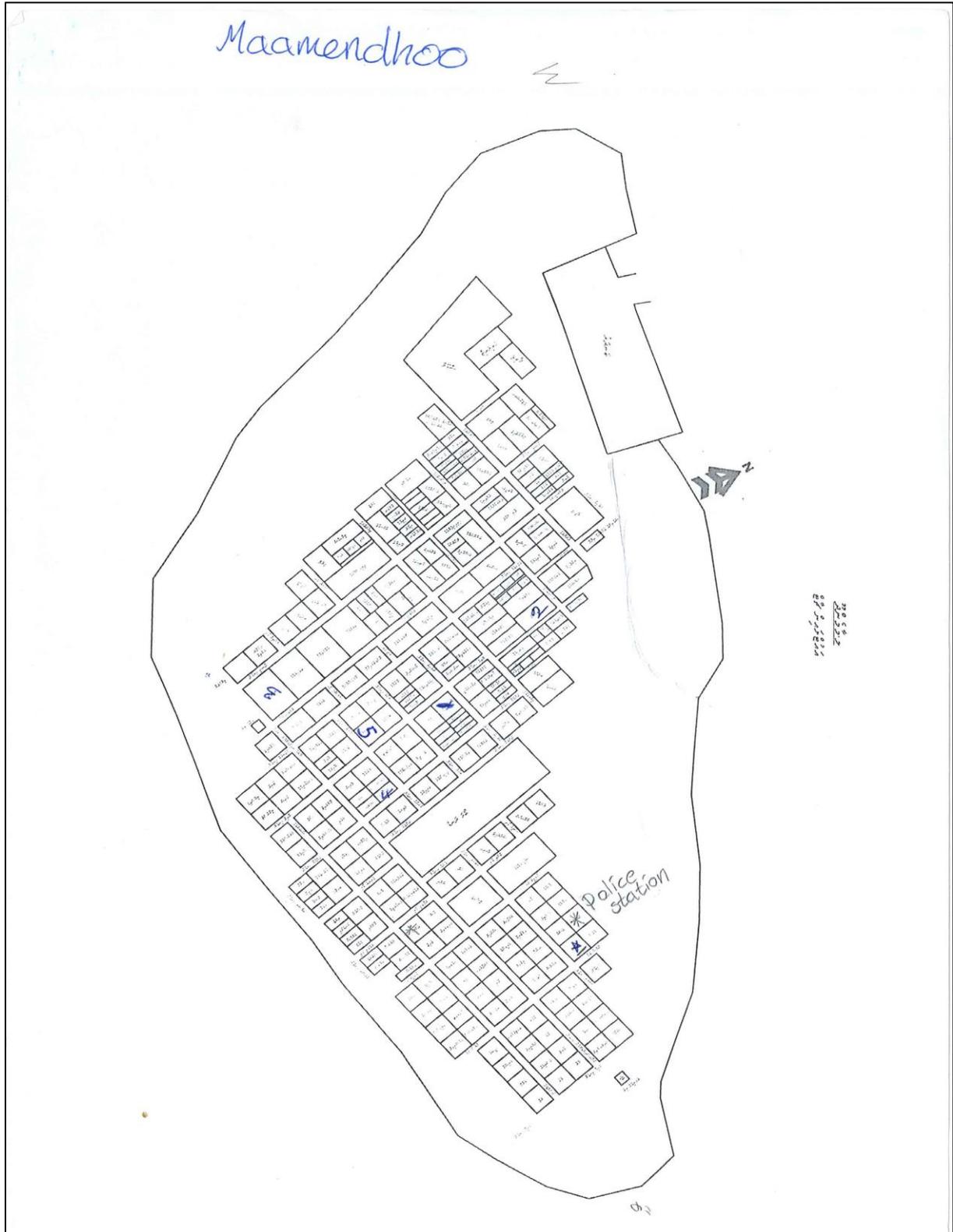
House wall close to the coastline (Englund, 2014).



A wall of building material, stones and garbage to protect from erosion (Englund, 2014).

Appendix 4

Map of Maamendhoo



Appendix 5

Photos of Six Senses Laamu



Geotube with accumulated sand (Englund, 2014).



Six Senses Laamu from above (Six Senses, 2014).



Seawall made by jumbo sandbags protecting the beach (Englund, 2014)



Seawall made by jumbo sandbags protection the beach (Six Senses Laamu, 2014).

Appendix 6

Map of Six Senses Laamu



CDE Consulting, 2011

Appendix 7

Interview guide - Atoll and island councilors

| |
|----------------------|
| Name and position: |
| Date: |
| Island: |
| Organization: |
| Telephone and email: |

Initial questions

| | | |
|---|---|----------|
| 1 | How long time have you worked as a councilor? | |
| 2 | Which sides of the island are residential houses affected? | |
| | Is infrastructure like road, electricity cables and pipelines affected? | Yes / No |
| | Are public services like health clinic, school, water management, power generation? | Yes / No |
| 3 | Is beach erosion more common now than 15 years ago on the island from your own experience? What do you think is the main reason that is causing the beach erosion? | |

Adaptation measures

| | | | |
|---|---|--|----------|
| 4 | What is the island council's responsibility to take precaution for beach erosion? | | |
| 5 | How much responsibility do the local people have to prevent themselves from beach erosion from your point of view? | | |
| 6 | Has the island council taken any of the following precautions to protect the island against beach erosion? If yes, what kind of precautions, have you financed it and was it your idea or someone else idea to do the measure? When did you take the precaution? If no, do you plan to take the measure in the future? | | |
| | Examples of measures Hard measures | Sea wall (of any material, permanent or temporary?) | Yes / No |
| | | Gryones | Yes / No |
| | | Breakwaters (Near - or foreshore) | Yes / No |
| | | Revetments | Yes / No |
| | | Land reclamation | Yes / No |
| | Soft measures | Beach replenishment | Yes / No |
| | | Land use controls and setbacks | Yes / No |
| | | Coastal vegetation retention and/or replanting of coastal vegetation | Yes / No |

| | | |
|-----------|---|----------|
| | Coastal ridge maintenance | Yes / No |
| | Artificial reefs | Yes / No |
| | Other measures: | |
| | Removed/helped to remove/demolished any residential or public houses? | Yes / No |
| | Important infrastructure like roads, electric cables, sewage pipelines? | Yes / No |
| | Do you construct buildings and infrastructure so it can withstand beach erosion? If yes, do you consider this in your development plan/land use plan? | Yes / No |
| | When you construct buildings or infrastructure do you ensure that the builders are trained in erosion proof construction? If yes, how do you train them? | Yes / No |
| | Does the island council control and monitor how beach erosion changes over time? If yes, how do you monitor the island? | Yes / No |
| | Do you plan to take any measures in the future? If yes, what kind of measures? Has this been considered in the island development plan? If yes, how? | Yes / No |
| 7 | Are there any NGOs operating on the island with beach erosion? If yes, what is the NGO called and how do they work with beach erosion? Any projects? Do you cooperate with them? If no, do you think they would be interested to have a project? | Yes / No |
| 8 | Are you lobbying against NGOs to obtain assistance to work against beach erosion? | Yes / No |
| 9 | Do you interact/cooperate with people in the local community to implement measures against beach erosion? | Yes / No |
| 10 | Does the island council cooperate with national authorities to implement adaptation projects of beach erosions? If yes, who do you cooperate with and how? Have you ever asked for help to national authorities? | Yes / No |
| 11 | How does the island council inform local people on Maavah about your current work to reduce risk to beach erosion and the measures you are planning to do? For example through awareness campaigns. | |

Storm events

| | |
|-----------|---|
| 12 | Has the island experienced a heavy storm the last 20 years? If yes, did it cause any beach |
|-----------|---|

| | | |
|-----------|---|----------------------|
| | erosion? | |
| 13 | <p>When a heavy storm (category 3) hits Maldives the Meteorological department is giving out warnings to different ministries, agencies and other stakeholders. Do anyone provide you the warning or is the island council responsible to find out the information by yourself? Alt. 1 or alt. 2</p> <p>If alt. 1, who provide you the warning?</p> <p>How does the island council further communicate the warning to the local people before, during and after the storm? For example TV, radio, newspaper, internet, megaphones, minarets, through other communities or NGO's etc.</p> <p>Are the information shared with near lying local islands? If yes, how do you share this information? Yes / No</p> <p>Are the information shared with Six Senses? If yes, how do you share this information? Yes / No</p> | |
| 14 | What kind of precautions do you take to reduce the impact of beach erosion until the storm emerges? | |
| | Do you have any standard routines how to prepare to reduce the damages of beach erosion? Yes / No | |
| | For example: Do you dispose of any sandbags, bricks, building material to be able to temporary protect from erosion? Yes / No If yes, explain how you plan to use it? | |
| | Do you provide any temporary accommodation for people that can be affected in the storm? | |
| 15 | Does the island council take any precautions under a storm? If yes, what kind of precautions? (previous storms) | Yes / No |
| | Do you assist the people living in the affected area to protect their households? If yes, how? | Yes / No |
| 16 | Does the island council take any precautions after a storm? If yes, what kind of precautions? | Yes / No |
| | Measures to repair the damages from erosion? - Repair waste water pipe to reduce risk for environmental contamination? - Repair sea wall, revetments etc. ? | Yes / No Yes / No |

| | | |
|----|---|----------|
| | | Yes / No |
| | Refill the material that has been removed? | Yes / No |
| | Take physical measures to protect the coastline? | Yes / No |
| | Does the island council provide any temporary accommodation for persons who may have to repair damages on their house or until the persons find somewhere else to stay/live? If yes, describe how it is organized. | Yes / No |
| | Are the council building/s insured so it covers damages due to beach erosion? | Yes / No |
| | Are public buildings insured so it covers damages due to beach erosion? If no, would the island council be interested/able to buy an insurance package? | Yes / No |
| 17 | Has the island council arranged any awareness campaigns about beach erosion for the local people? If yes, what was the objective of the campaign? (prevent yourself, prevent it to happen) | Yes / No |
| 18 | Has the island council carried out any risk assessment of beach erosion for the island? If yes, how have you used the information? If no, is this something you would like to do? | Yes / No |
| 19 | If the central government or the island council is doing a project that requires an Environmental Impact Assessments, EIA, do you follow the recommendations in the EIA regarding beach erosion, if there is any recommendation about this? If yes, can you give any examples? | Yes / No |
| 20 | According to you how well do the local people live up to the responsibilities you just mentioned? | |
| 21 | According to your experience, do you perceive that the local people are hindering or supporting your adaptive work against beach erosion? If yes, how? Hindering/supporting? | |
| 22 | If someone in the island communities are requesting for help to limit the damage of beach erosion, are you able to give that help? If yes, how? If no, why? | Yes / No |
| 23 | Do you think that you have enough resources and knowledge to protect Maavah against beach erosion? If no, what kind of resources and knowledge do you need? | Yes / No |

Mainstreaming

| | | |
|-----------|---|----------|
| 24 | <p>Do you have or have you had any projects how to minimize the impact of beach erosion? If yes, what is the main purpose of the project/s? Is this kind of project/s something you usually work with?</p> <p>If yes, if the island council have any projects, how does the council communicate with the people living on Maavah about the ongoing project/s?</p> <p>If no, do you plan to carry out a project about beach erosion in a close future? Yes / No</p> | Yes / No |
| 25 | <p>Has the island council taken any measures to reduce the risk of beach erosion during the development process of the land use plan? If yes, what kind of measures? For example land use setbacks.</p> | Yes / No |
| | For examples: Do you restrict how close to the coastline someone is allowed built a residential house? If yes, how long? | Yes / No |
| | Public service buildings? If yes, how long? | Yes / No |
| 26 | <p>Has the island council taken any measures to reduce the risk of beach erosion during the development process of the development plan? If yes, what kind of measures?</p> | Yes / No |
| 27 | <p>Have the island council changed any routines or procedures the last years to reduce the risk against beach erosion during the development process of a new land use plan and development plan? If yes, which routines have you changed?</p> | Yes / No |
| 28 | <p>Have the island council adapted any strategy how to incorporate climate adaptation into the council's daily work? If yes, what does it say about beach erosion? If no, do you plan to develop one the coming years?</p> | Yes / No |
| 29 | <p>Have the island council ever considered its own risk to beach erosion? For example, have you thought of the likelihood of the council building to get damages of beach erosion? Potential damage to office equipment or vehicles? Evacuation plan, disaster insurance for office facilities and equipment, back-up power supply.</p> | Yes / No |
| 30 | <p>Have the local councilors been educated in how to reduce risk to beach erosion?</p> | Yes / No |
| 31 | <p>Does the island council get help or support from the university and/or agencies to develop your own work on risk reduction to beach erosion? If yes, how do they help you/support you?</p> | Yes / No |
| 32 | <p>Do the local schools educate the pupils how to minimize the risk of a disaster?</p> | Yes / No |

| | | |
|-----------|---|--|
| | If yes, do you know if risk reduction to beach erosion is included? | |
| 33 | Where does the island get its tap water from? Tanks, wells, rain water harvesting etc.? If it comes from wells, do you experience increasing salt intrusion? | |
| 34 | What do you think could be risks that Maavah could face in the future due to beach erosion? | |
| 35 | How do you see on the future regarding sea level rise? | |

Appendix 8

Result of Borgudd (2014) study

The matrix below shows local peoples capacity analysis on Maamendoo.

| | Used capacity | Planned measures | Lacking capacity | Unused capacity |
|--------------------------------|--|---|--|---|
| Hazard reduction and avoidance | <ul style="list-style-type: none"> • Tree plantation programs. • Stopped taking sand from beaches. • Built temporary sea walls. | <ul style="list-style-type: none"> • Move from the island. • Put sandbags on the beach, if permission is given from the government. | <ul style="list-style-type: none"> • Put sand on the beach. • More economic and material resources are needed. For example big bags and stronger barriers. • People cannot plant trees without permission. • People want more information from authorities | <ul style="list-style-type: none"> • Want to put sandbags in front of houses. • School has interest in working with RR. • Two NGOs could work with risk reduction, but are currently not doing this. |
| Vulnerability reduction | | <ul style="list-style-type: none"> • Awareness programs about erosion. | <ul style="list-style-type: none"> • People are not able to remove their properties or electric cables, because the government owns the land. | <ul style="list-style-type: none"> • Interest in the community to learn more about how to prevent risk - incentive to have training courses in hazard reduction. |
| Preparedness for response | <ul style="list-style-type: none"> • Putting bricks on the beach. • Stay in family house if property get damaged. • Local people call family members and friends that a storm is approaching. • Put temporary sandbags on the beach. (Laamu atoll council, 2014) | | <ul style="list-style-type: none"> • No willingness among local people in protecting the beach from a storm, since the waves will destroy any protection. • No community house available to stay if a persons property get damaged by erosion. | <ul style="list-style-type: none"> • Community could have a "warning system". Before they used a horn for this. • Could have storage of sandbags to protect the beach before a storm hits the island. |
| Preparedness for recovery | | | <ul style="list-style-type: none"> • No economic capacity for repairing house. | <ul style="list-style-type: none"> • Interest in buying a insurance for damages caused by beach erosion (no possibility to do this today in Maldives). Är det så?? |

The matrix below shows local peoples capacity analysis on Maavah

| | Used capacity | Planned measures | Lacking capacity | Unused capacity |
|--------------------------------|--|---|--|--|
| Hazard reduction and avoidance | <ul style="list-style-type: none"> Plant trees (Hirúndhu and coconut palms) Built sea wall of round shaped cement blocks filled with sand Built temporary sea walls. Put corals on the beach. Do not take sand from the beach. Refill ditches with soil and sand Built a concrete revetment made of sand cement bags. | <ul style="list-style-type: none"> Move to safer place where land is available. Planting more trees Aware the community not to take sand from the beach. Refill small parts along the coast with soil and sand. | <ul style="list-style-type: none"> Can not build sea wall, breakwaters and revetments without permission from island council and an EIA. Do not have economic capacity to protect from beach erosion. Need finance from the government. Do not have knowledge about how the measures will decrease erosion and how it will affect other parts of the island (negative side effects). Did not get approval to do land reclamation after the harbor was built. | <ul style="list-style-type: none"> Currently teaching causes and reason for erosion in environmental studies. Can be upscaled to include how people can prevent erosion. Interest among younger people to learn other people about risk reduction. Want information on how to build good protection and how to avoid negative side effects from government. |
| Vulnerability reduction | <ul style="list-style-type: none"> People have enhanced the house foundation. | | <ul style="list-style-type: none"> Most people believe the government will do everything. They don't take initiatives to create an organization that could work with risk reduction of beach erosion. | <ul style="list-style-type: none"> Interest to participate in a community initiative to monitor the erosion. NGO (not functioning now) that have put net on the beach and moved material from one place to another with physical help from the police. This could be done again. |
| Preparedness for response | <ul style="list-style-type: none"> Put sand around the house, taken from nearby islands. Disposal of sandbags to temporarily protect from erosion (mainly for flooding) Stay at relatives if house will be damaged by erosion. Predict that a storm is approaching by the color, size of clouds and changing temperature. People warn each other when a storm approaches. For example by calling and knocking on neighbors door. Parents do not let children go out. | | | <ul style="list-style-type: none"> Schools might provide a place to stay if people's houses are damaged by erosion. |
| Preparedness for recovery | <ul style="list-style-type: none"> Would be able to repair damages on property caused by erosion with the help of other people. | | <ul style="list-style-type: none"> Low income that make people vulnerable and not able to repair damages on their property caused by erosion. | <ul style="list-style-type: none"> Interest in buying insurance that cover damages caused by erosion. Today only fishing boats are insured (not buildings) |

The matrix below shows the resort Six Senses Laamu's capacity analysis

| | Used capacity | Planned measures | Lacking capacity | Unused capacity |
|--------------------------------|--|--|--|---|
| Hazard reduction and avoidance | <ul style="list-style-type: none"> Planting of palm trees 4 times/year Do not cut trees down. Beach nourishment Breakwater - geotubes. Seawall made of sand cement bags. Follow the recommendations in the EIA (Environmental Impact Assessment) when the jetties were built to prevent beaches from getting eroded by building break walls. | <ul style="list-style-type: none"> More geotubes Plant more trees Beach nourishment | <ul style="list-style-type: none"> Want to have tetrapods (but do not have enough money to do it) | |
| Vulnerability reduction | <ul style="list-style-type: none"> Construct buildings so that it can withstand erosion - poles with 1,5 m high elevation. Ensure that builders are experienced from other resorts that have problem with erosion. Removed part of the room in one house. Also removed electric cables and sewage pipelines - they have a post in the budget for this purpose | | | <ul style="list-style-type: none"> Interest to learn more about risk reduction which could be an incentive to have training courses in hazard reduction. |
| Preparedness for response | <ul style="list-style-type: none"> The resort call nearby islands that a storm is approaching, and the guests on the resort. Disposal of sandbags to be able to temporarily protect from erosion. | | <ul style="list-style-type: none"> No place to stay if the resort will be damaged by erosion. | |
| Preparedness for recovery | <ul style="list-style-type: none"> Know how to repair wastewater pipes to reduce risk of environmental contamination Know how to repair sea walls and revetments Know how to refill sand that has been removed. Weekly meeting to get updated about precautions to take after beach erosion has occurred. Insurance that cover damages caused by beach erosion. | | | |
| Other measures | <ul style="list-style-type: none"> Monitor and control the development of beach erosion. Take photographs every day and have a stick in the ground. | | | |