Renewable energy and climate adaptation:

Exploring the role of solar power supply for climate adaptation on Moushuni Island, India

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Figures, maps and tables

List of abbreviations

ASHA - Accredited Social health Activist

BI- Background interview

COP- Conference of Parties

CPM- Communist Party of Indian Marxists

DRE- decentralized renewable energy

GI- Group interview

HI- Household Interview

INR- Indian Rupee

IPCC- Intergovernmental Panel on Climate Change

KWh- kilowatt hour

MI- Market interview

NOK – Norwegian kroner

SHS- solar home system

UNFCCC – United Nations Framework Convention on Climate Change

WBREDA – West Bengal Renewable Energy Development Agency

WHO- World Health Organization

1. Introduction

People have always adapted to the climatic conditions in their surroundings, and the fact that people live decent lives in extreme environments, from the freezing arctic to the hot desert, shows the capacity for adaptation (Burton 1994). Adapting to variations and changes in climate is important when dealing with both naturally occurring climate variability and expected human induced climate change (Ziervogel et al. 2006). Adaptation emerged as a term used in the climate change debate in the early 1990's when the United Nations Framework Convention on Climate Change (UNFCCC) in Rio in 1992 suggested two categories of responses to climate change; mitigation and adaptation (Schipper & Burton 2009). Mitigation received the most attention in the following years, and international negotiations focused on reducing the global emission of greenhouse gasses. Renewable energy became well established as a potential mitigation measure in the global policy context. The Conference of the Parties (COP) meeting in Delhi in 2002 recognized the need for significant cuts in global climate gas emissions through actions to "diversify energy supply by developing advanced, cleaner, more efficient, affordable and cost effective energy technologies [and added that] actions are required at all levels, with a sense of urgency, to substantially increase the global share of renewable energy sources" (UNFCCC 2002:2).

Adaptation was overshadowed by mitigation and was considered a passive solution that if carried out would limit mitigation efforts. It was not until 2001, with the 3rd assessment report by the Intergovernmental Panel on Climate Change (IPCC) that adaptation reemerged as an important term and measure in the global policy scheme. By 2001, climate change had already started to be visible and emissions continued to rise globally (Huq and Reid 2004). The growing focus on adaptation included a special concern for marginal groups that depend on climate sensitive resources and who lack the means to adapt fast enough (Ziervogel et al. 2006).

The renewed focus on adaptation, through politics and research, has caused a growing money flow towards these projects and an increase in adaptation projects globally. These climate adaptation projects vary greatly in what kind of measures they include, from measures targeting the direct impacts from climate risk, to vulnerability reduction and general development (McGray et al. 2007). Even though many adaptation projects and strategies already exist, there is a growing need for improved adaptation projects and strategies, as predictions show that climatic challenges will occur more frequently in the future, even with

successful emissions reductions (IPCC 2007). The need for adaptation solutions for communities facing climatic challenges and the call for mitigating greenhouse gas emissions are two factors that have been important personal driving forces behind this thesis, for which the aim is to study the role of decentralized solar power supply for climate adaptation.

Fieldwork was carried out on Moushuni, a small weather exposed island in the Sunderbans in West Bengal in eastern India. The inhabitants are constantly struggling with climatic challenges, such as floods, droughts and cyclones. There are two decentralized solar power plants on the island that have been operating for 10 years and supplied some electricity to a number of customers. Decentralized electricity production means that the production is done in the locality of the end users and is facilitated, organized and run by the state, private enterprises or the local community. It also implies that the electricity production is happening off grid, meaning that the power plant is a standalone system not connected to the national power grid, but rather supplies the electricity on a mini-grid which only extends to the local community.

Solar power supply was initiated on Moushuni in order to give basic electrical services to the remote and poor communities. An interest in climate friendly solutions was important for the implementing actors. Adaptation to climate change was not considered as a purpose of implementing this solar power supply. However, I suggest that there might be linkages between access to decentralized, solar electricity and the capacity of the people and local community of Moushuni to handle different kinds of challenges, including climatic ones. I will therefore explore which role electricity supply, in the form of decentralized solar power solutions, could play for adaptation to climatic challenges, using the island of Moushuni as my fieldwork location.

By investigating solar power from an adaptation perspective, I can shed light on the impacts of solar energy as an adaptation measure and not only as a mitigation measure. Similar approaches have not been common so far, with the exception of one previous work that addresses decentralized renewable energy as a measure for climate adaptation (Venema et al. 2004). There is a need for more research on the matter, because verified measures are needed to combat current and future climatic challenges, and renewable energy projects have the potential double advantage of having an impact on both climate mitigation and adaptation.

Thesis objective and research question

The objective of this thesis is to investigate how access to some electricity from decentralized solar power plants has influenced people's ability to cope with the climatic challenges, in other words: how a basic power supply has influenced climate adaptation. I will let the islanders of Moushuni tell the stories of how they survive and try to live decent lives under the constant threat of cyclones, floods and other climatic challenges. They will tell how they experienced the entry of electricity on their island and how it later has influenced their lives. I will analyze their stories and based on them develop an understanding of the potential roles of renewable energy in climate adaptation.

Adaptation to climate change is, as mentioned, a term which encompasses many different types of measures. Adaptation can be defined as "a process, action or outcome in a system (household, community group, sector, region or country) in order for the system to better cope with, manage or adjust to some changing conditions, stress, hazard, risk or opportunity" (Smith & Wandel 2006 p. 282). Climate adaptation implies processes, actions or outcomes that make a system to better cope with manage or adjust to climatic challenges.

In this thesis several terms are used in order to describe the weather. By climatic challenges I mean weather events that are experienced as challenging for the people exposed. Examples are floods, cyclones and droughts. Extreme weather events and climate stressors are other terms I use to refer to climatic challenges. Climate risk is "any added risk to current ways of securing well-being resulting from climate change" (Eriksen & O'Brien 2007: 340). It involved the risk which the climatic challenges impose on the people or communities. Climate risk will be elaborated further in my theory chapter. Securing well being involves people's strategies to secure elements of a basic living standard, including the "opportunity to earn an income and meet material needs; maintain health and a basic education; speak up for oneself; and have rights and maintain a sense of social and cultural affiliation (Eriksen et al. 2007: 3).

In order to capture the range of what climate adaptation is and how it can be carried out in practice, while simultaneously ensuring a functional and somewhat systematic approach, I have categorized climate adaptation measures into three groups depending on which aspect of climate adaptation they address. Climate adaptation can either target 1) the direct risk caused by climatic challenges, 2) the processes and factors leading to vulnerability to climate variability and change or 3) increase the adaptive capacity towards climate challenges. This

categorization of climate adaptation is based on work by Eriksen and O'Brien (2007) and other climate adaptation literature that will be discussed in the theory chapter.

Since climate adaptation can target three such different aspects of life, it is necessary to answer four introductory questions before moving on to the analysis of electricity's impact on climate adaptation in Moushuni, these are:

i) *What are the climatic challenges on Moushuni and which risk do they impose on the people?*

ii) *Which factors and processes contribute to people's vulnerability to these climatic challenges?*

iii) *Which actions do households and the local community takes in order to cope with and adapt to the climatic risk that they experience?*

iv) *How is the electricity from the decentralized solar power plant being used by the customers?*

Only when these aspects of life at Moushuni Island are understood is it possible to proceed to the main research question, regarding decentralized renewable energy as an adaptation measure:

Which role, if any, does electricity from the local solar power plants play for climate adaptation, through handling the direct impacts of climatic challenges, reducing the climate vulnerability and/or increasing adaptive capacity for households, businesses and the community, on Moushuni Island?

Addressing this question can contribute analyzing the role of renewable energy in the global climate debate, not only as a mitigation measure, but also as an adaptation measure in certain areas.

Thesis outline

Chapter 1 provides background information on the selection of the topic for this thesis, in addition to a presentation of the research questions and their relevance. Chapter 2 includes the necessary background information about Moushuni Island, the solar power plants and the people and society there. Chapter 3 consists of the conceptual framework this thesis draws upon, including different approaches from the climate adaptation, energy and development and socio-technological system literature. Chapter 4 accounts for the methodological decisions taken regarding choice of method, fieldwork and analysis. The analysis of the

empirical findings are divided into two chapters; chapter 5 presents the findings on the existing climate risk, climate vulnerability and adaptive capacity and aspects of life that are necessary to understand before proceeding to the analysis in chapter 6. Chapter 6 presents the findings on how electricity is being used on Moushuni and how the usage has influenced climate adaptation. Finally, chapter 7 is the conclusion, in which the findings from the study are summarized, the usefulness of the conceptual framework is discussed and suggestions for theory development are presented.

2. Fieldwork location - Moushuni Island

> "Between the sea and the plain of Bengal, lies an immense archipelago of islands. Here there are no boarders to divide the fresh water from salt, river from sea, even land from water. For hundreds of years, only the truly dispossessed braved the man-eating tigers and the crocodiles who rule there, to eke a precarious existence from the mud." (Gosh 2004)

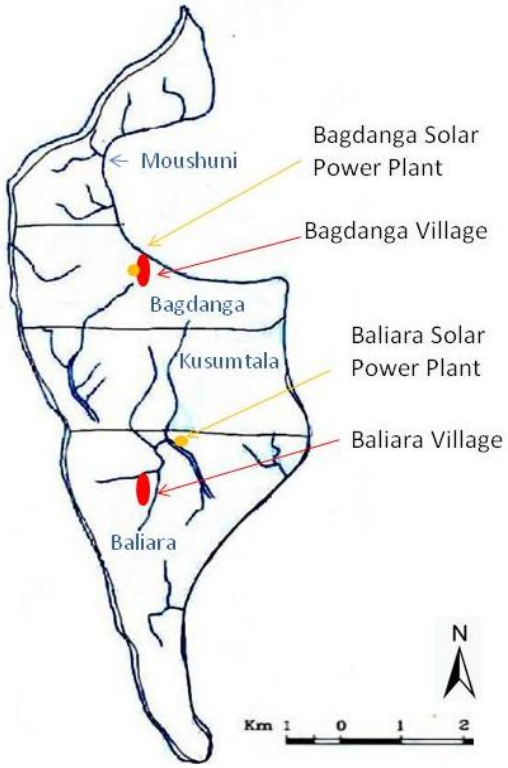
This is how the Bengali author Amitav Gosh introduces the Sunderban Islands in his book "the Hungry Tide." His words give the reader a sense of the hardship the inhabitants faced and still face as they struggle for their vital existence, and with the same stroke of pen he grants the reader's mind with beautiful images of an astonishing and mysterious place. The Sunderban, whose name means "beautiful forest", is a part of the largest river delta in the world, formed by the Ganges, Meghna and Brahmaputra rivers that converge in the Bengal basin, located in both Bangladesh and India. The Indian part consists of 54 islands crisscrossed by countless branches of Ganges and covers over 9630 sq. km. 70 % of the area on the Indian side is under saline water, this makes life for the 4 million inhabitants very difficult (TERI 2009).

One of the islands of the Sunderban is Moushuni, where the fieldwork for this thesis was carried out. To reach Moushuni one must take a two hours long boat ride from the port Kakdweep, which is a four hours bus ride north of Kolkata. The boat is crowded with people, chickens, cows, vegetables and other merchandise the islanders need in their everyday life, as it is the only connection to the mainland. This chapter is dedicated to giving the necessary background information about the island, its respected people and the two solar power plants on it.

Moushuni Island

Moushuni Island is located in western Sunderbans and consists of four mouzas (administrative districts); Moushuni, Bagdanga, Kusumtala, and Baliara. The Moushuni Gram Panchayat (local self government) is constituted by these four mouzas, and the Gram Panchayat is a part of Namkana development Block. According to the local Panchayat there are about 24 000 people on the island. There is one higher secondary school, one secondary school, several private coaching centers for students, four health centers and one hospital that is not in use. There are good cell phone facilities on the island, especially after a telecom base station was installed in 2008.

Map 1: Showing Moushuni Island (circled in red). Source: Google earth and www.naturalearthdata.com. Details added by author.



Map 2: Moushuni Island with the four Mouzas (Moushuni, Bagdanga, Kusumtala, and Baliara), the villages of Baliara and Bagdanga and the two power plants. Source: West Bengal Renewable Energy Department. Details added by author.

The first settlers to Moushuni came in the early 1900's from Midnapur, after the government of West Bengal changed the land leasing policy from only leasing exclusively to Zamindars (hereditary land owners) to also leasing to Ryots (peasant cultivators). People came due to land shortage and peasants were given 3.3 acres of land each, which they leased cheaply, directly from the government (Danda 2007). Today the population consists of about 60 % Hindus, 35 % Muslims and 5 % Santals (Ulsrud et al. forthcoming). The islanders have made impressive interventions to the landscape in order to make the island livable. An embankment made of brick or mud rises 6 meters above sea level and surrounds the island. This is a must for protecting themselves from damaging floods that destroys property, harvests and the soil with its saline water and powerful currents. The embankment was the responsibility of the Zamindars before the Zamindar system was abolished in 1951. Afterwards it became public property. Today there are big challenges with maintaining the embankment, and it is broken in several spots, something which worsens the consequences of flooding. People blame the government for its poor condition. The roads on the island are also elevated and some stretches rise several meters above the surrounding plains, and have deep ditches on each side. The roads function as barricades that stop the flood water. During a flood is it common that people cooperate to put extra mud on the embankment and roads in order to stop the water. When I was there, I saw areas where the fields on one side of the road were destroyed due to saline floods, while the other side of the road was saved and blooming as the saline water was stopped by the road structure.

Mud houses are the most common type of dwelling; however, some of the more wealthy households have built brick houses. Every house has at least one pond next to it, where they keep fish and use the water for washing clothes, dishes and taking baths.

Picture 1: Islanders relaxing on the road on top of the embankment. Picture 2: A normal house in Moushuni with a dug out pond and an elevated road leading to the house. Photo: Ragnhild Vognild

Agriculture is the main economic activity on Moushuni. People cultivate rice during the monsoon season from June to October and some grow vegetables during winter from November to February. The large fish boats in the area employ men, while women and children from poorer families often collect shrimp and small fry from the beach that they sell. Labor migration to Arab countries seems to be a rather new source of income which especially young and healthy men are engaged in. I interviewed several young men that had worked for a year in Dubai, and who were waiting to go back to work more. There are markets in both Bagdanga and Baliara, the two largest villages on the island. They have market days twice a week, in addition to shops being open every day and evening. There are also several producers of betel leaf on the island. They grow the leaf in fragile sheds and harvest the leaf before they pack them with flavor and sell them on the market for chewing. Betel leaf can be compared to chewing tobacco, and is common on Moushuni, especially among the males.

West Bengal has a unique political history. The left front coalition, with the Communist Party of Indian Marxists (CPM) in the leading position, has been the longest lasting democratically elected communist coalition in the world. They typically represent farmers, rather than workers. There are, however, political changes emerging as the All India Trinamool Congress party is expected emerge victorious in the 2011 elections. West Bengal decentralized political power to already existing local and traditional Panchayat boards in 1978, 13 years before the Indian central government did the same. The CPM had the power in Moushuni Gram Panchayat up until 2003, when the Trinamool Congress received most votes in the local election. The Tirnamool Congress also won the election in the Panchayat Samiti (the Panchayat at Block Level) in 2008. People on the island are generally very political engaged, something I noticed during my interviews, and several informants also said that the people in West Bengal were known for being politically involved.

Life on Moushuni is hard and people have been and still are poor. According to one of my informants, Moushuni suffered from a food crisis in the 50's and 60's. At that time, people grew one crop a year and were indebted and hungry. They borrowed money during the rainy season to buy seeds and agricultural artifacts, which they paid back after harvest. Development was decentralized in 1978, leaving the Panchayat in charge of much of the development processes on the island. In 1978 they started giving seeds and fertilizers at a subsidized rate so that the farmers could start double cropping. This action increased the living standards on Moushuni. 16 km of brick road was built on the island in 1984. This was

regarded as the first sign of modernity by the islanders and it made it much easier for the islanders to move around on the island, especially during monsoon.

The energy situation and the solar power supply on Moushuni

There are two decentralized solar power plants on Moushuni Island that distribute electricity through local electricity grids, also called solar mini grids. These solar power plants give electricity to people that otherwise would have been left without. One problem with this technological system is the limitations when it comes to the numbers of hours it can manage to supply and the number of customers it can serve. The two power plants on Moushuni supply 600 customers only for optimally 6 hours each evening. Some people also get electricity from a few other sources such as diesel generators that are used on the markets and in private households and from solar home systems (SHS). In addition, the islanders rely on a wide range of other energy sources such as kerosene and candles for lighting and firewood, cow-dung for cooking and dry cell batteries for the radio and torches. The usage and combination of different energy sources seems to be a constantly changing constellation. The islanders use the energy sources that are available for the least amount of money at the moment of need.

West Bengal Renewable Energy Development Agency (WBREDA) is the initiator and owners of most of the decentralized solar activity in the Sunderbans. They started their solar energy engagement in the region in 1993, and have since started 17 power plants in the Sunderban Islands. They own and still have the overall responsibility for the operation and maintenance of the plants. WBREDA has been a pioneer when it comes to solar power in the region. They have also learnt many lessons from their projects. These projects were initiated as electrification and development projects. Moushuni is located far away from the national power grid and was not expected to get connected to it in a long time and was therefore an ideal location for such projects. There are two power plants on Moushuni located in the two biggest villages on the Island, Bagdanga and Baliera.

The Gram Panchayat at Moushuni Island had heard about the solar power plants on the neighboring Sagar Island and contacted WBREDA to ask if they would be interested in building solar power plants on Moushuni. The Gram Panchayat provided the land, and WBREDA engaged two companies, Ashim Mandal and Taporn Gish, to construct and maintain the power plants and power lines. The funding came mostly from the national government. The gram Panchayat and potential customers put together the Beneficiary

Committee (BC), which was intended to protect the interests of the customer, be a link between the customers and WBREDA, and appoint the person responsible for collecting tariffs. There is one BC for the two power plants on Moushuni. The actual power and role of the BC since the power plants started has been less than intended. During the shift of the political party in power in 2003, a new BC had to be elected. This never happened, according to the Gram Panchayat, and the BC has not been functioning since. This has had consequences for other areas related to the power plant system and creates dysfunctions such as late and corrupt money collection and the theft of electricity by customers and unconnected households. Even though WBREDA is the owner and initiator of the power plants, there are many actors onboard to handle customer care, money collection, deliverance of technical equipment etc. Here is a figure showing the different actors involved and their relationship to each other, which shows this complex system.

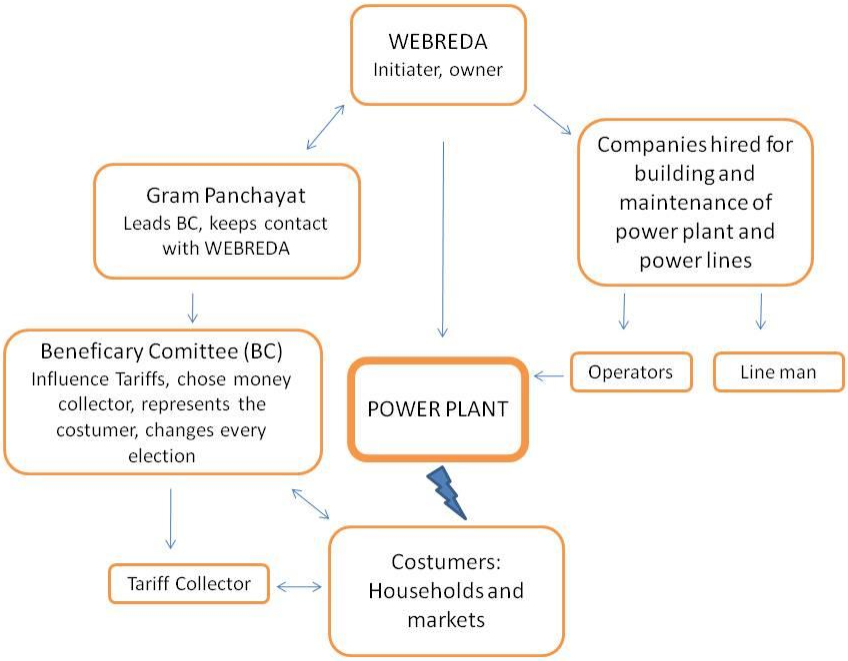


Figure 1: The different actors involved in the power plants on Moushuni Island.

The Bagdanga power plant opened in 2001 and has a capacity of 55 kWh and serves 300 customers. The Baliara power plant, on the other hand, opened in 2003, has a capacity of 110 kWh and serves 283 customers. The two power plants supply electricity to both the market and households. Optimally they deliver electricity every evening for five hours, from 6 pm to 11 pm. The connected households either bought a 3 point connection for 1000 Indian Rupees (INR) (123 Norwegian Kroner (NOK)) or a 5 point connection for 1500 INR (184 NOK), and the monthly fee is respectively 80 INR (10 NOK) and 125 INR (15 NOK). The connected

inhabitants on the island were very excited when they first received electricity. There are restrictions as to how the electricity can be used; only lights, fans and black and white TVs are allowed. One of my informants described the first day with electricity: "We thought that a dream was true when the electricity came. The children were running and they were so happy" (HI 7).

The power plants have been working for many years, however, both plants have experienced problems with supply recently, and none of them were actually working during my fieldwork. According to the customers the supply had decreased steadily at Bagdanga, while it was shut down suddenly at Baliara. There were several reasons for the problem at Bagdanga, one of them being poor battery maintenance which was caused when distilled water was not being delivered to the batteries. In 2008, 120 out of 240 batteries were replaced; however, the output of the power plant continued to decrease before it reached a full stop the 15th of May 2010. Baliara had other challenges; there, the battery was working well because the power plant had a much higher capacity compared to the Bagdanga power plant, however, the inverter was overloaded. According to one of my informants, the power plant was supposed to run on an 8 kWh electricity demand; however, the actual amount consumed was 32 kWh. Customers using more electricity than they were allowed to and illegal connection to the grid by unregistered households caused the rise in consumption. This shows that electricity was popular on the island and people wanted to use more electricity than the solar power plants could supply. WBREDA is now working to develop a new operation and ownership model of the power plants, hoping that it will take care of the challenges they have had with the existing model. An informant, an elderly man, reflects about the loss of electricity during the last months: "When we started to use electricity the happy time started. We cannot return to the dark times now. It is very difficult. I have some problem with eyesight, so for me it is extra important with light" (HI 9).

Since this thesis studies the effects of local solar power supply for climate adaptation, I first believed that the dysfunction of the power plants during my fieldwork would make it very challenging for me to get the data I needed. Fortunately, this did not turn out to be the case. As the power slowly had disappeared, many of the people I interviewed appreciated the electricity even more than they had before as they were encountering new challenges since it had disappeared. The situation made it easier for them to distinguish the impact electricity had on their lives. One challenge, however, was that it was difficult for me to observe electricity usage, as the households were left only with kerosene as the night emerged.

3. Conceptual framework

The purpose of this chapter is to present the theoretical fundaments that this thesis builds upon. The main research question; "*Which role, if any, does electricity from the local solar power plants play for climate adaptation, through handling the direct impacts of climatic challenges, reducing the climate vulnerability and/or increasing adaptive capacity for households, businesses and the community, on Moushuni Island?"* is complex and several different theoretical directions can be applied when analyzing this question. Three theoretical directions have been selected to constitute the conceptual framework, since I find them complimentary so that they can work together as tools for analyzing different aspects of the research question. The three theoretical fields of literature are the climate adaptation literature, energy and development literature and literature on socio-technical change. Combining material from these three theoretical realms is challenging since there are many differences between them, but also important as they all contribute with different aspects to the analysis.

First, the climate adaptation literature will be presented. Different theories and frameworks on how to approach climate adaptation will be presented and discussed. Based on this discussion, three aspects seen as central in climate adaptation are presented in depth, these are; climate risk, vulnerability and adaptive capacity. An understanding of these three aspects will be used in order to understand how decentralized solar power supply can influence different aspects of climate adaptation.

The second field of literature is the energy and development literature, which recognizes and analyzes the role of energy access for development and poverty reduction. This literature has poverty and electricity as central issues and contributes with insights into how electricity can influence people's life, especially for the poor. This is useful not only for analyzing the role of energy for development, but also the role of energy for climate adaptation in rural areas in developing countries.

The third field of literature integrated in the theoretical framework is about socio-technical systems and change. This literature presents processes that happen in the interaction between human beings and technology and how new technological systems develops. The literature adds to the understanding of how people use and relate to technology and might thereby contribute to the understanding of how, why and for what purposes people use solar energy

supply for climate adaptation measures. The inclusion of this perspective assures that important processes directly tied to the human technology interaction are given significant space in the analysis.

In this chapter these three directions of literature is explored and presented. They are also seen in relation to each other and at the end of this chapter it is explained how these three theoretical directions are applied together in the analysis.

Climate adaptation

Adaptation as an academic concept was for a long time associated with Darwin's theories of evolution and natural selection. The term was just occasionally used in relation to climate change and environmental risk. The Intergovernmental Negotiating Committee working on the draft of the United Nations Framework Convention on Climate Change (UNFCCC) started to use the word adaptation in 1992. In the Convention text agreed upon in Rio the same year two categories of responses were established, mitigation and adaptation (Schipper & Burton 2009). Mitigation was for long the main emphasis of international and national climate policy. It was first after IPCC's 3'rd assessment report in 2001, which highlighted that climate gas emissions continued to rise and impacts actually were occurring already, that adaptation gained more attention in the policy discussions (Huq & Reid 2004). Adaptation in the context of human dimensions of climate change can be defined as "a process, action or outcome in a system (household, community group, sector, region or country) in order for the system to better cope with, manage or adjust to some changing conditions, stress, hazard, risk or opportunity" (Smith & Wandel 2006: 282).

Adaptation can be nuanced by distinguishing adaptation to climate change and adaptation to climate variability. Climate change refers to human induced changes in the climate and climate variability refers to climatic changes that occur naturally, such as seasons and variations in the weather. Distinguishing between these two characteristics is seen as important when dealing with funding from the UNFCCC for example, as they only support the human induced climate change adaptation measures (Huq & Reid 2004). Others, however, include naturally occurring climate variability and associated extreme events as an integral part of climate change and therefore see adaptation to climate change to include adaptation to climate variability as well (Smith & Wandel 2006). I agree with the latter, and see no point in differentiating in this thesis between climate challenges experienced due to naturally

occurring climate variability and human induced climate change, because I regard climatic challenges as severe for the people exposed, independent of what caused the challenge.

Adaptation is a term that is understood differently by different practitioners, this is visible in the variety of climate adaptation measures that has been conducted, and they do not only focus on the risk posed by climate change. McGray (et al. 2007) has identified a continuum of ways in which climate adaptation has been addressed by different actors globally by studying and categorizing projects that were called climate adaptation projects. He placed all adaptation measures on a continuum where the impact- and vulnerability approach represent the two extremes. The impact approach includes measures that reduce the risk posed by climate change, such as reducing risk of floods from glaciers by draining water. While the vulnerability approach deals with the processes that makes the community vulnerable in the first place and considers any action which decreases the vulnerability of a community as an adaptation measure, such as better access to markets or building health clinics. Between these two extremes he identified adaptation measures aimed at building response capacity, such as reforestation, and measures aimed at managing climate risk, as integrating climate data into planting decisions among farmers. McGray's (2007) work shows that there are great differences in how climate adaptation is understood, what climate adaptation measures can address and how they can be carried out.

Eriksen and O'Brien (2007) have created a climate adaptation framework that was developed in order to identify measures that target both climate adaptation and poverty reduction simultaneously, something which is beyond the scope of my thesis. There are, however, some key elements from their framework that I find very relevant for understanding adaptation and analyzing adaptation measures. They identified three types of targets for adaptation measures; these are 1) reducing climate risk, 2) addressing the processes leading to climate vulnerability and 3) strengthen adaptive capacity. Any measure that addresses any of these three targets can be considered adaptation measures. For my analysis, it could be useful to see how access to electricity supply in Moushuni Island has contributed to climate adaptation by either reducing climate risk, addressing the processes leading to climate vulnerability or strengthening the adaptive capacity.

The approaches of McGray (2007) and Eriksen and O'Brien (2007) have much in common, as both are based on a wide understanding of adaptation to include more than just measures addressing climate risk. Both approaches can be useful for analyzing how decentralized solar energy supply can influence climate adaptation, because they both provide a systematic

approach for a rather challenging analytical task. I have decided, however, to use Eriksen and O'Brien's framework as a backbone for the further exploration of climate adaptation literature and the later analysis. This is because I find their threefold approach a little easier to apply than McGray's continuum. The threefold approach can be criticized for being rigid and leaving out important aspects of adaptation that a continuum would include, however, I find each of the three types of adaptation measures in Eriksen and O'Brien's framework to be quite wide categories themselves, embracing the aspects of adaptation that I wish to include without becoming too extensive.

I will here present the three aspects of Eriksen and O'Brien's (2007) framework, climate risk, vulnerability and adaptive capacity. At the same time as elaborating on their framework these central terms in the climate adaptation literature are also discussed including insights from McGray and other climate adaptation researchers.

Climate risk

Climate risk has been defined as "any added risk to current ways of securing well-being resulting from climate change" (Eriksen & O'Brien 2007: 340). Climate risk is related to the direct physical impact of climate variability and change on individuals and communities, through the exposure to stress and crisis as a result of climatic challenges, as storms and drought (Eriksen et al. 2005). Other examples are changes in rainfall, increased tropical cyclone activity and instability of winds. These are challenges as they threaten infrastructure, property, health and lives (Ulsrud et al. 2008).

Perception of danger posed by climate risk is important to understand when looking for ways to reduce impacts from climatic challenges. One way to categorize perception of danger is by dividing it in two, external and internal definitions of danger. An external perception of dangerous climate change includes scientific risk analysis conducted by "experts," while an internal perception is the social and individual perception of danger, by the people experiencing it and feeling the insecurity and lack of safety that is a part of danger. It is argued to be impossible to develop sustainable responses to climate change based on knowledge about the external perception of danger only; a robust response must include both the external and internal perception of danger (Dessai et al. 2003).

Reduction of climate risk has been the common way to think and do adaptation in the past. Common measures in the attempt of combating climate risk are early warning systems for cyclones, embankments to avoid flood and irrigation facilities. These are measures that

address the climate risk directly (McGray et al. 2007). Studies have found, however, that climate adaptation must go beyond measures to reduce the biophysical impacts and climate risk, and consider the context that influence vulnerability as well (Eriksen and O'Brien 2007). This leads to presentation of the second target of adaptation measures in this adaptation framework.

Vulnerability

The second dimension of climate adaptation is vulnerability reduction. Vulnerability can be defined as "the social and ecological contextual conditions that result in inability to cope or secure well-being in the face of climate variability and change" (Eriksen et al. 2007: 14). Vulnerability can be generated by several processes and factors, such as "social relations of resource access, political and economic marginalization, loss of employment opportunities, and weakening social networks" (Eriksen et al. 2007: 14). The consequences of climatic challenges are influenced by the vulnerability of the people affected and the vulnerability context is closely related to environmental, social and economic possesses (Eriksen 2007). Examples of processes or factors leading to vulnerability to climatic challenges can be lack of alternative income-generating activities, poor health facilities and lack of sufficient infrastructure.

Climate risk reduction and vulnerability reduction is often treated separately in different forums. Measures aimed at reducing the impacts of climate change have been addresses more frequently than measures to reduce vulnerability, which are often excluded from climate adaptation projects. There has also been a limited focus on the local capacity to adapt and the processes leading to vulnerability in research and policy (Eriksen & O'Brien 2007, Schipper 2007). However, it is argued that vulnerability reduction should be fundamental in adaptation strategies, since social transformations that reduce the vulnerability of a society, such as flexible livelihoods, increased diversification of livelihood, service infrastructure and land reform, can contribute to climate adaptation (Eriksen et al. 2007).

Climate vulnerability can be seen in relation to scale. Agder (1999) distinguishes between two aspects of social vulnerability which he identifies as individual and collective vulnerability, depending on scale and unit of analysis. Agder defines the two scales as the following:

> "Individual vulnerability is determined by access to resources and the diversity of income sources, as well as social status of individuals or collective households within a community. Collective vulnerability of a nation, region or community is determined by institutional and market structures, such as the prevalence of informal and formal social security and insurance and by infrastructure and income" (Agder 1999: 252).

To discover processes that cause both the individual and collective vulnerability will be necessary when carrying out an analysis of the vulnerability of a social unit. In addition it is important to include the factor of time, because a measure which reduces vulnerability in the short term might not reduce it in the long term (Eriksen et al. 2007). Vulnerability is dynamic and changes over time.

Poverty and vulnerability are often found similar; however, they are not the same. Not all poor people are vulnerable and not all vulnerable people are poor. And the vulnerable people are not vulnerable in the same way, because they differ in their social and political relations, degree and type of exposure to climate stress and livelihood strategies (Eriksen et al. 2007). A common generalization is that women are more vulnerable to climate change than men. In the Indian Government's National Action Plan on Climate Change (NAPCC) women are referred to specifically as it is believed that they are more vulnerable. NAPCC state that:

> "The impact of climate change could prove particularly severe for women. With climate change there would be increasing scarcity of water, reduction in yields of forest biomass, and increased risk to human health with children, women and the elderly in a household becoming the most vulnerable" (Government of India: 14).[1]

Jonson (2011) claims that this feminization of climate vulnerability and the female focus in adaptive measures is a generalization that silences contextual differences and excludes insights into the configuration of social relations of power in particular contexts. This is similar to the arguments used by Eriksen et al. (2007) and Agder (1999) regarding how vulnerability differs across scale and time, and the importance of considering context. I believe it is important to avoid the automatic assumptions of poor or women being more vulnerable than others. Simultaneously, however, I see nothing wrong with following NPCCC recommendations by giving women special attention when studying the vulnerability situation, as long as it is not on the expense of the contextual understanding. To automatically assume that women are more vulnerable would be unfruitful.

Adaptive Capacity

The third dimension of adaptation included in this framework is increased adaptive capacity. It is defined as "the particular strengths of the poor people for coping or adapting in the face of climate stress" (Eriksen & O'Brien 2007: 340). Adaptive capacity refers to the ability a system has to adapt and can be found by studying what people do in order to cope with and manage the climatic challenges they are exposed to. Adaptive capacity is related to resources that people both have within themselves such as skills and knowledge and resources they have

[1] http://pmindia.nic.in/Pg01-52.pdf available April 2011

access to, "including poor people's access to resources, power, information, education, technology, social networks and insurance" (Ulsrud et al. 2008: 6).

Adaptive capacity is context specific and varies over time. All societies hold the ability to adapt and adjust to climate stress, but the ability can be unequally distributed across and within societies and countries (Eriksen et al. 2007). Factors that influence adaptive capacity at the local level can be access to financial, technological and information resources, political influence, cultural conditions as kinship ties and infrastructure. Some of the these factors are mainly local, such as kinship ties and the ability and experience a society has in coping with existing climate variation and extremes (Smith & Wandel 2006, Eriksen & O'Brien 2007). Others factor reflect more general political and socioeconomic conditions that influence the local adaptive capacity (Smith & Wandel 2006). An understanding of the scale of adaptive capacity is fluid:

> "The scales of adaptive capacity are not independent or separate: the capacity of a household to cope with climate risks depends on some degree on the enabling environment of the community, and the adaptive capacity of the community is reflective of the resources and processes of the region" (Smith & Wandel 2006: 287).

In order to carry out adaptive measures that strengthens the already existing adaptive capacity of a unit of interest, it is necessary to understand the already existing coping strategies that people do in order to secure their basic needs already.

Summing up

Climate adaptation is a concept which is understood and practiced in a range of ways. I have in this section operationalized climate adaptation by recognizing three central aspects that I have presented in depth; climate risk, vulnerability and adaptive capacity. Measures aimed at reducing climate risk, reducing climate vulnerability or increasing adaptive capacity can all be considered climate adaptation measures. These aspects will be central when analyzing the role of decentralized solar energy supply for climate adaptation. In order to better conduct the analysis, it is necessary to explore the literature that presents electricity's impact on society. Such insights are found in the next literature realm included in this thesis, the literature on poverty, energy and development.

Poverty, energy and development

The poverty, energy and development literature revolves around how energy supply influences people, more precisely on how changes caused by energy supply can contribute to development and poverty reduction, especially in rural areas. This literature with its theories

and empirical insights from research, can contribute with perspectives that will be valuable when analyzing how a little electricity supply can influenced climate adaptation. This is because, as shown above, climate adaptation includes aspects of life which are not directly climate related, but more related to societal factors in general, such as vulnerability and adaptive capacity, factors that have commonalities with poverty and development.

This field of literature is full of controversy. The question of what comes first, development or electricity, is an issue which has brought much debate through the last decades. In order to understand the current theories on energy for development I find it necessary to include some of the history of this field.

History of electricity and development

From the 60s to the 70s power lines into rural areas were seen as synonymous to providing the essential infrastructure for boosting rural development (Barnes 1986). The power lines were built over-dimensioned in order to have capacity for the expected industrialization and development that would follow (Hirschman 1970 in Kirubi et al. 2009). A reliable energy source in rural areas would lead to the expansion of rural industries and the quality of rural products would improve. In the long run, it was expected that modern energy service would provide indirect social benefits, such as equity and improved quality of life. It was soon found, however, that important contextual geographical attributes were overlooked, such as sparse population, long distances, difficult terrain, and poor purchasing power, which lead to big loss of electricity. The expected increased demand for electricity did not follow the power supply in rural areas either, and the expected socio-economic benefits were slow in materializing, if materialized at all (Barnes 1986).

The agricultural sector has been the main receiver of rural electricity in electrification programs in India in the late 70's, and it was especially the usage of electric pump-sets for irrigation electricity was used for. Electricity had an impact on well irrigation, but little effect on total levels of irrigation (Barnes 1986). India experienced growth in their agricultural sector in the 60s and 70s, mostly due to intensifying agricultural practice by increased inputs of fertilizers, hybrid seeds and water. The current status of the pump-sets, both electric and diesel, are poor, as they draw much more electricity or fuel compared to the amount of water derived (Reidhead 2001).

Foley (1992) claims that rural electrification does not cause development, and thereby represent a new turn in the debate. He claims that "electricity is a derived demand occurring

only when an area has reached a certain economic development" (Foley 1992: 1). He does, however, recognize the role of rural electrification for long term rural development. It is rather the timing and level of resources which should be committed to it one should question. Spending many resources on electrification for people who haven't even requested it, should be avoided, he says. It is more difficult in cases where people do want electricity, but live far off, sparsely populated in rural areas and have no money to pay for it.

A common denominator for these differing opinions about electricity and rural development is that development is measured in increased agricultural gain and income. This traditional way of measuring the electricity impact excludes other effects electricity can cause for education, women's empowerment and health, for example. These kinds of perspectives are found in more current understandings of electricity and development.

Current understanding on electricity and development

Current thinking on energy understands electricity to have mainly two purposes for rural development; these are the residential and productive use. The productive use is supposed to result in better rural productivity, economic growth, rise in employment and reduce migration of the rural poor and the residential use is considered to improve quality of life and/or rural living standards (Cabraal et al. 2005).

New ways to look at productive use of energy have emerged due to the increasing emphasis on education, gender and health for development. Cabraal et al. (2005) argues for a need to broaden the definition of productive use of energy to get a better understanding of how energy is related to development and he especially sees an urgent need to examine the linkages between energy and women's empowerment, education of children and adults, health and income generation. The traditional view where productive use of energy excludes electrification of households has a strong gender bias. Agriculture and cultivation is usually regarded as male domains, while the household is regarded the female domain.

This broad understanding of productive use of energy requires a wide understanding of poverty reduction and development. Since 2000 several researchers have sought to understand the development value of rural electrification through multi-dimensional development frameworks, which have linked electricity access with poverty reduction and broad development goals (Cabraal et al. 2005, Cecelski 2005). The Millennium Development Goals of the United Nations (UN) is one such framework that is widely accepted for measuring development progress. The Millennium Goals that are adopted by the UN seek to get rid of

poverty and hunger; achieve universal primary education; promote gender equality; empower women; reduce childhood mortality; improve maternal health; combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability; and develop a global partnership for development.[2]

Cabraal (2005) has collected empirical data from many energy research projects to show how access to energy can contribute to reaching the Millennium Development Goals. He found evidence on electricity's positive impact on rural nonfarm businesses and education due to light and improved health through better indoor air quality and better facilities at health clinics. Women watching television are found to have greater knowledge of gender issues than women who do not. Carbraal's main point is that one must expand the understanding of productive use of energy to include not only income generating activities, but also any use of energy that contributes to health, education and gender equity.

Cecelski (2005) has compared several studies statistically in order to find correlations between electrification, gender and empowerment. She found that increases in energy access in low income countries were related to increases in gender related development, which is being monitored by the UN Gender-related Development Index. She did not, however, find any correlation between energy and the UN Gender Empowerment Measure. Legal, social and policy frameworks are most likely more important in changing gender relationships and promoting empowerment, rather than electricity. A case study from rural Afghanistan found that the presence of solar energy increased the women's mobility within the village after dark and gave new opportunities for women to meet in empowering settings, as socializing with other women in networks and reconnecting with extended family networks. The presence of the light even gave some women the opportunity to participate in the women's sura (local council) (Standal 2008). The case study implies that electricity can bring development in gender empowerment, even though it is not statistically evident overall.

Another link between rural electrification and development is that a sound rural electricity access is recognized as a modern facility that can attract teachers, doctors and other educated people and increase the quality of health clinics and service. Electricity has also resulted in better health improving the indoor air quality when kerosene is replaced with electric light and by giving the opportunity to use new and better instruments at health facilities (Cabraal 2005).

[2] http://www.un.org/millenniumgoals/bkgd.shtml available April 2011

In current thinking of electricity and development electricity has regained its position as an important factor contributing to development, but this time it with a broad understanding of development including many other factors that economic development only, such as health, education, gender and empowerment. A secure and adequate energy supply is again viewed as a factor which is required to ensure economic growth, socio-economic development and to help improve the standard of living of the people (Chakrabarti & Chakrabarti 2000) Deprivation of energy in rural areas is considered one of the reasons for weak human health, ecosystem degradation and rural underdevelopment (Venema 2007).

The traditional and current theories are mostly developed by studying 24 hour conventional electricity supply in rural areas, and is not based on decentralized renewable energy solutions with more limited supply of electricity. There are significant differences between these two ways of supplying electricity. Still, I believe that analyzing the impacts of decentralized solar power supply will benefit from these theoretical and empirical insights from previous research. This might be useful with regards to mapping out and analyzing climate vulnerability and existing adaptive capacity, as these aspects of climate adaptation have much in common with poverty reduction and development. Solar energy is a new technology on the market. In order to understand more of the consequences of dealing with a new technology is it relevant to move over to the next theoretical realm.

Socio-technical systems literature

The two bulks of theory presented above give a fundament that can help understand the role of decentralized electricity access for people's situation and climate adaptation. It is one aspect, however, which I believe should be given some more attention, and that is theory on the relationship between humans and technology and the complexity of technology and the system around it. These insights can be found in the literature about socio-technical systems.

Socio-technological systems

When technology is viewed to include device, skills and organizational structures they are thought of as a system (Volti 1992). A socio-technological system consists of many elements, as technology, regulation, user practices, markets, cultural meaning, infrastructure, maintenance- and supply networks (Geels et al. 2004). In line with this, Rohracher (2008) identifies energy systems as:

> "socio-technical configurations where technologies, institutional arrangements (e.g. regulation, norms), social practices and actor constellations (such as user-producer relations and interactions, intermediary organizations, public authorities) mutually depend on each other and

> are embedded into broader contexts of cultural values, socio-economic trends (globalization, individualization, etc.)" (Rohracher (2008: 147).

It is obvious that a technology such as solar power supply system involves much more than just the solar cells, as it also includes many societal aspects. The artifacts by themselves have no power and do nothing (Geels 2004).

Solar power supply technology represents a relatively new and not very well established socio-technical system. Many challenges can arise during the development of such a system because "radical technologies often have long development times and require for their operation special skills, infrastructure and all kinds of institutional changes (organizational changes, regulation, new ideas and values etc)" (Kemp 1994: 1023). Changing from traditional energy supplies such as biomass and kerosene to solar power can be regarded as such a socio-technical system change. This can be challenging because "a shift towards a different energy system involves not only different energy sources and energy supply technology but also changes in science, education, manufacturing, transport and consumption patterns" (Kemp 1994: 1042). Successful introduction of energy technology can also be dependent on- and require requires changes in factors such as culture, values and daily routines etc (Winther 2005).

The role of the human actor

Theory shows that very many aspects of society and life needs to be changed in order for a new technological innovation to become mainstreamed. It is a time consuming process. I also find it necessary to highlight the role of human actors on the different levels which is a key to success. Technology which might seem "self-evident" is not successful automatically, but relies upon local users' motivation and ability to maintain and apply it correctly. At an intermediate level, actors must through decisions and actions ensure that the technology is appropriate to the context and must build the human capital necessary at the local level. At a global level the policy decisions shape the political and economic environment relevant to the technology (Ley & Corsair 2008). Decentralized solar power is no exception. The human actors involved in the implementation and maintenance of the system as well as customers are important in order for the system to work optimally. If the operator of a solar power plant lacks the knowledge of maintaining the batteries or the customers use more electricity than allowed, the technology will degrade faster than necessary (Ulsrud et al. forthcoming).

Having an understanding of the complexity of technological changes is useful for understanding the processes of interaction between humans and technology during the

introduction and development of solar energy on Moushuni Island. These insights may be useful when analyzing if and how usage of solar energy is influencing climate adaptation.

Building the conceptual framework for this study

In this chapter I have presented three different realms of literature that are useful for my later analysis of how decentralized solar energy has influenced climate adaptation on Moushuni. It is now time to see how these three realms can be combined in order to create my own theoretical framework.

The first and most important literature bulk is the climate adaptation literature. I elaborated on three central aspects of adaptation; climate risk, vulnerability and adaptive capacity, in order to present the complexity of climate adaptation as a term and to show the range in types of measures that a climate adaptation measure can be. These three aspects will be central when analyzing the way in which people are affected by climatic challenges on Moushuni Island. It is necessary to understand what the climate risk on the island is, what the processes and factors causing vulnerability are and what the islander's adaptive capacity consists of. Eriksen and O'Brien's (2007) framework is central for this part of the analysis, however, the other perspectives presented are also important and will be applied.

The report "More than Rain" by Ulsrud et al. (2008) applies the three aspects of climate adaptation in a similar way as I will attempt at to use it. The report is influenced by Eriksen and O'Brien's framework and explores whether development projects initiated by the Norwegian Development Fund can be considered adaptation measures. In the report they identified the climate risk, factors and processes leading to vulnerability and the adaptive capacity of three different villages in Nepal, Ethiopia and Nicaragua. Then they investigated if the development projects of the Development Fund had made any impacts at any of these three aspects. Their approach studied the effects of development projects, while my approach studies the effects of decentralized renewable energy supply for climate adaptation.

The fact that I am investigating the effects of a solar energy project, made me incorporate the second theoretical realm into my framework, the poverty, energy and development literature. This provides good insights into how electricity affects people and societies. The theory and empirical evidences from this literature will be useful when analyzing how people use electricity and how the little electricity supply has influenced their lives. This theory will also be applied when I explore if and how electricity has influenced the climate risk, the factors and processes causing vulnerability and the adaptive capacity.

The last theory realm, of socio-technical systems gives tools for understanding both the challenges with developing and introducing new technology and how people relate to new technology. This will be applied in the coming analysis when insights are needed into how and why people use electricity in the ways they do.

I have created a simple model to illustrate the relationship between my conceptual framework and analysis shown in figure 2 below. The arrow going from solar power supply to Household/Community illustrates that the energy supply influences the community. Theory from the socio-technical literature and energy, poverty and development literature can be useful for understanding this process. The next arrow going from the household/community box to the climate adaptation box indicates that people and community are adapting to climatic challenges that they meet, and climate adaptation literature and energy, poverty and development literature can help to understand this process. The long fragmented arrow is the main relationship that I am aiming at exploring; if solar power supply can contribute to climate adaptation through being used by the households and community.

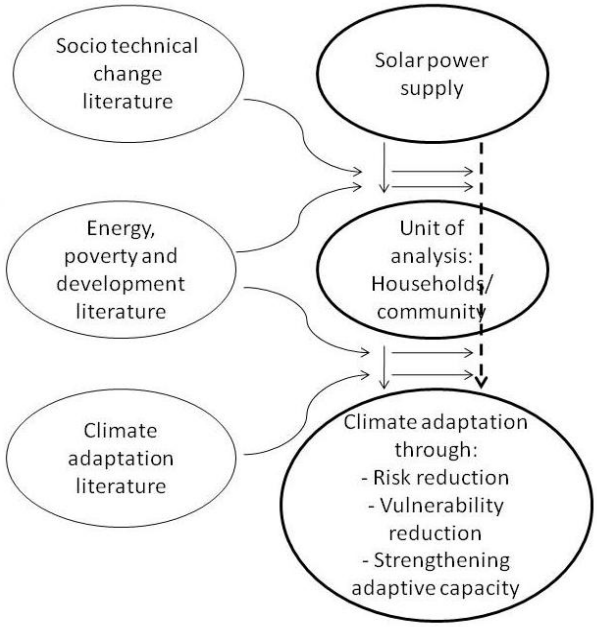


Figure 2: Showing the relationship between the theoretical framework and analysis.

By integrating the three theoretical directions in this manner I hope to have created a conceptual framework that will be useful for guiding me when analyzing my main research question, regarding if and how decentralized solar power supply has influenced climate adaptation on Moushuni Island. This conceptual framework might also be useful for other contexts than Moushuni Island, where the topic being studied is the influence of technological measures on climate adaptation.

4. Method: A qualitative case study

The process of doing research is by no means linear and the researcher must manage to work simultaneously with the different stages of the research process (Thagaard 2009). Nevertheless, I have decided to structure this thesis's method chapter in a rather chronological way, beginning with the methodological background and decisions taken prior for the fieldwork. I then continue with presenting my experiences with being in the field and discuss issues such as choosing informants, using a translator and being a Norwegian girl alone on a small rural island in India. Towards the end the analysis done after fieldwork will be accounted for together with ethical aspects of the research process and the transferability of the research. The methodological choices are described in detail in order to pursue high reliability and validity of the results of this thesis. It is therefore necessary to elaborate on these concepts before presenting the rest of the chapter.

Reliability and validity

In order to ensure good quality of the research it is important to consider reliability and validity. Reliability is an important criterion in social research as it is tied to whether the research is conducted in a credible and trustful manner (Thagaard 2009). The researcher can argue for reliability with detailed descriptions of research strategy and method of analysis. Making the research process transparent is one way to strengthen the reliability (Silverman 2006 in Thagaard 2009). One common way to measure reliability is by the replication potential of the research. A well described research process is easier to replicate later to find similar results. In social research, however, the setting, researcher, informant and the relationship between them influences the outcome of the data, and replication can therefore be both more difficult and a less important criterion. Throughout this chapter I have aimed at explaining my methodological and analytical strategy and choices in order to increase the reliability of this research. I believe I have done this to such a degree that other researchers can conduct similar research and receive similar data and conclusions.

Validity is tied to the legitimacy of the interpretations the researcher has reached. Validity can be emphasized by questioning if the interpretations are valid in relation to the reality the researcher has studied (Thagaard 2009). This means that the researcher has to go critically through the fundament of her own interpretations and share this with the readers, in addition to giving qualified justifications for the conclusions in the research. Validity can be strengthened by showing how different interpretations can be less relevant (Thagaard 2009).

Another way to strengthen validity are by assuring that the informants that are interviewed actually can provide data material that is relevant for what the researcher wants to investigate. The power relationship between the researcher and the informants and how the informants perceive the researcher can influence that data material. Throughout the chapter I will comment and reflect upon the precautions I have taken in order to strengthen the validity of this research.

Deciding on a qualitative case study approach

When planning research, the researcher must decide how data should be gathered and which data is most relevant (Thagaard 2009). I will here explain why I ended up choosing a qualitative case study approach as the methodological strategy for this thesis.

Qualitative vs. Quantitative method

It is common to make a distinction between two methodological directions, qualitative and quantitative. These two directions have much in common, as they both are methods for social research aiming to construct representations of social life through scientific approaches. They vary, however, as they are based on different research logic (Thagaard 2009). This results in dissimilarity in the strengths of two different methodological directions and differences in how they are conducted in practice. I will here explain how these differences have influenced my choice of methodological strategy for my thesis.

There are several practical differences on the qualitative and quantitative approach. Firstly, the quantitative approach stresses extensiveness and numbers and draws results from a large selection of informants aiming for statistical generalizations. The qualitative methods, on the other hand, aim for analytical descriptions through in-depth understanding and emphasize meaning based on much information drawn from a few informants (Thagaard 2009). This creates differences in the kind of knowledge created. One of the main goals of this master thesis is to achieve an in-depth understanding of how decentralized solar energy is affecting climate adaptation for people on Moushuni. The meaning of solar power for these people's lives is a central issue, and I believe that this information best can be uncovered with a qualitative research approach and in-depth understanding.

Second, there are differences in methods for data collection. Quantitative method tends to have a strong structure that is likely not to be changed during the research period, and survey is an important tool for quantitative social research (Thagaard 2009). There are many ways to achieve an in-depth understanding of a phenomenon in the qualitative approach. Well-known

tools are in-depth interviews, observation, fieldwork and ethnographic study. Common to these methods are they can be changed during the research process and therefore are flexible. Since I had little knowledge about the case before I started, a flexible research structure was preferable. The tools of in-depth interviews and fieldwork give room to follow up on new unforeseen topics as they arise during the interview situation. I experienced this several times, and a flexible method gave me the opportunity to explore the unforeseen.

A third distinction between the two research methods is the closeness to the informants. Quantitative research is known to have larger distance between the researcher and informants. Most methods within qualitative research, on the other hand, are based on a subject-subject relationship between the informant and researcher (Thagaard 2009). The data I aimed to gather included information about how people on Moushuni relate to climate challenges, how they use electricity and how electricity access has influenced their opportunities and efforts to adapt to climatic challenges. These are issues that can be discovered through in-depth interviews and fieldwork, as the tools give room to reveal the uniqueness of each informant's story and life.

When choosing a methodological approach it is essential to choose the method that best answers your research question (Thagaard 2009). It is therefore important to highlight the differences in the interpreting opportunities within the two methodological approaches. The data collected by quantitative methods are limited and uniform which gives an opportunity for more precise interpretations of whom, when and where. Qualitative methods, identified by the attributes mentioned above, are especially well suited to answering questions about how and why (Yin 1994). The latter, the answer to the how and why questions, is more important for this thesis as I am interested in whether and how solar energy influences climate adaptation.

The differences in qualitative and quantitative approaches can, however, be more nuanced than presented above. For example text and document analysis can be subject to qualitative research, where the distance between the researcher and informant is large. It is also, as mentioned, possible to do qualitative interpretations of quantitative data and vice versa (Grønmo 2004). Despite the differences not being absolute, a qualitative approach gives more room for complex information in a broad sense, with an attention to meaning and closeness to the informants. It seemed like a natural choice for me to select a method with flexibility and one that gave me the chance to get close to people in order to understand their complex situation, rather than a method that aims for generality and quantification.

Applying the case study approach

Doing a case study is a common strategy when conducting research via both qualitative and quantitative methods. A common understanding is that a case study is research on a empirically limited unit, as a group or an organization where the phenomenon is being studied in its natural environment and the research is based on several sources of data (Thagaard 2009). The empirically limited unit is not always easy to distinguish, as it might be problematic to see when the phenomena or activity started and to identify the geographical borders of a case. If a village is the case, for example, might it be difficult to say where the village ends. A case study is a good "method of choice when the phenomenon under study is not readily distinguishable from its context (Yin 2003: 4)." The research question is an indicator of whether a case study should be applied or not. If you need to know "how" or "why" through your research question and you are focusing on contemporary events, then case study and fieldwork can be a good option (Yin 1994). In this study, climate adaptation is understood in relation to social and biophysical processes. There is no absolute distinction between the phenomenon and its relations and the context in which it occurs. A case study approach is justified as it aims to investigate the phenomenon under study in its own context. Case studies are usually very intensive studies that include a large amount of information about the unit that is being studied (Grønmo 2004).

Case studies can be divided into different types and two of these types are the intrinsic and instrumental case studies (Stake 1995). Intrinsic cases are studied due to the special interest in the case itself. Instrumental cases have a supportive role for the understanding of something else, such as giving insights into a certain issue or to generate some kind of generalizations. It is also possible to have a mix of these two case types. I see my case as an instrumental case, a case which is examined mainly to provide insight into an issue or to draw a generalization. The case facilitates the understanding of something else, and is therefore secondary. I aim to say something about how renewable decentralized solar power can influence climate adaptation. The communities at Moushuni Island and its decentralized solar power plants are, however, also a case with some intrinsic value as it has a unique setting and context that is very interesting on its own as well.

The significance for theory for case studies is disagreed upon in the literature. Stake (1995) argues that in studies which focus on describing a case and the issues tied to it, theory can be absent. Yin (1994), on the other hand, highlights the role theory can have for guiding the case

study in an exploratory way. In my case, theory has been applied and has been very helpful for guiding my case study in an exploratory direction.

Approaching Moushuni Island, the location and case

The process of finding a location for this thesis started long before my research question was decided upon. Having studied climate change for my bachelor's degree and having been a climate change activist for years, one of my motivations of doing a master's in the first place was to focus on solutions to the problem of climate change. The Solar Transitions Project at the Department of Sociology and Human Geography at the University of Oslo became an entrance point to investigating the opportunities of solar power supply in a climate vulnerability context. The Solar Transition Project aims study the transfer of technology and knowledge of solar energy in poor remote villages from India to Kenya. The Project has already gathered much knowledge on the social and technical aspects of solar power supply on Moushuni and Sagar Islands in the Sunderbans in West Bengal, India and established contacts with knowledgeable and experienced people on the topic both in India and Kenya. I got involved with the Project early in my master's program as a project assistant, and through the Project I gathered much information about the Indian experience of decentralized solar power. As my interest for the solar power supply grew, I decided to investigate one or more of the villages that the Project already had located for this thesis. Being a master's student with limited resources of both time and money, I felt it was not only convenient but also necessary to use the contacts that were already established through the Solar Transitions Project as a start when I approached the field. This gave me a good opportunity to use more time on planning the details of my research, instead of dealing with establishing the first contact.

I had two criteria for selection of location and case; these were 1) the area should have had a local solar power plant for at least five years so that the people would have had time to live with and experience life with electricity and 2) the area should be prone to climatic challenges such as floods, cyclones and/or droughts on a regular basis. There are 17 villages with solar power plants in this area of the Sunderbans and 14 of the power plants are more than 5 years old. All of them are located in areas that regularly experience climatic challenges. Two of them are on Moushuni Island while many of the others are on the bigger Sagar Island.

There are many reasons I decided to pick Moushuni as the location for my research. There are two solar power plants on Moushuni built before 2005. Moushuni was one of the islands that were the most affected by the extremely strong cyclone Aila, which hit the Sunderbans on the 25th of May 2009. This meant that people had the cyclone fresh in mind and this could

therefore be used as an entry point in order to understand how electricity had affected climate adaptation on the island. Choosing Moushuni over Sagar Island also had its practical benefits. I was offered accommodation in a guestroom in the Bagdanga Power Plant on Moushuni by WBREDA, the state agency for renewable energy. The available accommodation options on Sagar Island were guest houses located far away from the nearest power plants. Choosing Sagar would have made me dependent on a car, something which would have increased the expenses and time spent on getting to the informants. Moushuni was a good choice not only as it suited my criteria well, but it was also practically easier for me to conduct my fieldwork there.

I defined my case as the Bagdanga and Baliara villages, which constitute the area surrounding the two power plants on Moushuni Island. The bigger body of relevant cases, from which I picked my case, is villages with decentralized solar power plants around the world. I limited my body of cases by excluding all villages with non solar renewable energy projects, as a decentralized solar power plant has some attributes that are technology specific, which one will not find in small hydro power or bio energy installations, for example. Most areas experience some form of climatic challenges, but maybe less severe than the case of Moushuni. I therefore found this area especially relevant in order to study linkages between access to solar energy supply and the ways in which the village deals with climatic challenges. Such cases exist in other countries than India as well, but India and especially the Sunderbans in West Bengal was ahead of most other communities in the solar energy field.

The unit of analysis is the social unit or the element in society that the study is based on (Grønmo 2004). According to Yin (1994), defining the unit of analysis is a sometimes frustrating and difficult exercise. The unit of analysis is closely linked to the research question and I wanted to investigate how the solar power supply systems have influenced people's ways of handling climatic conditions in their everyday lives. To investigate this, I had to interview the people living with electricity under harsh climatic conditions. My unit of analysis is therefore the individuals constituting the communities in the villages where the solar power supply is available, in Bagdanga and Baliara on Moushuni Island.

The fieldwork

The fieldwork of this thesis was mainly conducted on Moushuni Island in the Sunderbans in India during two periods from the 28th of May to 1st of June and the 7th to 20th of June 2010. I spent one month in West Bengal, from the 24th of May to the 24th of June, and the time off

Moushuni Island was spent in Kolkata and on Sagar Island planning the fieldwork and carrying out some background interviews. Three people were essential for my work during the stay on the island: the WBREDA official who arranged accommodation for me on Moushuni Island and gave me all the information I wanted from him; the local line operator who assisted me with all practical needs that occurred during my stay, from food and water, to rehydration salts; and last, but not least, my translator, who was the only English-speaking person on the island in addition to myself and was thus essential for the interviews. The data was gathered mainly through qualitative interviews, which is the leading method within qualitative inquiry (Thagaard 2009). Considerations regarding the choice of informants, conduction of interviews, using a translator and other aspects about being in the field will be described in this section.

Choosing informants

Qualitative studies are based on strategic selection of informants. This means that the researcher picks informants who possess certain attributes and qualifications that are strategic in terms of the research questions and theoretical perspectives of the research (Thagaard 2009). There are different ways of conducting strategic selection. Some examples are theoretical sampling, where informants are selected in order to develop new theory or develop new terms and perspectives, and convenience sample, where the informants are selected because they have the wanted qualities and are available for the researcher. A third way to select informants is through quota sampling, where different categories that should be represented in the sample are defined beforehand and people are elected to fit any of these categories in order to assure a width in the sample (Thagaard 2009). I decided to use a quota sampling in order to aim for a range of types of people among my informants and diversity in the responses. Choosing the right informants is important for the validity of the research, as the informants are the main source of data and it is important that they actually can provide the perspectives and information that is needed in order to address the research question. I believed that a diversified sample would give me a comprehensive understanding of the situation regarding climate adaptation f and electricity on the island. Before fieldwork, I decided to interview three groups: background informants, businesses and households. I chose these groups in order to assure that I interviewed people that both lived with electricity supply in their homes or business and who were experiencing climatic challenges. If I only spoke to government persons or solar energy experts, I would miss out on important inside information of these people's reality, something which would weaken the validity of my research.

Background interview informants

The first group consisted of people with special knowledge regarding the power plants and Moushuni Island, such as members of the local Panchayat, school teachers, health workers and power plant operators. These were interviewed mainly in order to get the necessary background information about the place and power supply systems. A few of these interviews, such as the one with the WBREDA official and Panchayat members, were planned beforehand through phone or a personal meeting. The other informants in this group were approached when I met them and asked if they were available for an interview. Some were available and others asked me to come back later. The background interviews were necessary in order to understand the electricity supply system and the adaptation efforts of the people in the face of climatic challenges on the island. I experienced, however, that some information was difficult to get. I was promised maps, consensus data and other information from the Panchayat, and I went to their office many times in order to get the promised data. When I visited the office on the last day, they said they could not give it to me because it was locked inside a closet. This was frustrating; however, I believe that I received enough data from my sources in order to draw a good picture of Moushuni Island and the power plants.

Household informants

My main group of informants consisted of households because they represent the people living with electricity supply in their homes and can therefore give good insights into how this has influenced their lives. I wanted to interview households that were connected to the power plant, in addition to a few households that had no connection. I also wished to talk to both poorer and richer households in order to register possible nuances in how electricity has influenced their lives depending on economic status. The type of house served as an indicator for household wealth. There are few brick houses on Moushuni and they are more expensive to build and therefore owned by wealthier people than the more common mud houses. I assured that households from both house types were represented in my sample. I also wished to interview both women and men. I had several ideas about how to approach the households. Scheduling interviews for later in their home or in another space that could work as my "office," were two of the options. However, I tried the easiest method first, by approaching the houses that fitted to my category and asking if I could interview the people there. People were mostly friendly and had time to participate. I experienced that people had time to talk to me and welcomed me into their homes or businesses. The interviews lasted from 30 minutes to almost 2 hours. The average length was a little bit longer than an hour. The setting made

them feel comfortable and relaxed in the interview situation and it also gave me the opportunity to observe their daily activities.

The local line man, who arranged for my stay, joined me and my translator for the first interview. He picked out the first house that we approached... Afterwards, however, I told him that I had to choose the households in the future, to avoid a bias in my sample to only include his friends for example. This was not a problem, and from then onwards I selected all the households I interviewed based my informant categories.

Business informants

Before going to Moushuni, I heard that electricity use supposedly had led to changes to the market in Bagdanga and Baliara. In order to explore this I decided to include some of the market's business owners in my sample. I aimed at interviewing different types of business owners and my final sample included, among others, a tea shop owner, two tailors, a hairdresser, and a jeweler. I approached the business owners by visiting them while their business was open and asking for an interview. Some had time; other asked me to come back later. The interviews were in general shorter than the household interviews and lasted from 20 minutes to an hour, because the business informants got busy with a customer or other work. In retrospect I see that I could have created better interview settings for the market interviews so that the interviews could have lasted longer and been victim to less interruption. However, both mine and the businessmen's time limits made this difficult. Despite this, the short interviews resulted in valuable information on how the solar power supply had changed the market areas and the ways of doing business, how climate challenges had influenced their businesses and how electricity had influenced the business owners' opportunities to adapt to these climatic challenges.

Deciding to conduct group interviews

During most of my interviews, family members, neighbors and friends gathered around when the interview took place. This is a part of the culture, with joint families and little privacy. I did not ask to be in privacy with the main person I interviewed, as it would have been regarded as rude. Electricity and climatic challenges were obviously something of great interest to everybody, and I experienced that the surrounding family members, neighbors and friends often came with useful additional information. I did try, however, to talk directly to the person I first approached. If it was a woman, I experienced on a few occasions that they

fell quiet when the male head of the house was in the room. This was not the case all the time, as most of the women found no problem with talking when there were other people around.

Because of the experiences from my interviews, I decided to arrange for a group interview with women only, hoping that a new interview setting would reveal new information. The flexibility of the qualitative approach allowed this change to be made to my research plan without problems. A group interview is an interview where a group of people discusses different issues and the researcher leads the discussion (Thagaard 2009). The group interviews were arranged with help from the local Panchayat. They put me in contact with two local self-help groups of women that I interviewed separately. Problems that can occur in these interview settings are that the most dominating people dominate the interviews, and the others might be reluctant to disagree. To avoid this, it is an idea to have a group with participants that regard themselves as equals (Thagaard 2009). The self-help groups consisted of women who knew each other well and were in similar situations. Even though a few women did most of the talking in my group interviews, the others participated with shorter comments and nodding. I found these interviews to be very valuable, as the women gave new insights to the research topic. I also conducted two more ad-hoc group interviews with a group of women by the roadside in Baliara and with a group of men at the Baliara market.

Limitations to the body of informants

Originally I planned to interview people that lived and worked in both the villages that had solar power supply, in order to get a greater variety of data on electricity and climate adaptation. I started my interviews in Bagdanga village, the village in which I also had my accommodation. I spent the whole first period there, and the beginning of my second stay. By the time I got ready to go to Baliara village, the rainy season stood on the doorstep. I managed to go there for only two days, as the rain and muddy roads made it very difficult and time consuming to travel the few kilometers from Bagdanga to Baliara. Due to this, I decided to stay in Bagdanga to do my interviews there. The three household interviews and the two ad hoc group interviews I conducted in Baliara are still included in my data material for my analysis as both the electricity supply and climatic situation in the two villages are very similar and the data from Baliara brought interesting aspects to my research.

The sample

In the end, my sample consisted of 37 interviews, spread over the categories showed in table 1 below. My sample includes 10 background interviews (BI), 9 market interviews (MI), 4 group

interviews (GI) and 15 household interviews (HI). The sex of the informant is written in brackets in the table, W equals woman and M equals man. The type of house of the household informants is either mud or brick, and the different electricity connections are either 3 or 5 electrical outlets from the power plant, private SHS or no electricity at all. The interview was conducted in Bagdanga if nothing else is written.

Background Interviews (BI)	Market Interviews (MI)	Group Interviews (GI)	Household interviews (HI)	House type	Power supply
Panchayat Group Interview (M&W) (BI1)	Jeweler (M) (MI 1)	Group by roadside(W) Baliara (GI 1)	Household 1 (W)	Mud	3 points
Panchayat member (M) (BI 2)	Tea stall (W) (MI 2)	Self help group 1(W) (GI 2)	Household 2 (M&W)	Mud	No el
Power Plant Operator(M) (BI 3)	Taylor 1 (M) (MI 3)	Self help group 2(W) (GI 3)	Household 3 (M)	Mud	3 points
Diesel Generator Owner(M) (BI 4)	Hairdresser (M) (MI 4)	Market group (M) (GI 4)	Household 4(M&W)	Brick	3 points
Health Supervisor (M) (BI 5)	Taylor 2 (M) (MI 5)		Household 5(M&W) Baliara	Mud	3 points
Employee at Sagar Rural Hospital (M) (BI 6)	Retail shop (M) (MI 6)		Household 6 (W) Baliara	Mud	3 points
WEBREDA officer (M) (BI 7)	Fish sale (M) (MI 7)		Household 7(M) Baliara	Mud	3 points
Schoolteacher in Bagdanga (M) (BI 8)	Sari craft 1(W) (MI 8)		Household 8 (M)	Brick	5 points
Political leader (M) (BI 9)	Sari craft 2 (W) (MI 9)		Household 9 (M)	Mud	No el
WWF official (M) (BI 10)			Household 10 (M)	Brick	3 points
			Household 11 (M)	Mud	SHLS
			Household 12 (W)	Mud	3 points
			Household 13 (M)	Mud	3 points
			Household 14 (M)	Mud	3 points
			Household 15 (M&W)	Mud	No el
10 background interviews	9 market interviews	4 group interviews	15 household interviews	12 mud 3 brick	11 con 3 no el 1 SHLS

Table 1: Showing the sample of informants from the three categories; background interviews, market interviews and household interviews.

Being a researcher for the first time was scary, interesting and fun. In retrospect I can see, however, that I carried out more interviews than necessary as the saturation point was reached before the fieldwork was over. However, since I was so new in the game, I was worried about not getting enough information. This turned my fieldwork into one of the hardest working periods of my life, in addition to a period with a steep learning curve.

The interviews and the interview situations

The interviews I conducted to gather my data were semi structured, meaning that I used an interview guide with a partially structured approach (Thagaard 2009). The different themes to

be discussed in the interviews were decided beforehand, but the order was decided during the interviews. The two most important topics in my interview guides were regarding electricity usage and climate adaptation and challenges. I had formulated questions beforehand where I avoided using academic words such as climate adaptation and vulnerability, but rather asked what the informants experienced as challenging weather conditions and what they did to prepare before the last cyclone etc. Extreme types of weather were a topic that people were eager to talk about, but it was also a topic that reminded them of bad memories and difficult times. I consciously ended my interviews talking about an emotionally neutral or positive topic, such as what they found good about life on Moushuni. This gave the interviews a comfortable dramaturgic composition, both for the informant and me. I found myself using the interview guide less and less, as I quickly learned to remember the topics I wanted to cover and I found it easier to get a good flow in the interview when I did not look down on the paper. It was also fruitful to be open for talking about things that were not on my list, and customize the interviews depending on the informant. Flexibility is important to tie the questions to each informants qualifications (Thagaard 2009). The flexible structure increased the validity of the information I gathered, as I had the opportunity to dig deep into the unforeseen topics that emerge which I understood as revealing information that was very relevant for my research.

A digital recorder was used in all of my interviews, in order to limit the possibilities of losing information. I always asked if the informant was comfortable with the recorder, and it was not a problem in all but one of the interviews. That one I did not record. The recorder was usually placed on the "bed," a high wooden table with blankets that all houses had and we usually sat on during the interviews, and I did not touch it during the interviews. As long as I did not give the recorder any attention, it seemed like they forgot about it as the conversation became more engaging. I also wrote notes during the interview. One could argue that taking notes would make me less participatory in the interview as I would be busy writing. However, I found that I had time to do this, as using a translator leaves time between every question and answer where I could write my notes.

Factors such as status, race, gender and behavior influence how the researcher is perceived by the informants and the power relation between the informant and the researcher (Scheyvens et al. 2003). Both perception and power relations can influence the data gathered, it is therefore important to reflect upon these issues in order to strengthen the validity of the data (Thagaard 2009). My experience of being a young white woman on Moushuni was quite unproblematic.

I felt respectfully treated by the people I interviewed and I aimed at behaving in a way that made them feel respected too. I took conscious choices about how I dressed, avoiding over exposing arms and legs and at times using a shawl over my hair. I also started the interviews myself, by asking my informants their name in Bengali. "Apnar nam ki" means "what is your name", and I asking this question in Bengali created some laughter and a relaxed atmosphere. I respected their "rest time" during the day and was always humble and expressed my thankfulness for their participation in my research. In the interview situation I avoided mentioning the word "poor" and I also made sure to ask about the good aspects of life on Moushuni. Focusing only on poverty and challenges can reinforce feelings of low self esteem and be stigmatizing for the informant in the interview situation, something which again can influence the information given (Scheyvens et al. 2003). During the interviews I always looked interested in what the informants were saying and I believe this made them feel like that they had valuable and interesting information to share, something that they also had. By taking these precautions the informants felt comfortable, something that could have reduce the power imbalance between me and my informants. I believe I managed to receive confidential responses from my informants, both men and women.

Most of my informants knew what a researcher was, as researchers had been on the island before doing research on solar power supply and climate change. One of my informants had a slightly negative view of researchers. One of the more outspoken and engaged women I interviewed confronted me during one of my group interviews: "So many researchers come here, only to ask questions and go. We are in the same situation. We depend on our fortune" (GI 1). I could do nothing but tell her that participation was voluntarily and that I had nothing to give my informants. This incident influenced me quite a bit, and I figured out a way that I could give a little bit back to the people that shared their precious insights and time with me. During the remaining fieldwork, I always asked after their interview was over if my informants had any questions for me. I quickly learnt that they were very curious about Europe and Norway, and especially the midnight sun that they had learned about at school and how we lived our family lives. This resulted in many good conversations and I think the informants really appreciated getting answers to the questions they were so curious about. This incident was one of several ethical dilemmas that emerged during my fieldwork, and one of those I manage to find a solution too. Other ethical dilemmas will be presented towards the end of this chapter.

Since I lived in the village during two periods, I also saw my informants during the time when I was not doing interviews. This made my appearance at all times important. When I first stepped onto the island and the first days that followed, people stared at me, naturally, as I was a stranger on the island. I always smiled back, and this usually made the islanders face change expression from a serious and curious stare to a big smile. This "smiling strategy" paid off, as one of the women I interviewed said that she saw me smile to her a few days before. This created a very good and relaxing atmosphere for the interview that followed. As mentioned, Moushuni is a place where people are very politically engaged. The islanders noticed which political figures I spoke with. I interviewed the local leader of the party in opposition, the CPM. He also invited me to a conversation in the office building of the party, where he asked me questions about Norway and where we discussed differences and similarities with our two countries and cultures. I did not know that it was the party office before my translator told me afterwards, as the office consisted of a house with one room only, with a high wood bed. It is only in retrospect that I see that this could have affected my relationship to the Panchayat and the reliability of my data. However, I felt that my relationship with the Panchayat remained rather unaffected by my meetings with the Marxist leader.

Distinguishing whether people tell their own opinion or rather what they think the interviewer wants to hear is a common problem in qualitative interviews. The interviewer can approach this challenge by having an open mind in the interview situation and aim at not letting their values affect the informant (Thagaard 2009). I attempted this in order to limit the influence of my values on the informants' answers. I felt that this worked and that people gave me their honest opinions, as my informants gave both positive and negative stories about their experience of the solar energy and climatic situation on the island. I noticed, however, that the few higher educated people that I spoke with quickly started to talk about human-induced climate change in academic terms when we were talking about climatic challenges experienced on the island. This happened without me bringing it up. I felt this was a result of them believing that I had an interest in climate change, as other researchers have been there talking about climate change before me. It was not necessarily something I did or said which revealed my values regarding climate change, but rather a pre-perception they had of me because I was a researcher. This incident did not influence my data negatively, as it was interesting for me to hear their opinions about climate change; however, it made me aware that others also might have adjusted their answers based on their perceptions of me as a

researcher. I took all the precautions I could in regard to assuring the validity of my data by reducing my influence over what was said in the interview situations, reducing the power relation and making them feel comfortable. There could have been, however, some elements that were outside of my control, such as their opinions about how to act and what to say to researchers.

The power line maintenance man, who was my important local helper during my fieldwork, accompanied me and my translator for some of the interviews. At first I thought that this could make people hold information back, because he has a position connected to solar energy on the island. However, this did not seem to be an issue, and having him there was helpful. He was a popular man in the community, with good humor, and he introduced my translator and I in a way that made people feel comfortable. I had to tell him, more than once, to be quiet during the interview, as he a few times started talking when he became engaged in the topics we were discussing. But I do not consider this a problem either, as he always listened to me and fell quiet after the few times I reminded him about it. He was not present in the majority of the interviews.

The time of the year fieldwork is carried out can significantly influence the fieldwork and the data collected (Hesselberg 2011). The period I spent in the field was during their summer vacation, a time when little work needed to be done on the agricultural land. This surely increased people's ability to participate in my interviews. The islanders took some rest during the hottest time of the day, between 12 pm and 4 pm. I quickly adjusted to this and conducted my interviews from 8 a.m. to noon, and 4 to 7 p.m. The afternoon rest was also necessary for my wellbeing, because I was not able to do much at all when it exceeded 40 degrees Celsius and the humidity wrapped itself around my body. I usually relaxed on my bed and either slept or typed on my computer during mid day. I noticed a great shift in the rhythm of the people when the monsoon started. People became very busy with plowing and other agricultural work. People had less time to talk to me and the activity in the market declined. I still continued my fieldwork, but it was more challenging to get long interviews.

Using a translator

Using a translator gives a researcher the opportunity to talk to people whom otherwise would be impossible to interview, this makes the translator an essential part of the data gathering. Bengali is the language spoken on Moushuni and very few of the islanders spoke English. This left me in need of a translator. I got in touch with Krishna, a young man who previously had been working for the Solar Transition Project. He agreed to work for me and stay with me

on the island as long as I wanted. Before we started, we discussed a few essential issues regarding the translation situation, such as the importance of me leading the interviews and asking the questions and him only translating what the informants said. Krishna has translated a few times before, and it was my first time ever using a translator. It was great working with Krishna, and we worked very well together as a team; however, we also stumbled upon a few challenges that we had to solve during the time we worked together.

When using a translator, the appearance, gender and status of the translator are equally important to that of the researcher. I was worried that women would hesitate to talk in his presence because he was a man. However, I did not experience problems. Krishna was very gentle and kind in his appearance and managed to establish a good tone with informants of both genders and with people with different status. There was, however, one issue that became problematic. Krishna was a busy man, and his cell phone often rang during the interviews. He usually rejected the call, but the ring and his reaching for his pocket created an unnatural stop in the conversation. At first I did not say anything; however, it escalated when he actually picked up the phone in the middle of one interview and walked outside to talk for several minutes. The informant and I sat waiting, without being able to communicate, and I could see that she was getting impatient and I felt very uncomfortable. After this episode I had to explain to him that I found his behavior rude, as the informant was kind to give us a part of their valuable time with nothing in return. Krishna appreciated this little pep talk, and said that he never regarded it as rude to take the phone before, but now he understood my perception. He kept his phone switched off during the interviews after this episode.

Krishna quickly understood what kind of information I was looking for. There were moments when he asked a follow up question without me having asked it first. In general I did not like this, which I told him. However, during a period when the heat was extra bad in addition to me having the famous "Delhi-belly" (stomach problems), his tendency to actively ask questions was of help, as I was struggling to hold myself together. Once I discovered, however, that he added words to the translation that the informant did not say. We were discussing the reasons for diarrhea after floods and cyclones with one informant. By that time I had picked up a few Bengali words, one of them was "jal" which means water. As the informant talked about the reasons for diarrhea, I did not hear him use the word "jal." But Krishna said, in his translation to me, that they mentioned food and water contamination for reason to diarrhea. I confronted him on the spot and asked if they really said water. And he said they didn't. He explained to me afterwards that he often found it frustrating to ask

questions that he, as a local, knew the answer to. It added to the frustration that I sometimes didn't understand their answer and asked them to elaborate. In moments like this he sometimes used his own words to explain to me the issue we were discussing. I told him that no matter what, he had to translate directly, and that his prior knowledge was not important in the interview setting. And if he, by any means, wanted to say something of his own opinion during the interview, it was very important that he made this clear to me. Krishna understood this immediately, and this was not an issue again. But this made me realize that the frustrations that emerge during translation are at times felt by both the translator and the researcher.

Using a translator was both the key to talking with people I otherwise never could have interviewed and one of the limitations to this study. I experienced that the information exchanged during a two-hour interview is much less when using a translator than when both the informant and researcher speak the same language. This was frustrating, and I believe that data got lost in this process, even though we both aimed at reducing the loss of data as much as we could. We both learned much from our work together, about the interview situation and about both using and being a translator. We reflected upon this as our time together came to an end. Krishna and I became good friends and developed a close relationship during the fieldwork. He filled many roles for me during the stay on Moushuni: he was my translator, he helped me with practical arrangements such as transport and accommodation, and he was a good interlocutor as he had much experience with solar energy in India and life in the Sunderbans. He also became a good friend to whom I complained about the heat, with whom I shared my joys—and he even helped me pump water from the well when I washed my hair.

Analyzing data – an issued centered analysis

The analysis of data starts the first day in the field. However, much of the analysis usually happens after the fieldwork is finished. I will in this section clarify my decisions on the strategy for analysis. I will also explain why I have chosen to present my data as I do.

Issue centered analysis

I had many pages of interview notes in addition to hours with sound files when the fieldwork was over. Every day while I was in the field, I had some hours off duty during mid day which I usually spent on my bed relaxing and typing the notes I took by hand during the interviews into my computer. I found my typed notes to be so rich on information that I considered it unnecessary to transcribe my interviews. I also had the sound files I could listen to if

something was unclear or I wanted to double check any information. Only a handful of interviews which I had not typed out during fieldwork were transcribed some time after I got back home.

The analysis is a result of a dialectic relationship between theory and my empirical data; this means that established theory is central for giving direction to the research and that the analysis of patterns in the data creates the base for theory development. It is important that the researcher is sensitive concerning important tendencies in the data material and that she ties the empirical data to theoretical perspectives. This process is referred to as abduction. Abduction is a combination of induction, where the theoretical perspective is developed based on the analysis of the data, and deduction, where the research is based on hypothesis from earlier theories (Thagaard 2009). The abduction process was present throughout my whole analysis process, as I constantly shifted between scrutinizing my data and seeing my data in light of the theory. I saw my theory in light of my data and the dialectic process influenced my theoretical framework. I also aimed at looking at my data without having the theory in mind, to avoid being limited by my conceptual framework. Due to this, I found some results that were not directly mentioned in theory I knew beforehand. All in all, however, I experienced my conceptual framework as an eye opener when analyzing my data towards the complex field of climate adaptation.

I decided to use an "issue-centered" analytical approach, as it was the issues people talked about that were of my interest. This involves comparing data from every informant about different issues, and this can give an in-depth understanding of each issue (Thagaard 2009). Data from my interviews were deconstructed and categorized depending on which issue the different pieces of the interviews concerned. The different issues, or categories, crystallized from my empirical data. However, the categories were also influenced by my prior theoretical and empirical knowledge about solar energy and climatic challenges. Examples of categories that I use are weather-related challenges on Moushuni, factors they felt made their lives more difficult and how they applied electricity, to mention some. The program Nvivo was applied during this categorization and coding process. The categorization process was very useful for me, as I got familiar with the different parts of data material that I had gathered and once it was categorized it was very easy for me to find the pieces of data that I needed during the analyzing and writing process.

A common critique to the issue-centered approach is that the data is taken out of its original context. Giving information about the informant and the context that the piece of information

is a part of is one way to keep the holistic perspective (Thagaard 2009). This is not always necessary since considering the context that an issue is a part of sometimes can be redundant. It is the researcher's choice to decide when a contextualization of the piece of information is necessary. I have given a detailed presentation of Moushuni Island in my background chapter. This gives the reader an idea of who the people on the island are and how they live. In addition I have, when necessary, given some information about each informant as I use citations in my analysis chapters.

Wishing for findings?

I have presented myself as a climate activist, engaged in renewable energy. Giving this information is important for the validity of this research, as the readers themselves can consider my interpretations based on this information (Thagaard 2009). There may be reason to believe that my positive attitude towards renewable energy has influenced the way I analyzed my data in such a manner that I see links between renewable energy supply and adaptation as stronger than they really are. However, I have throughout the whole analysis process been very aware of this and aimed at having a critical attitude towards my own findings. This critical attitude could even have influenced my result in the other direction, resulting in me doubting my own findings. I had people read through my analysis chapters in order to get an idea of how other people perceived my findings, and the feedback I got was that I seemed to present a balanced and modest picture of renewable energy's impact on climate adaptation. I also compared my findings to research done in other settings throughout my analysis chapter. It is necessary to reflect upon what my findings really show. I am aware of my data being influenced by myself, my informants and my translator in addition to the setting in which the information was generated, despite the fact that I have attempted to limit the possibility of influencing the data through conscious methodological decisions. The reader of this thesis must have this in mind.

Presentation of data

I have chosen to write my thesis in English because the thesis concerns topics, renewable energy and climate adaptation, that is of high interest internationally. By writing in English I manage to reach out to more people in the international audience that might be interested in my results. I have also received help and guidance from the participants in the international Solar Transitions Project. Writing my thesis in English makes my results available for them. Writing in English has also been a good learning exercise for me.

I decided to use a number of direct quotes from my informants in this thesis because it brings more life to the information I found during my fieldwork and into the presentation of my findings. This has problematic sides, because I have used a translator from Bengali to English and the quotes are influenced by my translator's interpretations and his vocabulary. They are also derived from my notes, something that means that I also have influenced the quotes. However, I feel that this is acceptable as long as the reader is informed about the problematic aspects of it.

Ethical dilemmas

There are ethical dilemmas tied to all stages of doing social research. During the first period when the research is planned and developed is it important to consider what types of implications the participation will have for the informants (Thagaard 2009). If it can be harmful in any way, is it important to reconsider the planned approach. I find my topic of study quite harmless; however, the information that people shared with me did at times include sensitive personal information, such as descriptions of economic situations and health conditions. I took ethical precautions throughout my fieldwork in order to protect the informant as much as I could. These are described below.

It is important that the researcher keeps the integrity of the informant throughout the interview and makes sure that the informant does not answer questions that he later would regret or that could hurt the informant (Thagaard 2009). I believe that my identity as a foreigner made it easier for me to conduct my fieldwork as people were curious about whom I was and this could have made them more interested to participate in interviews. I carried out the interviews in my informants' homes or businesses where they felt comfortable and in this way the interview situation turned out to happen on more equal premises. I was also conscious to keep a certain distance to my informants in order to avoid developing close relationships, as that again could create false expectations and openness which might be unfortunate for the informants (Thagaard 2009).

I made sure to stick to the principle of informed consent in order to make the participation as voluntarily as possible. This principle involves the informants receiving correct and understandable information about the research before they agree to participate, that they participate voluntarily and know that they can withdraw from the participation at any time (Thagaard 2009). My translator and I started every interview with giving the necessary information in order to receive an informed consent from the informant. It was, however,

difficult for me to understand if they had understood the principle of informed consent as the information was exchanged through a third person. Giving correct and understandable information about a qualitative research project is not as simple as the principle might imply. The flexibility attribute of qualitative inquiry is one reason for this, as the research questions and direction of the research might change during the fieldwork. At that time it can be impossible to find all the informants to inform them about these changes. For me it became problematic as I did not repeat the informed consent information when other family members or neighbors joined the interviews, which often happened as I conducted the interviews in people's homes. I still feel that I took the necessary precautions in order to fulfill the principle of informed consent.

Most topics that were discussed during my interviews were not of a sensitive character, and I felt that my informants were comfortable telling me what they did. One topic area, however, was met with unease. This was questions of a political nature that involved the organization and operation of the solar power plants. It was obvious that some of my informants had strong opinions about why the power plants were not being operated optimally. However, they would rather not talk about this. I decided not to push to get information about this issue, as it was not central for my analysis. My emphasis was on the way in which the available electricity was used by the villages and the linkages between this use of electricity and adaptation to climatic challenges.

I assured my informants that they all would be treated anonymously, which is another important principle in order to avoid unforeseen negative effects to the participants in the research. In the presentation of findings in this thesis, the informants are given codes, where HI stands for Household Interview, MI meaning market interview and BI meaning Background Interview, and numbers depending on the order they got interviewed during my fieldwork. I kept the category of interview visible as this can be interesting information for the reader, without revealing the identity of the informant.

Transferability

Transferability is connected to the understanding that what is developed within one project also can have relevance for other contexts (Thagaard 2009). In social science, "theoretical generalization" is a term which is used to discuss the transferability of the research. Theoretical generalization is based on the theoretical understanding of the social aspects that are being studied and has two important goals. These are to use the study to develop terms,

hypothesis and theories that from a theoretical reasoning is believed to be applicable for other entities. The other goal of theoretical generalization is to study certain entities and develop an understanding of the bigger group or context that the studied entities make up (Grønmo 2004). A case study often has a more general aim as it can have significance in other similar cases depending on the "perception and completeness with which the class of cases has been defined and the degree to which the case exemplifies the class" (George and Bennet 2005). I have attempted to give a good description of my case. It still entails risk to transfer findings to other cases as they might differ from the original case in unforeseen ways. However, sometimes the relevance a project has for other situations is unpredictable for the researcher as the readers are free to interpret and understand the research findings as they want and they can use them if they find it relevant for their projects.

The role of decentralized solar energy for climate adaptation has been analyzed in my thesis by studying how decentralized renewable energy has influenced risk posed by climatic challenges, vulnerability and adaptive capacity. There are communities experiencing similar climatic challenges as Moushuni with comparable energy options. I believe that my research can have value for these contexts, if not for direct application of my findings to their settings then for the theoretical generalizations that can be drawn from my research from the terms and understanding I have developed. My research can also be an inspiration and starting point for further studies. There is a growing focus and interest in both renewable energy and climate adaptation, and my attempt at combining these two topics and studying how the one influences the other might also be useful for other contexts.

Summing up

In this chapter I have presented the methodological decisions taken and method and analysis strategies applied in this thesis. A qualitative case study approach and an issue centered analysis were found as the best strategies in order to address my research questions. Ethical dilemmas tied to the research project and issues regarding transferability have been discussed. By openly and critically presenting how this data material has been gathered and analyzed I have manage to strengthen both the reliability and validity of this research.

5. Analysis part I: Climate risk, vulnerability and adaptive capacity on Moushuni Island

This is the first of two chapters that present and analyze the findings from this research. This chapter contains the empirical data and analysis of the situation on Moushuni regarding 1) existing climate challenges and the risk they pose to the inhabitants on the island, 2) the processes and factors which affect the vulnerability to climatic challenges and 3) existing adaptive capacity and strategies that people use in order to strengthen their ability to handle climatic challenges. These three dimensions of the current climate related situation are central to my three first introductory research questions, and they are derived from the adaptation framework by Eriksen and O'Brien (2007) and discussed in-depth in the theory chapter earlier in this thesis. According to the theoretical framework applied, adaptation measures can target one or more of these three dimensions of the climate related situation. Only when these three aspects of the situation of the people on Moushuni are understood is it possible to proceed with the analysis of how the decentralized solar energy supply has influenced any of these three dimensions or, in other words, how electricity may have influenced climate adaptation.

The current climatic challenges and the risk they impose on the people on Moushuni will be presented first, before moving on to the processes and factors leading to vulnerability. At last, the factors influencing the capacity to adapt to or handle climatic challenges will be accounted for. The information is based mainly on data gathered during fieldwork; in addition to some secondary data from other researchers, which has been carefully added. This section will naturally have few references to electricity; how electricity is used and the role of electricity supply in climate adaptation will be analyzed in the next chapter.

Climatic challenges and climate risk on Moushuni Island

This section address the first introductory research question: *What are the climatic challenges on Moushuni and which risk do they impose on the people?*

As explained in the theory chapter, climate risk is the risk caused by the direct impacts of different kinds of weather events, such as extreme heat or flood. Reducing the risk posed by climate change was identified by both Eriksen and O'Brien (2007) and McGray (2007) as one of several ways to carry out adaptation to climate variability and change. In order to reduce the risk, it is necessary to understand what kinds of risk the climatic challenges cause and how they influence people's lives. There are two ways to present the climate risk experienced in an

area: that of an "expert outsider" and that of an "insider" perspective. In order to develop good and sustainable solutions to the global problem of climate change and extreme weather events it is necessary to include the social and individual perception of danger and not only rely on outside expert opinions (Dessai et al. 2003).

In the analysis of the climate risk the inhabitants' perception is emphasized. Several of the interviews were started by talking about the weather and how the weather influenced the informants' lives. It is a subject most people have an opinion about. People can, however, become so used to their daily climatic reality that they do not mention stressful climatic events when asked for their opinion about local climatic challenges: they simply consider it as a normal part of their reality. One way to reduce the chances of missing out on climatic challenge on Moushuni was to gather information from external sources to become aware of typical climatic conditions in the area.

The different climate risks that the inhabitants of Moushuni Island are exposed to will now be presented together with the type of risk they cause for them. Both the insider and the outsider perspectives will be included. They will be presented in this order: flood, drought, cyclones and heat. The experienced climate change will be discussed towards the end, as it was brought up as a climatic concern by several of my informants.

Impacts of flood on Moushuni Island

The first things visitors notice when approaching Moushuni Island for the first time is the high embankment that encircles the island and the massive damages on both the embankment and the shore caused by erosion. This erosion stands as evidence of the immense force of the surrounding torrential waters; the tales of past floods and cyclones are imprinted into the land as holes and cracks in the embankment. For a visitor it becomes clear that the people of this island are highly influenced by the ocean and rivers which encircle them.

There are many reasons why Moushuni and the rest of Sunderban is flood prone. Experts have found that the area is created by silt and sand from upstream that falls and settles to the delta as they react with the salt water of the ocean. The low topography creates conditions for a strong backwater effect, and there are seasonal variations in the water, as fresh and brackish water dominate during the monsoon and saline water reaches further inland during the dry season (Agrawala et al. 2003). Salt water floods make the soil saline and can leave agricultural land uncultivable for long periods. According to the informants, at least one monsoon is needed in order to wash out enough salt in order to make the soil fertile again.

Researchers also believe that human interaction has worsened the impact of flooding in the region. The Fakharra dam was built in 1974 in West Bengal, in order to divert water to the region and make the Bhagirathi-Hooghly River navigable. This has created great changes in the hydrology of the water, for example by silt and sand being stopped by the Fakharra and other dams, making the flow of silt decrease. This has caused the flow of the river to increase during the monsoon and to decrease during the dry season. The changing hydrology has thereby made the salt water from the Bay of Bengal penetrate further inland from the sea during dry season which has caused more saline floods (Miraz 1998).

Outside experts project the risk for flood as severe based on hydrological research presented above. It is now time to show how flood influences the lives of the people on Moushuni Island. The insider perspective is necessary in order to reveal this information. Flood is a climatic condition that greatly concerns and influences the life of the interviewees. This informant describes how family life was influenced by flood some years ago:

> "6-7 years ago we were affected. The house was completely destroyed. We lost our crop. It was in September- October time. 2-3 ponds were destroyed and the fish died"(HI 10).

Most of the informants had experienced similar losses due to flood. Flood has destroyed agricultural land and ponds due to the salt that the flood brought with it. Houses have been destroyed due to the sheer strength of the water. One reason why the destruction is so massive is due to the type of houses people have. Mud houses with straw roofs are most common, and they are easily destroyed by large masses of water. A few have brick houses which are much stronger and flood-resistant than the mud houses. Other losses occur because the fresh water ponds, which are used for washing and keeping fresh water fish, get flooded with salt water and the fish die. The ponds must be emptied of saline water before they get refilled with freshwater again.

The impact of saline floods on agriculture is observable when traveling around the island. Large areas are left uncultivated compared to neighboring land. The destroyed land and the unaffected land are often separated by an elevated road or other barriers that stop the saline water from flooding farther onto the island. Agriculture is the main economic activity on the island and saltwater floods are very damaging for this sector, it endangers the people's economic security. In addition to having severe impacts on the household level, the climate risk posed by flood has an influence at the village level as well, as several of the market interviewees reported losing income due to less activity on the market after floods.

Agricultural land destroyed by saline water (left) and a broken embankment, taken on the day after it flooded that spot (right). Photo: Ragnhild Vognild

The embankment is one of the structures that protect the island from flood. According to the informants, the embankment is in a poor condition. One interviewee who lives 20 meters from the ocean shared his opinions about the embankment and the impacts of flood:

> "The embankment breaks every year. We fear it happening every time. The government is not taking any proper action. Before, the embankment was 2 meters high and made of mud. Now it is 5 meters and made of bricks, and it is still breaking every year [...].We have lived here from the beginning. The ocean was about 540 meters from the house. 6-7 people lost their land between us and the water. He [a neighbor who was present at the interview] has lost 7 acres and became a landless laborer" (HI 11).

The water level increases in the rivers during the monsoon season and this increases the danger of the embankment breaking. The damage caused by flood depends on the strength of the embankment: as the embankment gets weaker, the easier it breaks and causes flooding.

In addition to destruction of property, there are other more indirect consequences of flood on Moushuni. My findings show that flood affects health. The chief of the hospital in Sagar, a nearby island, explained the situation after a flood:

> "The main problem is diarrhea after a cyclone or flood, as the drinking water gets contaminated. The teams give out halogen tablets to clean the water. They don't die of diarrhea" (BI 7).

The experience of diarrhea after floods and cyclones was confirmed by several of the interviewees. For example, a flood that happened in 2009 caused one whole family to get diarrhea that lasted for several days. Snake bites also increase after cyclones, causing health problems and death. An employer at Sagar Rural hospital also stated this:

> It is also an increase in snake bites after a cyclone or flood. The success story of this hospital is that no one dies of snake bites here" (BI 7).

Other household informants gave similar stories, as snakes were mentioned in the interviews as a threat to health after floods. The situation on Moushuni Island is quite different from the situation on Sagar, where they have a functioning hospital. The Moushuni hospital is not in use and there is no doctor on the island. Snake ointment needs to be refrigerated in order to

stay usable, and there are no such facilities on Moushuni. If someone gets bitten by a snake, they have to be transported to the nearest hospital by boat. Some victims get the antidote in time, while others die on their way to the hospital. Encounters with snakes and deaths caused by snakebites happen frequently on Moushuni. One of my informants shared his perception on dangers of snakes after floods:

> "The house was full of water. We had a "water bed" with frogs, snakes and insects. Snakes are common here. It [the house] was destroyed and full of saline water […]. 1 year ago a man died of snakebite. He died on the way to the hospital. I am 63 years old and from my birth maybe 100 people have died from snakebite. In a very few cases they made it to the hospital" (HI 9).

This interviewee gives an idea of the risk caused by flood when it comes to the situation with the poisonous snakes during flood, describing them coming inside the house with the water. This can result in deadly outcomes, even though less people die from snakebites now than before, due to fewer snakes on the island.

Another indirect consequence of flood is the difficulties it creates for people's mobility on the island. Normal monsoon rain dumps enough water on the island to influence mobility and flooding makes it even more difficult for people to get around. Only a limited number of the roads are brick roads. The rest are mud roads that turn into muddy, slippery slopes when it is raining. During monsoon, the people of Moushuni take their shoes off when they walk outside in order not to slip. The mud limits their possibilities of moving around, especially for kids, elderly and sick people that already have some problems with walking. Even the animals struggle. One of the informants explains how the monsoon affects him and his family's life, and mentions mobility aspects in addition to more severe outcomes:

> "The monsoon lasts for 2 months. It is rain, which can stop for 1 or 2 days before starting again. We cannot use the road as it is wet. There are problems with the cattle we cannot take them outside. Cattle are inside for 2 months. We fear the flood in monsoon. Water level increases in the river and the river bank breaks. 4 years ago we had a flood, the river bank broke. Saline water came in and destroyed our agricultural land" (HI 12).

This household had also experienced getting property destroyed due to flood. They also mention, however, the impact of monsoons and flooding on mobility, especially for the elderly, sick people, and children, who are most affected by the muddy roads. The muddy roads also affect shop owners, as they lead to a decrease in business activity. In addition to that, the monsoon season is the peak season for people to work on their agricultural land. The fact that people are very busy during this time also contributes to the decrease in customers. One of the informants owns a small shop in an intersection on Moushuni and he has noticed the impact of the monsoon on his business activity:

> "In this time people in general avoid to go out of their house. So the business is sometimes affected. Sell little compared to other seasons. Road connection is not so good, as most of the road is clay. Mud roads. People avoid coming out at this season. But in emergency situations they have to come to the shop" (HI 13).

Both the outside experts and my informants agree that Moushuni is a flood prone area. The informants fear the embankment breaking and the floods that can follow. My findings show that flooding causes direct impact on people's lives through destruction of property as ponds, agricultural land and houses, in addition to more indirect consequences such as health and mobility difficulties. Flooding is a factor that contributes to the climatic risk on Moushuni as it constitutes an added risk to securing economic well being for the inhabitants.

Destructive cyclones and the impacts on Moushuni

The Bay of Bengal is a cyclone prone area. The cyclones usually occur in early summer in June-May and late monsoon in October-December. They start off due to low pressure over the bay. The cyclones bring a massive wave of water that has destructive effects on the Sunderban Islands, with its water canals, flat topography and densely populated areas. In addition, the wind speeds can reach up to 200 km/h, and these winds are highly destructive. Cyclones in the Sunderbans have created some of the highest death rates in the world following these kinds of disasters (Kahlil 1992). According to the Moushuni Gram Panchayat there have been cyclones on Moushuni in 1993, 1995, 1998, 2005 and 2009. The latest heavy cyclone, Aila in 2009, affected 5.4 million people and killed 115 people in all of West Bengal.[3]

The external descriptions of cyclones say little about how the cyclones affect the inhabitants of Moushuni. The informants told many stories about what risk the destructive cyclones had on their lives. Several of the consequences are similar to those caused by flooding, since cyclones bring a massive wave of water with them. The strong wind speed, however, leads to other additional damages.

The latest cyclone, Aila, became an important theme in the interviews, as the informants had the cyclone fresh in mind and several of them still had not recovered fully when interviewed. Aila hit the island on the 25th of May 2009, with a wind speed from 120-140 km/h (Bhattacharjee et al. 2010). The following quote describes how Aila affected one household

> "Aila affected my family. There was a house next to this one that was totally destroyed. The roof broke off this house. 1 acre of land was destroyed due to saline water. There was no cultivation there last year. The monsoon this year will decide if we can use the land this year"

[3]http://www.reliefweb.int/rw/RWFiles2009.nsf/FilesByRWDocUnidFilename/MINE-7SN3ZJ-full_report.pdf/$File/full_report.pdf available April 2011

(HI 7).

The destruction on the property was fatal, and they had not been able to rebuild their house when interviewed a year later. In addition saline water had damaged agricultural land. This household was far from the only one that had experienced losses during Aila. Several people interviewed had experienced similar damages. Aila destroyed agricultural land, caused health problems as diarrhea, saline flooding of people's ponds and problems with getting around the island. One family I spoke with lived on top of the elevated road for three days after Aila because their house was flooded.

Aila was not the first hard cyclone the islanders had experienced. One of the informants recalls the memories from the 1998 cyclone:

> "More people were affected by the 1998 cyclone. It destroyed houses and land. Some came to the flood shelter in the night, those from the riverside came in the morning. Livestock died. The cyclone had a very high speed. We tried to protect our home with wire. The Panchayat informed everyone. But this was the first time we were hit by such a hard cyclone, so people thought it would not be so bad. The 1998 cyclone was the worst" (HI 9).

The strong winds caused problems unique to cyclones, such as more severe damages of houses. This informant is also says that the 1998 cyclone was experienced worse than Aila, mainly because the people were less prepared and had not experienced a cyclone of such strength before.

Producers of betel leafs that were interviewed feared the winds of the cyclones very much, as the betel plantations consist of fragile buildings that house tall, thin plants that easily break when the wind speeds up. Cyclones were also found to cause risks for the business owners. For example Aila destroyed fish worth 10 000 rupees for a local fish trader, as no ice was available after Aila for keeping the fish cold. Another owner of a retail shop lost two boats that he used to transport goods during the cyclone in 1998. He had no insurance to cover the lost property. My findings also indicate that severe climatic challenges, such as Aila, cause a decrease in the market activity, as people are busy taking care of themselves and those badly affected have less money to shop for as they must use their money to repair damages, etc.

The people on Moushuni are regularly affected by cyclones that cause much damage to individuals, households and businesses. Cyclones are more severe than flooding due to the strong wind and according to my findings the likeliness of property and bodily damage is higher during cyclones than during floods. Cyclone causes a risk to households, farms and businesses since it affects people's source of income from agriculture and business, especially

betel plantations. It also causes similar health problems as flood, as diarrhea and snake bites, since cyclones are always followed by flooding.

The impacts of drought on Moushuni Island

Between monsoons there is normally a dry period on Moushuni. However, there are usually a few days of rain in between the end of one monsoon in September/October and until the next starts in May/June. These few days of rain are very important for the people living on the island, as the rainfall waters the land and refills people's ponds. In 2010, however, there was no rain at all between the 2009 monsoon and the 2010 monsoon. According to my informants, this year was the first time without any rainfall at all from October to May. The consequences for the inhabitants were severe.

One of my informants, a young woman living in a newly built house with her husband and baby told me about this year's situation:

> "This is the first time that we experience such dryness in the winter. The rain usually comes the first week in May, and the monsoon starts fully in mid June. Usually there are some days with rain in the winter. This year we have had drought from October until now. We cannot use irrigation, as the pond is dry, so we must use the tube well for drinking and washing. Our land is usually irrigated, but not this year. 90 % of our agricultural income is gone" (HI 2).

Their well being was affected by drought in several ways. First of all, their chili production was reduced by 90 % because their pond went dry and they could not irrigate. This severely reduces the income of this poor family, as selling the chili on the market was an important source of income for this family. Second, the dry pond is influencing the dynamics of the household, as the family can no longer wash their clothes, dishes and themselves in their pond and must go to the well to get water for this.

Other informants confirmed the lack of rain and described how this has influenced their lives:

> "Sometimes the monsoon is late, it is problematic. This winter we have no vegetables as there is no rain the last 8 months. We depend on irrigation from the pond. We were not able to irrigate and produce vegetables" (HI 9).

This household was not able to produce vegetables at all, since the ponds they use for irrigation went dry.

The impact of the drought in 2010 has been severe for many households. Other people interviewed had similar experiences with drought this year and lost their vegetable production due to dry ponds and no water for irrigation. This severely affects people's income, as eating and selling their own vegetables are an important part of the economy of the household. Having to buy the annual vegetable consumption in the market becomes an extra expense.

The ponds are also used for keeping fish and washing dishes and clothes. One interviewee, a woman, informed me that "people start using the t-well for taking a bath, which makes the lines long and we must walk further to fetch the drinking water. The ponds are the problem, in them we have fish, and we use it for cleaning utensils, washing clothes, irrigation and bath." (HI 1).

Not everybody experienced their ponds going dry. This was especially the case for those who owned more than one pond. One of my informants, a shop owner, explained that:

> "We have three ponds. We use irrigation water from three ponds. In the last few years, or generally after the winter there is some rain. But this year there was no rain, so we just drain water from one pond to another, and shifted the fish of this pond to the other pond. We use this for household. It was not so much production of vegetables in this season in the winter so we don't need the water for the irrigation. We managed the situation. There are three ponds of this household, but sometimes households have only one or no pond. […] So they are basically suffering from the situation" (HI 13).

Another informant that owned three betel plantations had three ponds as well, and was not affected by drought in the same way as other informants owning one pond only. This indicates that drought hits those with less land and resources hardest.

Drought has not received much attention in reports and research from the area, as I believe it gets placed in the shadow of the more dramatic cyclones and floods. Nevertheless, the drought creates a very severe climate risk by those affected, as it adds risk to their livelihood and quality of life.

Heat as Climate Risk

The summers on Moushuni are hot as the average high temperature in April and May are 34-35 degrees centigrade.[4] Hot summers are normal there and for most people the heat is not perceived as a risk. However, when asked direct questions about challenges during summer or heat directly, interesting aspects of heat and how it affects everyday life started to emerge. One of the informants said, after being asked about if and how summer can be a problematic season:

> "Summer is problematic mostly due to heat. We depend on the wind. We use hand fan in day and night. We had a fan when we had electricity, only one or two. It is 8 people in the household, so it is not enough for everybody. It is nothing we can do in the summer to make us feel better. Sometimes some tube well goes dry and we must walk longer for drinking water. Old people are mostly affected, as they cannot move themselves outside" (HI 12).

This implies that some people are more vulnerable to heat than others, such as the sick and the old. But this informant also explains how the people manage to cope with the heat by using

[4] http://www.weatherreports.com/Sagar_Island,_India?units=f available April 2011

hand-fans or electric fans, and fanning each other. The rhythm of their day was well fitted with the heat peaks, as most people took a nap during the hottest hours, the market closed and people were generally not seen outside. For local enterprises this lead to a decrease in income due to lost work hours. One local tailor expressed during an interview that "I cannot work as much as I want due to the heat. I work from 6 to 12:30 and from 14:00 to 11:00 pm." The same informant wanted to get a SHS so he could run a fan during the day so he could work for more hours during the summer.

Heat is, as drought, excluded from research reports about the climatic conditions in Sunderban, probably because it constitutes a more moderate climate risks than the more drastic cyclones and floods. My findings show, however, that despite people being used to the heat and that they do not consider it an immediate threat, it can still be considered a climate risk as it influence peoples well being. Old and sick people's well being is influenced by the heat as they cannot fan themselves or move themselves outside to the natural winds and business and families' income are also affected by the heat, since the heat limits the number of productive hours during the day.

Experienced changes in the climate on Moushuni

The Sunderban Islands have received much attention from both researchers and media because it is considered one of the areas in the world that is experiencing climate change already and that will suffer the most from climate change in the future. Research indicates that the annual rise in sea level is very high in the Bay of Bengal, as it has been found to increase 3.14 mm pr year, compared to 1.06-1.75 mm per year which is the national average.[5] Climate change is expected to impact flooding in the Sunderbans. Increased freshwater flow during monsoon due to growing rainwater runoff will give more freshwater in the basin. However, an opposing effect will come from the increased sea level which will simultaneously push the saline waterfront further inland. These two opposite effects make the climate change impact during monsoon difficult to predict. More water in the Delta will, however, contribute to the already severe erosion on the islands (Saha 2008). The dry season impacts are easier to predict, as decreased freshwater flow and sea level rise together will add to the salinity during dry season in the Sunderban (Agrawala et al. 2003).

[5] http://www.climatecommunity.org/documents/SugataHazra_001.pdf available April 2011

One of my interviewees, an old man, gave his perception of how the climate threats had developed during his life time on the Island. He has lived on the island in decades, and meant it has been an increase in floods.

> "Flood was a problem. The embankment was made by mud then, now concrete. But it still is flood. It is an increase in the breaking of the embankment. Previous it only broke in rainy season. It was not so harmful, as the fresh rain washed out the salt at low tide. It is more frequent breaking now. The water level is increasing. And the height of embankment is also increasing, made by man. But it is still more floods" (HI 3).

His experience of the situation is strengthened by outsiders' view of the situation regarding climate change. There is reason to believe that increased erosion caused by more water in the delta will take a harder toll on the embankment and cause more flooding. However, the information I received from the inhabitants' experiences regarding noticeable changes in the climate and the impacts of this change are not sufficient to make irrevocable conclusions. Breaking of the embankment can be caused by other factors, such as changes in the maintenance routines of the embankment and other matters that there was not enough time to look into during the fieldwork. The damages can also be perceived as worse now than before due to more people living on the island. This is a subject that should receive more research.

Processes and factors causing vulnerability to climatic challenges

This section will present findings related to my second introductory research question: *Which factors and processes contribute to people's vulnerability to these climatic challenges?*

This involves insights into the factors and processes that contribute to the vulnerability of the people to the above mentioned climatic challenges and climate risk. As expressed in the theory chapter, there are many factors and processes that can make people and communities vulnerable to climatic challenges. These processes are not necessarily directly related to climate, but rather related to politics, the environment, culture and social issues (Eriksen et al. 2007, Schipper 2007, Ulsrud et al. 2008). Unraveling these vulnerability factors and processes is a huge task, and in retrospect I see that it was impossible for me to discover them all. Through the fieldwork and analysis, however, some processes and factors that contribute to vulnerability to climate challenges among the inhabitants on Moushuni crystallized. These are deforestation, lack of modern facilities, slowness in governmental processes, debt, little opportunities to diversify income and social and cultural factors.

The process of deforestation

Deforestation is an environmental degradation process in the Sunderban that started a long time ago. The need for land was the main driving force behind this transformation. However, the feelings of fear towards the tigers, snakes and other animals living in the forest also contributed to the removal of the dense mangrove forest. The consequences of the deforestation are severe, and many local animals have disappeared, such as the horned rhinoceros, the Indian rhinoceros, the golden eagle and the pink headed duck.[6] According to the local WWF official on Moushuni has deforestation contributed to erosion on the island. The mangrove ecosystem plays an important role in coastal areas in the Sunderbans. The mangroves absorb energy from the waves and slow down erosion processes (Othman 1994). Sir William Huntington described the function of the mangrove forest during his encounter with the Sunderbans in 1875 as something that "offers itself to the cultivators as a stony shield. […] This belt of forest serves as an admirable breakwater against the ocean; and in the recent cyclone in 1869, which were accompanied by storm-waves, it broke the force of the tidal wave before it reached the cultivated tracts, and thus prevented a great destruction of life and property" (Hunter 1875 in Chaudhuri 2007:6).

The mangrove forest is an important source of wood for the islanders. Historically, it has been used for construction, firewood, boat building and medical purposes. During fieldwork, however, the usage of the forest on Moushuni was limited. A recently passed law prohibited the people to take down mangrove trees. Regretfully, I did not investigate further into this matter. There are also ongoing mangrove tree planting projects on the island. Trees are planted in the costal zones to decrease the deforestation process and prevent coastline erosion in order to improve the situation of the people by the riverbank. Due to the law and replanting of trees, the deforestation process on Moushuni has slowed down or even reversed. Deforestation has nevertheless been included as a vulnerability factor, as the severe deforestation that has occurred already is a factor that increases the vulnerability to climate risk today. Deforestation can also easily reemerge as a problematic process if, for example, the need for fuel wood grows. If the removal of forest continues on the shore of the island it will worsen the impact from extreme weather events and thereby make the people more vulnerable due to the direct link between mangrove forest by the shore, flooding and erosion.

[6] http://www.sundarbans.org/index-4.html available April 2011

Poor public and private facilities

Moushuni struggles with poverty and lack of resources which have left the health and education facilities, infrastructure, energy supply and insurance opportunities in a poor state or not existing at all. Their absence or poor state can be factors contributing to vulnerability as they influence difficulties with securing well-being in the face of climate variability and change. This section will be used to present the findings regarding the islanders' experience of lacking these facilities on Moushuni Island and how it can be linked to vulnerability.

Poor health facilities

The current situation regarding the local health facilities was an issue that several of the Moushuni residents brought up during interviews and it seemed to be an issue concerning many of the inhabitants on the island. There is one hospital on Moushuni, which is closed, in addition to some "quack doctors" and four rural health centers, one in each mouza. The health centers have no electricity connections and consist of one room where medicines are kept and family planning advice is given. Each health clinic has four women employed that receive training through the national Accredited Social Health Activist (ASHA) program. The program is a key component of the National Rural Health Mission, which aims at giving every village a trained female health activist.[7] The women get their training from a radio program that everybody can listen to. One of the informants was an ASHA worker, she said that her "duty is to go to pregnant women and new born babies and advice them to come to the health center to take iron and oral rehydration salts and vaccinate their babies" (HI 6). According to her has the birthrate on Moushuni gone down and a nurse from Namkana visits the center three days a week.

A good health service is important in order to handle the aftermath of climatic challenges, such as diarrhea and snakebites which are outcomes of climate risks such as cyclones and floods. These findings indicate that poor health facilities on the island, caused by little resources can be considered a contextual factor contributing to the climate vulnerability on the island.

Poor infrastructure, communication facilities and weak construction of building

Among other factors, the collective vulnerability of a community is determined by institutional and market structures, infrastructure and income (Agder 1999). The roads and communication options are in poor condition on Moushuni. Only about 24 km of the road on

[7] http://www.mohfw.nic.in/NRHM/asha.htm#abt available April 2011

the island is brick road. The rest is made of mud. As mentioned, the mud roads cause mobility problems during monsoon. In addition it is a two hours' boat ride to the nearest hospital, and there are no available speedboats for emergencies. One of the informants expressed his opinion about the factors that made it difficult to live on the island as "problems with communication. There is no car or train to go outside in short time. If we have a meeting, we must leave the island one day early. And we must arrange a boat to go to the hospital, some die on the way. There is also no good road on the island." This indicates a link between poor communication facilities and health, as it is time consuming to get off the island during emergencies. The poor infrastructure and communication facilities add to the vulnerability to climatic challenges, since health related emergencies increase after floods and cyclones.

The data collected also point towards poor communication facilities influencing business during monsoon. Informants reported a decrease in customers during monsoon as the rain makes it difficult for the islanders to move along the roads and visit the shops. However, there can also be other reasons for this aside from just the poor roads. People are busier with agricultural work during this time of the year and have less time to go to the market areas. There are also no festivals on the island during monsoon; festivals are occasions when people shop more and spend more time in the market areas. Poor communication facilities were also a factor that limited some businessmen to reach "their full business potential." They were not able to meet with clients and customers off the island as much as they wanted, as it is considered time consuming and expensive to go to the mainland. This might influence peoples' income negatively and thus is a factor in making them more vulnerable to climatic challenges.

Good education with few facilities

The education facilities on Moushuni were often referred to as something my Moushuni residents were satisfied with and proud of. The students do not have to leave the island to go to secondary school, unlike past generations. One of the local primary school teachers did, however, mention some challenges they faced at his school:

> "Electricity is used for light and fan. We want to use the electricity for a computer lab and science lab, but the school has no fund to buy the equipment. These facilities are not there due to lack of money, not lack of electricity. It is also not compatible with the number of rooms, staff and students. In class five there are more than 300 students. There are 16 teachers in the school and 1500 students. Little less than 200 student pr teacher! We are not able to help all the students. We cannot recruit teachers at our own sweet will. We must go through a system. The headmaster must contact the district officials. Some teachers are not willing to come here due to remoteness and isolation" (BI 9).

There are few teachers per student and this has lead to a blooming of coaching centers, where the students go before and after school to do homework and get help, especially in English and math. These are funded privately and the parents pay for their children to go there, and they also need to pay for kerosene and for the lantern that the students use in order to get light. This becomes an extra expense for the poor households. It is difficult for me to draw any conclusion on how the educational situation influences vulnerability to climate variability and change on Moushuni, especially because the school facilities are considered good by the inhabitants, but there are still major challenges experienced by the staff and students. This example shows, however, that there is a general lack of resources on the island, something that is also reflected in the poor state of facilities for health and infrastructure.

The "Kerosene problem"

One issue that the informants were concerned about was the shortage of kerosene on the island. The inhabitants of Moushuni can buy governmental subsidized kerosene for 10 rupees per liter, but this is only a certain amount per household. The informants had had to buy kerosene on the open market as well, for 35 rupees per liter. This is a significant expense for the families. According to my informants, the market runs out of both subsidized and market priced kerosene every month. During a group interview with a female self help group I got the kerosene situation explained:

> "The kerosene problem is that kerosene is not always available from the market or from ration. We must pay from 40 to 50 rupees pr. liter. We have 4-5 kids and they cannot read in the complete darkness. Sometimes the ration distributer sells the kerosene on the open market. In ration it cost only 10, 5. He sells the ration kerosene for market price. We have only ration kerosene for 15 days of the month. Other days they must use kerosene from the open market or candles for 4-5 days. We pay 5 rupees a candle and need 5 candles for one night" (GI 4).

This informant had no connection to the solar power plant or a SHS. For the households without electricity there is a higher dependency on expensive energy sources such as kerosene and candles, and it must be emphasized that the majority of the households on Moushuni have no kind of electricity supply. The fuel situation influences the household's well being by reducing their possibilities for having sources of proper lighting and pushing the household further into poverty by digging into their private economy. Market structures influence the collective vulnerability (Agder 1999) and access to resources influence both individual and collective vulnerability. The kerosene situation is interlinked with global processes and market structures which affect the global prices and access to petrol products. These findings indicate that the kerosene problem in addition to lack of other proper sources of energy adds to the contextual situation that makes it difficult for the islanders to cope during climate

variability and change, because it affects their private economy and opportunities for proper lighting. This can therefore be considered a factor that contributes to climate vulnerability on the island.

Few options for irrigation

Proper irrigation equipment or other arrangements to water crops were lacking on the island. The most common was to water by hand with buckets and water from the ponds. In 2010 the drought was severe, as they got no rain in between the monsoons. The drought lead to several of the ponds going dry and people lost their crops as they had no water to irrigate. Not having proper irrigation for agriculture makes the people very vulnerable to variability and change in climate. Digging deeper wells is not necessarily a solution to the problem. Digging deeper for water to irrigate the fields might only be a short time benefit, if the water table decreases because of this, it can make the general water situation more difficult on the island. Despite the possible backfire effects of digging deeper wells for irrigation, the interview data gave reason to believe that the current irrigation situation adds to the climate vulnerability of the islanders.

Cannot afford insurance

None of the informants had insurance on their property. When they get affected by extreme weather events, they get no money back on insurance to cover the cost of the damages. A local man who worked with selling life insurance on the island said that the most common insurance there was that people "pay money for 16 years, and get it back afterwards with interest. About 30 % here has this kind of insurance. Very few people insure their property" (HI 8). It is not that property insurance is not available as it is likely that someone would sell insurance if it was a market for it. The reason is rather the lack of resources in the households, and it is thus not prioritized. This weakens the formal security options on the island, and thus contributes to vulnerability (Agder 1999).

Poor public and private facilities meaning for vulnerability

These findings show that the quality of public facilities as health, education and infrastructure are poor at the community level on Moushuni and that the individual households have little money to pay for private services such as insurance. One reason for this is rooted in poverty, since the island has little funding and resources to get these types of facilities and people in general are poor. This section has shed light on how the lack of certain facilities can be linked to climate vulnerability both at the collective and the individual level; one example is the link

between poor health facilities and the health of the inhabitants after cyclones and storms. This indicates that there is a tight link between poverty and vulnerability, even though they are not always the same. People being vulnerable are not necessary poor and vice versa (Eriksen et al. 2007). I have decided to treat poverty as one of many reasons for the situation regarding poor public and private facilities, and since there is a link between these poor facilities and vulnerability, poverty can also be indicated as one of the factors that contribute to the vulnerability context of the people on Moushuni.

"Slowness in the system"

There are several emergency relief and development programs on Moushuni driven both by the Panchayat and non-governmental organizations. Some of the programs are supposed to strengthen the livelihood of the inhabitants on the island. Maintenance of the embankment and subsidized seed and fertilizer programs are two such programs. According to the informants these programs do not function as they should. There are many reasons for this condition, such as lack of resources, information and bureaucratic challenges. This is referred to, by a leading political figure on the island, as "slowness in the system" (BI 5). This section will analyze if and how this "slowness in the system" can be a factor contributing to vulnerability to climatic challenges.

A government program initiated in 1978 gives subsidized seeds and fertilizers to the inhabitants. The trust of the program is poor among the inhabitants, since they often experience that the subsidized seeds are available too late in the season. This means that the farmers must buy seeds for full price on the market in order to get them in time for the planting season. The people also lack information about seed preparation so they cannot prepare their own seeds. This slowness in the system is quite common in the Indian bureaucracy and has been explained by some as a result of the low politico-bureaucratic morale that manifests itself through corruption (Dwivedi & Jain 1988). Another explanation could be the lack of resources and communication facilities. According to the findings this slowness in the system forces the farmers that are supposed to be a part of this program to buy their own seed on the market for market prices, or in the worst case, it leads them to plant their seeds too late, something that can influence their harvest. If the harvest is reduced their home grown food supply is usually reduced, forcing them to buy more food from the markets. Others, who rely on selling their crop, lose significant amounts of their income. Less income or more dependency on food from the market as a result of "slowness in the system" contributes to the contextual conditions that make it more difficult for the inhabitants to face

climatic challenges, because they have fewer resources to use when recovering their livelihood and quality of life after extreme climatic events.

Another issue that possibly suffers from the slowness in the system is the maintenance of the embankment. The embankment is absolutely necessary for the people to make a living from agriculture on the island, and to protect property and lives from floods. The embankment is in a poor condition. The Drainage Wing of the Irrigation department in the Government of West Bengal was responsible for the maintenance of the embankment. The responsibility was divided down to subdivisions and Section Offices. In 1993, the landmark constitutional amendments lead to the Section Offices no longer having the budgets to carry out the maintenance. The responsibility was now given to the Panchayat Summiti (intermediate level of local government), who lacked the skills on how to maintain the embankments (Danda 2007).

The interviewees were not satisfied with the management of the embankment. One of them who lived ten meters from the embankment and just had experienced a flood the day before the interview said:

> "We fear the river. The embankment breaks every year and we fear it happening every time. The government is not taking any proper action. Before, the embankment was 2 meters and made of mud. Now it is 5 meters and made of bricks. It is still breaking every year. The embankment is 17 years old. The government built a new embankment then. This has allowed us to do agriculture" (HI 11).

The routine for maintaining the embankment is not functioning properly, as the embankment is visibly weak on many stretches and breaks and causes flood several times a year. In retrospect I see that it is difficult to pinpoint the reasons why the maintenance is poor. I can lean on Danda's (2007) conclusion that the Panchayat Summiti lacks the proper skill and knowledge to conduct such work. Little resources can be another reason. Whatever the causes of the situation are, the findings indicate that poor maintenance of the embankment is a factor that contributed to vulnerability. The lacking capability to assure a good maintenance and condition on the essential embankment worsen the consequences of cyclones and floods and therefore make the inhabitants more vulnerable to such climatic challenges.

Income and economic factors causing vulnerability

The vulnerability of individuals does, amongst other reasons, depend on the opportunities to diversify income (Agder 1999). In this section it will be discussed whether the limitations to diversifying the income on Moushuni is of such character that it can be called a vulnerability factor to climate vulnerability.

An income is diversified when the household gets its income from more than one source. Diversified income is seen as important for reducing vulnerability, as the risk of getting the source of income reduced due to climatic impacts is less when the household depends on more than one source of income. Among the informants most households seemed to have more than one source of income. One of the informants combined working abroad with chili production and more than half of the people I interviewed at the market had some cultivable land as well. But there were some, however, that only depended on agricultural income, and they were recognized by the other islanders as extra vulnerable:

> "The biggest problem is the embankment; it can be washed out every year. It is a larger problem for people growing paddy and vegetables, especially if they have this as only income. Every year there is a flood" (HI 9).

This informant specifically states that floods are especially difficult for those who have agriculture as their only income. It is clear that these people are extra vulnerable to extreme weather events which happen regularly on Moushuni, as drought, flood and cyclones. My impression is, however, that these were only a few. None of the informants were caught in this situation. One of my informants, however, told me that people who had lost land to erosion had moved off the island, because the lack of income opportunities on the island (HI 11). This could be a reason why I did not meet with people who only depended on agriculture, as they had already migrated from the island. For the few households that are stuck in dependency on agriculture only, however, the difficulty of finding other options for generating income contributes more to increased vulnerability to climatic challenges than for others.

The next economic factor that emerged as a possible vulnerability factor during the interviews was the debt situation for many of the inhabitants. Borrowing money when a crisis occurs is very common on Moushuni. People borrow from self help groups, the bank in Kakdwip, from loan programs organized by the Gram Panchayat, from neighbors or from private money lenders. The situation of debt is something that causes difficulties for the households. Several of the informants struggled to pay back their debt. This household had difficulties paying back their loans:

> "Every year we borrow money. From neighbors or a self help group. The governmental self help group gives money with 3 % interest pr year. Others have 5 % interest pr month. All people need to borrow money sometimes. [...] We have a loan of 25 000 rupees at the bank and loan in the local self help group of 40 000 rupees, and some loan from neighbors. We just manage to pay back their interest" (HI 1).

Being in debt is difficult, and it might contribute to worsening the opportunities of securing the well being when faced with climatic challenges. This is so because being in debt can make it difficult to get new loans, which may be useful when a climatic accident strikes. The situation of borrowing money on Moushuni did; however, seem to have its own dynamic. It was something "everybody" did, and it is possible that it should be seen as an adaptive strategy rather than a possible path to increased climate vulnerability.

Social and cultural factors causing vulnerability

Social and cultural factors such as social status of the individuals or collective households within a community have been recognized as determinants to vulnerability to climatic challenges (Agder 1999). I will here discuss two social and cultural factors, gender and age, that emerged as possible factors contributing to some being more vulnerable to climatic challenges than others.

Considering gender's role for the impacts of climate risk can be fruitful for understanding more of the individual vulnerability in a society. Jonson (2011), however, warned that a feminization of climate vulnerability is a generalization that silences contextual differences and exclude insights into the configuration of social relation of power in particular contexts. Despite this the NAPCC encouraged special attention towards women in adaptation measures as they found the women to be especially vulnerable to climate change. While I studied the vulnerability context and analyzed my data towards climate vulnerability, I found some indications for gender roles having an impact on individual climate vulnerability.

The identified water scarcity caused by the drought in 2010 made many of the ponds used for washing and taking baths to go dry. One of the interviewees mentioned that they now had to walk longer to fetch water for household needs and that even some tube wells had gone dry. Fetching water is an activity mainly done by women on the Island. The observable lines of colorful sari dressed women in front of the community wells is an indicator for this being a female chore. The links between climate risk and health has been recognized earlier in this chapter. Women in the Indian society are generally those who take care of sick family members. From this it is possible to infer the likely increase in work chores for women during times of climatic challenges that are experienced on the island. This extra work load on women's shoulders can increase their individual climate vulnerability because increased chores influence their ability to secure their well being when facing climate challenges. My data show that women experience increased workloads during and after climatic challenges. However, the data material is also missing information about how men experience the same

situations regarding their workload. I did, however, not dig deep into this issue, nor did I investigate the extra work load climate challenges caused the male half of the population. There is reason to believe that all members of the household must work extra hard after a cyclone or flood in order to make the ends meet.

Age and disability were factors mentioned in several of my interviews when we talked about who were more vulnerable to climatic challenges than others. As mentioned before, the elders were specifically vulnerable to heat as they could not move themselves outside to the cooling winds and they were pointed out as a group, together with children and disabled, that had extra problems moving around during monsoon due to the muddy roads. Cyclones and flood are also experienced more difficult by these groups. One of my informants explained the situation during Aila; "For pregnant women it was difficult to come to the [flood] shelters. My father is 105 years old and he was in a very difficult situation during Aila. He had to be carried out" (HI 9). These insights show that factors such as age and disability are factors contributing to individual climate vulnerability, as it limits their ability to secure their own needs, such as bringing themselves to safety, during climatic challenges.

Factors constituting the adaptive capacity of the inhabitants on Moushuni Island

This part is dedicated to the findings and analysis relevant for my third introductory research question: *"which actions take households and the local community in order to cope with and adapt to the climatic risk that they experience?"* Adaptive capacity is a concept developed to describe how people cope with climatic challenges and adapt their livelihood in the long term (Eriksen et al. 2007). For the poor it can be seen as the "the particular strengths of poor people for coping or adapting in the face of climate stresses" (Eriksen & O'Brien 2007: 340). Resources that the people have themselves or have access to are important aspects of adaptive capacity. It is a huge task to uncover all the contributing factors in the adaptive capacity of people on Moushuni Island, since adaptive capacity varies across scale, time and between people. Discovering the contributors to adaptive capacity is done by investigating how people cope with and adapt to climatic challenges. This discussion concentrates on those factors that have emerged as important through the interviews. These are infrastructural and technical resources, emergency measures, local knowledge and experience, strong social networks, acceptance and spirits, flexibility and multi-locality. Some of these factors, especially those connected to infrastructural and technical resources, can also be viewed as measures that

reduce the direct risk of climatic challenges. I have, nevertheless, decided to include them here, as they also can be considered one of the resources from which the people draw their adaptive capacity.

Infrastructure and technological resources

There are several infrastructural and technological measures that have been conducted on Moushuni implemented by the inhabitants, government or other actors, such as the ability to build an infrastructural construction like the embankment and elevated roads and other technical installations as the loud speaker system, telecommunication system and irrigation pumps. Here, these measures' role in the adaptive capacity of the people on the island will be discussed. Although poor quality of some of these was mentioned as factors creating vulnerability, their presence is still important for people's ability to protect themselves.

Efforts and capacity to build necessary infrastructure: embankment, elevated roads and ponds

The embankment has been highlighted as an infrastructural element necessary for living and doing agriculture on Moushuni. I have already highlighted the links between its poor maintenance and climate vulnerability. Despite this, it is necessary to analyze the embankment as a resource that people have access to that can influence their ability to cope with climatic challenges. Based on my findings from my interviews, I believe that the embankment is absolutely critical, since it is necessary for the people to live and do agriculture on Moushuni, as it protects people and land from flood and erosion. Because of this, the existence of the embankment is an infrastructural installment that is an important part of the adaptive capacity on the island, despite its poor condition. The embankment is an example of long time adaptation carried out by the inhabitants in order to live with the climatic challenges they experience. This finding is supported by other research that has found the river embankment to be crucial for the existence of human settlement on the Sunderban Islands (Danda 2007). The roads are elevated infrastructural installments, something that according to the informants act as barricades to flood water once it has penetrated the island, and they also function as a dry place where people take shelter once areas are flooded with water. One of my informants explained that they "stayed on the brick road, for shelter, for two three days. Everything here [in the house] was with water" (HI 5). The elevated roads are not as crucial as the embankment, but they are still limiting the damage caused by floods.

This embankment is an example of how close vulnerability and adaptive capacity are linked, since the state of the embankment caused by the previously discussed lack of maintenance is a process leading to vulnerability while the embankment itself and people's ability to construct and maintain it is a factor contributing to adaptive capacity. The tradition on the island to build the elevated roads and the ability of the people to strengthen them in time of disaster are also elements which contribute to the adaptive capacity of the people. The sheer existence of these infrastructural installments can also be considered as factors contributing to limiting the impact caused by flooding.

The tradition of digging ponds outside every house is another element in the cultural landscape that can be argued to be important for the adaptive capacity of the people on Moushuni. The ponds provide water that is used for irrigation during the dry period (in-between monsoon). The water is also used for other chores as washing clothes, dishes, taking baths and keep fish in. The ponds contribute to climate adaptation towards climate variations such as dry winters as they give the opportunity for the people to irrigate and have water to use for household chores. However, during severe drought they appear as a poor source of water since they often dry up and people lose their source of water for washing and irrigation. This show that time influences the status of the ponds as an advantage contributing to adaptive capacity on the island. Normally dry winters strengthen the adaptive capacity of the community; however, as soon as there is drought they lose their status as a factor being a part of the adaptive capacity and can instead be considered as a poor and fragile source for water for irrigation contributing to vulnerability. This analysis of the pond illustrates the complexity of the trisection of climate adaptation as a concept as the same measure can be consider both an adaptive capcity and a factor causing vulnerability, depending on the time of analysis. In addition the ponds are the ponds as well can also be considered a factor reducing the direct impact caused by drought as a climatic challenge.

The irrigation pump, a resource during salient floods

The irrigation pump is a machine that increases the adaptive capacity for those who have access and money to buy fuel for it and/or rent it. The irrigation pumps are used to pump water from the ponds to the fields, which is important and labor saving for the farmers. However, most farmers still water by hand. The irrigation pump also has another important function. "Some people use the irrigation pump to remove the salt water from the ponds if it gets flooded" (HI 12).The faster the salt water is removed from the ponds, the quicker fresh water can fill up the ponds and the inhabitants can use the ponds for their daily chores. This

usage of the irrigation pump is an interesting function which turns the pump into a factor influencing the adaptive capacity for those who can afford to buy or rent one, in addition, can it also be considered to reduce the risk caused by climatic challenges.

Instruments for informing people about upcoming storms and cyclones

A loud speaker system that is owned by Moushuni Gram Panchayat is a technical measure that is used to inform the people about upcoming storms and cyclones, among other things. The system is mobile, carried around the island to give weather warnings. It runs on dry-cell batteries. Not everybody gets the message though, as Aila, for example, came surprisingly on many of the informants. The radio and telecommunication systems which provide good cell phone reception everywhere on the island are two other instruments that serve similar purpose. The radio is used to get information about the weather and this gives people time to prepare for upcoming extreme weather events as they can hear cyclone warnings on the radio. A good cell phone reception was found to give people the opportunity to contact each other prior to and after cyclones to warn people and to hear how relatives have managed. The Panchayat said that "Most of the people get in touch with the family members in other places after the cyclone over phone. There is not any other way to get in touch with the family members. So, cell phone is very important now to them" (BI 1). Another technical intervention is a planned early warning system in a climate adaptation center run by the local WWF office on the island. The early warning system was not working yet, due to technological problems. It will finally be run by a standalone solar energy system.

These technical instruments and measures and the way that people apply them can be regarded as resources that strengthen people's ability to adapt to climatic challenges. These can, however, also be regarded at measures reducing the impact from climatic stress. The radio, loud speaker system, early warning systems and cell phones give the people the opportunity to prepare themselves for extreme weather events and that reduces the risk caused by these climatic challenges.

Electric fans reducing discomfort connected with heat

I interviewed households and businesses with electricity connection that had prioritized to get fans in their homes and instead of an extra light. I found that heat is, as mentioned, a climatic challenge for people, especially the elderly who cannot fan themselves and businessmen who wish to work during the hottest hours of the day. The possibility to use a fan can be seen as a contributor to the adaptive capacity to those who have access to the fans, since it is one of the

resources some of the islanders have access to that makes them cope with and adapt to heat as a climate challenge. This can also be regarded as a factor reducing the direct impact caused by heat as a climatic challenge.

Emergency relief programs, providing help when most needed

There are several flood shelters on the island, in addition to several emergency relief programs that are government led or initiated by nongovernmental organizations. These include emergency relief during and right after a cyclone or a storm, where food, water, medicine and tarps are given out to those most in need. There is also a 100 days of work program which gives anyone the opportunity to work 100 days during the year for the government for money. I will here highlight their importance for climate adaptation.

During cyclones and storms the flood shelters are important. People take shelter in the school and other brick buildings, including the power plants and private homes. Staying in mud houses is dangerous as there is a risk for the mud house to be destroyed. Hence, the flood shelters and brick buildings on the island are a resource everybody on the island have access to which helps the islanders cope with cyclones and storms, in addition to it reducing the risk for human beings caused by extreme weather events.

The emergency relief programs were found very important for the islanders after disaster, especially for the poorest. One of my informants describes the situation after the cyclone in 1998:

> ”The government supplied food and water, medicine and tarp. The 1998 cyclone happened just before harvesting, so it destroyed everything. […] The governments programs are only for the poorest first. Then it slowly steps up to those better off. After a flood politicians say that they will provide aid, house construction, betel leaf protection etc. Some politicians use the flood for “political propaganda” (HI 9).

Other informants also depended on the dry food given by the government during the first day after Aila, since their own food storage was destroyed by saline water. Nongovernmental organizations were also mentioned as providers for the basic necessities needed after Aila. This turns the emergency relief programs into a contributor to the adaptive capacity, as they help people manage after climatic disasters.

National Rural Deployment Guarantee Act (NREGA) is an act that makes it a right for the Indian poor to be employed for at least for 100 days during the year doing unskilled jobs for the government. The program is organized by the local Panchayat (Mukherjee 2009). This is a true commitment to the poor and the act has been initiated all over India, also on Moushuni Island. Those taking part in this program on Moushuni do mud cutting, strengthening the

riverbank and road building. The findings uncovered that households rely on these programs when they have lost their main income due to extreme weather events. This is how one of my household informants managed after the cyclone Aila:

> "We engaged in the government program "100 days of work" and started fishing. Others migrated to other places .Most young people have migrated. We lose agricultural land every year. The Panchayat gives a card to the families that want to work and call them whenever they need work. If we do not work 100 days we have to pay back half of the money. We clean ponds and fix the riverbank" (HI 3).

100 days of work program gives the people a chance to make an income if they have lost their main income source to a cyclone or a storm, and can therefore be regarded as a contributor to the adaptive capacity of the inhabitants on Moushuni.

Local knowledge and experience

Moushuni is, as previous sections of this thesis have elaborated, an area that is prone to extreme weather. This means that people have a lot of experience dealing with difficult climate related situations. The experiences that a society has in coping with existing climate variation and extremes have been recognized as factors strengthening the capacity for climate adaptation (Smith & Wandel 2006). The role of prior experience and local knowledge for how the people cope with climatic challenges and for their adaptive capacity is here highlighted.

Something I found surprising was that few interviewees said that they did anything particular to prepare for disaster as cyclones and floods, when they were asked directly. Comments like this were normal:

> "We cannot do anything to prepare. It happens to everybody, all neighbors are in the same condition. We can move if it gets too difficult" (HI 14).

This can reflect a feeling of helplessness and that they have given up preparing themselves for disaster. However, when asked more direct questions about what people did before, during and right after the Aila cyclone, that hit Moushuni the 25th of May 2009, I found a number of things they did to limit the damages of the cyclone. I believe this shows that the people on Moushuni are very used to dealing with climate stress, so used to it that it has become an integrated part of their life.

Measures found that took place prior to Aila were pushing sticks in the soil on the riverbank to limit the erosion caused by the cyclone. People were also securing their houses with wire and packing foodstuff together in waterproof bags or off the ground to avoid water damage. They strengthened the roads and the embankment with mud before and during cyclones, in

order to make them strong enough to keep the water out. These measures were important to limit the outcomes of Aila.

One informant who lived next to an elevated road mentioned the collective action they did to hinder the water overflowing the road on the day that Aila hit the island:

> "That day we tried to protect this road. We put mud on the road to avoid the saline water to get on this side of the road. But the people on the other side of the road were affected by Aila" (HI 13).

The people on the other side of the road were affected because the saline water flooded their fields, while my informant's property was left unaffected because the water was stopped by the elevated road. Another woman living in a mud house with her whole family mentioned a few preparations that the family did before Aila. "Actually, this portion of the wall is not strong. So we tried to protect it with bamboo and wire" (HI 15). Others I spoke with also used wire to protect their houses and betel plants prior to and during Aila.

One informant, who was quoted earlier in this thesis, experienced the 1998 cyclone more severe that Aila. When he was warned about the cyclone in 1998, he could not imagine how strong the cyclone would end up being until it was too late. So, this experience made him take few preparations, something which again could increase the experiences of the severity of the cyclone. This can be an indicator of the importance of prior experience with heavy weather for preparations and action. Unfortunately have I not found any studies that compare the strength of the 1998 cyclone to Aila, but Aila is considered one of the hardest cyclones that have hit the region in years.

An old man that was both a farmer and a shop owner said he understood that a strong cyclone was about to occur two days before Aila struck. He could see it from the wind in the rice fields and from the wind that blew the night before (HI 13). Others I spoke to about signs from which they could predict the weather, knew of no such signs. Having the knowledge and experience to interpret the climatic signs is another factor that increases the adaptive capacity of the few people who can do it, as it gives people more time to prepare.

These findings show that experience with these extreme weather events and knowledge of how to prepare for them are important contributions to the adaptive capacity of the people on Moushuni. The skill to understand local weather related signs are another factor that can contribute to the adaptive capacity to some people, as it gives them time to prepare for upcoming extreme weather.

Strong social network

During the interviews it was one thing in particular that was brought up as important for the people both during and after disasters, climatic or others, and that was the strong social network on the island. Here, I will investigate whether this finding can be another factor strengthening the adaptive capacity on the island.

The data indicates that the cooperation among the inhabitants on Moushuni is important in order to collectively limit the impacts of disaster such as cyclones, storms and floods. For example, one informant said that people got together to carry out preventive measures during disasters, such as putting extra mud on the embankment and placing long sticks in the mud by the river to limit flood and erosion. One betel farmer described the actions during the 1998 cyclone:

> "Women were inside with kerosene lamps. The men went outside to protect the riverbanks, with torches on battery. We used it on the riverbank. We threw trees in the river and put mud on the riverbank. No one died. The women were inside all night, and they had no sleep" (HI 4).

The men gathered on the embankments to protect the island, while the women gathered inside to find comfort in each other, both important acts in order to reduce the negative impacts from cyclone. Another informant explained, "We have a concrete house, so we are not so affected by natural disaster. We also have a different house, in which we were when Aila came last year. Many people took shelter in our house" (HI 8). This indicate a strong cooperation and willingness to help each other, the more wealthy living in brick houses keep their doors open for their neighbors during disaster.

After disaster the help from neighbors and friends is very important too, in the process of getting life back on track. Informants told me about a group of youth that collected money after Aila for which they bought food and gave to the most affected. One of my informants said that "The most important thing when accident strikes, is the support from the neighbors" (BI 9). People are aware and appreciate this relationship. Helping each other was so common, it appeared, that people helped each other without thinking about it. A household I interviewed was asked if they helped anyone after Aila, and the answer was first no, because they had no savings. But then they remembered that they did give straw for repairing roofs and firewood to neighbors and friends that were affected.

Lending money to friends and neighbors seemed to be a very common way of helping each other after disaster. One informant borrowed money from neighbors and leased some land to

other people. This is how he got money to rebuild his house. Other informants mentioned that they borrowed money after disaster, such as the betel plant owners:

> "13 years ago there was a big cyclone in the night. It destroyed 2 betel plantations. It was a very difficult year. We started to produce vegetables after the plantations got destroyed .Our source of income was stopped and it is very expensive to start a new plantation. We had to do other things. We collected money to restart the plantation. It costs 3-4 rupees pr betel plant. Neighbors helped us to borrow money" (HI 4).

The drought in 2010 was another extreme weather event where borrowing money became the solution for some. One interviewee lost much of his harvest of vegetables due to the drought in 2010, and said that "This year we had to buy vegetables from the market instead of selling. We used savings as well and borrowed money this winter. We have borrowed money 4 times during the last 4 years" (HI 12). Another family was also affected by the drought "We lost 80 % of our paddy. We needed irrigation. Now we buy food from the local market and we borrow money from neighbors and friends" (HI 1). Apparently neighbors and friends are important moneylenders for helping people through the hardest times. It is important to remember that paying back the borrowed money not is easy for everybody, as discussed previously is the section about factors contributing to climate vulnerability.

One of my informants revealed another special way of helping relatives after climatic disasters. He said that "Relatives from neighboring blocks were affected by the flood, food grains destroyed, everything. They came here. I arranged a marriage for the girl and boy from neighboring island. They are now wealthy" (HI 14). His story shows that the social network spreads further than the borders of the island, and that there are several ways to help each other.

People depend on each other during and after cyclones and droughts, they shelter and comfort each other, cooperate with strengthening the constructions that stop surging water and help each other to get back on their feet afterwards by lending money or giving materials. This network is a strength that the inhabitants in Moushuni possess. One reason why this social network is so strong is that the feeling of unity on the island is very important to the islanders. My informants also knew that they might be the next one to be badly affected by disaster. My findings show that the people use and rely on their strong social network and cooperation on the island during climatic challenges and this cooperation and network is therefore an important part of the adaptive capacity of the people on Moushuni.

The feeling of acceptance

The people of Moushuni have experienced floods, cyclones and other climatic challenges for as long as they have lived on the island. Some of them have lived their whole life with climatic risks threatening their everyday lives. Among the informants all had experienced at least once to get property, such as the house or agricultural land, destroyed due to cyclone, flood or drought. It seemed like the constant threat of climatic disasters had made the informants used to living with them. One of the informants in a self help women's group said that: "It happens every year. We are used to this. Some have lost their house in the river, washed out. Others have lost their pond and agricultural land" (GI 3). There is reason to believe that the people have accepted that they can lose things to the forces of nature, and it seems like they have settled with and accepted that reality. Bandyopadhyay (1997) discovered the same phenomenon during a research period on environmental hazards on Sagar in the 1990's. The people in his study had stoically accepted the loss of important assets in human life such as houses and property.

To link this state of mind up to the concept of adaptive capacity is difficult. However, there is reason to believe that their acceptance of their own situation is a result of a long time of mental adaptation which is necessary in order to live a good life in such a place, which is so often threatened by natural disasters. If so, their acceptance can be one way that the people cope with and adapt to their current situation with the threats of climatic challenges. Having accepted the situation might also, on the other hand, lead to less preparations and precautions taken in order to limit the negative outcomes of climatic challenges. The data may be too poor in order to draw any conclusions; however, it is an interesting phenomenon which would be useful to investigate further.

Diversifying income and multi-locality

The last group of factors found important to include in the analysis of the adaptive capacity of the people on Moushuni, is their capacity to diversify their income and draw on several localities in order to make an income, especially in times after disaster. I will here analyze this capability in relation to adaptive capacity. Diversifying income means that "households construct an increasingly diverse portfolio of activities in order to survive and to improve their standard of living" (Ellis 2000: 15). Multi-locality involves building the livelihood of the household from incomes coming from different localities, such as one family member working abroad (Haan and Zoomers 2003).

This is some of the ways people diversified their income after Aila.

> "The day after Aila we started daily labor work. We got food from the shop on credit. Our son started pulling the van" (HI 10).

> "Before we only depended only on the paddy. We have diversified now. We have a boat" (HI 11).

> "We leased land to other people, which gave us an extra, stable income after Aila. We were not affected by the saline water, so we could continue our agriculture" (HI 4).

All three of these were affected by Aila. The last one was the betel plantation owners that got their plantation damaged by strong winds and their income reduced. These examples show how diversification can be done when the main income source is affected. This implies that people are flexible and creative in finding new sources of income when their main income source is affected by climatic challenges. This ability to diversify income was identified, despite that the opportunities for diversifying the income are limited on the island.

Another work option that several of my informants used was to move from the island for temporal work. Several young and healthy men have been employed for periods of 11 months doing construction work in Saudi Arabia and Qatar. One informant told me how the employment happens:

> "There is a placement agency in Bombay. They send some people to interview the people here in Kolkata. And we show up on the interview. In this area there is a middle man that makes contact with the interviewer and the people. And he takes some money for arranging the interviews. And after that he can go to an interview. The company makes the arrangements so they can go" (HI 14).

The men usually take up loans in order to pay the middleman and for the interview in Kolkata. When the interview is done, 50 to 60 % get a job. One of the interviewed migration workers lived in a small mud house together with his wife and their little son. They said they lost 90 % of their agricultural income in 2010 because of the drought and their house got completely destroyed during Aila in 2009. He earned 100 000 (12 000 NOK) rupees in the piping industry in Qatar, but he had to borrow money to go to Bombay and pay back the interests. He was left with 25 000 rupees (3100 NOK) for 11 months of work. He said that food, decent accommodation, and international flight tickets were paid for by the employer. Since he got back he has been doing daily labor for 100 rupees a day (12 NOK). Both the men I spoke with who had already been abroad for work have applied to go abroad again.

Temporary labor migration is an option to diversify income that involves migrating for short periods. Other research has found an increase in both diversification and increased multi-locality. These are recognized as processes that are escalating as a result of globalization and rapid urbanization (Haan and Zoomers 2003). The ability to diversify in time of need and the

opportunity for young men to get a job abroad are two factors that are a part of the adaptive capacity on Moushuni, since it increases the opportunities for people to cope and deal with climatic challenges. These opportunities can also be considered as factors reducing climate vulnerability, as they make people less dependent on agriculture and one income only.

Discussing analysis part I

This chapter has been dedicated to explore and analyze my three introductory research questions by giving an in depth picture of the climatic challenges and the risk they constitute, the climate vulnerability and the adaptive capacity of the people on Moushuni Island.

It has been made clear that the inhabitants face climatic challenges, as floods, cyclones, droughts and heat, which impose a large risk for their ability to secure their own livelihoods and well being. These climatic challenges can lead to property destruction, sickness, decreased mobility and loss of income. Several processes and factors contributing to vulnerability have also been identified, such as deforestation, poor public health facilities and little opportunities to diversify income and livelihoods. In addition the factors contributing to the adaptive capacity on the island have been presented. Technical and infrastructural resources and people's knowledge about them, emergency relief programs, local knowledge and experience, a strong social network and the opportunity to diversify livelihoods were all identified to influence the adaptive capacity of the people on Moushuni Island.

It is important to consider the above mentioned factors in relation to scale and be aware that not all people are similarly affected by climatic challenges, for example the wealthier people who own brick houses are less vulnerable to cyclones than others. Similarly, the adaptive capacity varies among people; for example not everybody have the same previous experience and local knowledge to deal with climatic disasters. Some measures, as the flood shelters, influence the collective adaptive capacity, while other measures, such as access to irrigation pumps for emptying the ponds of salt water after floods, influence the individual adaptive capacity for those who can afford to use the irrigation pumps. However, what I find to be the biggest strength of the people is their ability to draw from this range of opportunities in order to best manage a difficult situation. Different households choose which options to use during and after extreme weather events in order to create a unique constellation of actions and measures that best help them.

The threefold approach to climate adaptation was applied in order to structure this chapter and capture the width in the climate related situation on Moushuni. It has been both a useful

framework as it has guided me to capture the complexity of the climate related situation for people and the community on Moushuni Island. In addition it has been challenging as the same measures can be reviewed as measures both reducing climate risk and strengthening adaptive capacity simultaneously. This was especially prevailing for technical and infrastructural measures as the early warning systems and embankments. Others that had applied this threefold approach in order to understand the climate related context of a community has come to a similar conclusion as "several of the risk reducing measures at the same time enhanced the capacity to adapt, by increasing the available number of livelihood options" (Ulsrud et al. 2008: 50). A poorly maintained embankment was recognized as a factor contributing to vulnerability. However, the sheer existence of the embankments, even though it was in a poor condition, was simultaneously regarded as a factor reducing impacts from climatic challenges and the ability the people have to build these embankments and cooperate to strengthen them during flood was also identified as something enhancing their adaptive capacity. To understand these three aspects of life on Moushuni has been a necessary first step of this analysis in order to proceed to analyzing what role, if any, electricity has for climate adaptation.

6. Analysis part II: Electricity usage and its role for climate adaptation

Three of the introductory questions of this thesis were addressed in chapter 5 where I presented and discussed my findings regarding climatic challenges and risk, factors and processes causing vulnerability and factors influencing to the adaptive capacity on Moushuni Island. Only when these three aspects of the climatic situation on Moushuni are understood is it possible to proceed to my main research question which addresses the role of electricity supply for climate adaptation, or in other words: *Which role, if any, does electricity from the local solar power plants play for climate adaptation, through handling the direct impacts of climatic challenges, reducing the climate vulnerability and/or increasing adaptive capacity for households, businesses and the community on Moushuni Island?* This question will be addressed through simultaneously addressing my fourth introductory research question: *How is the electricity from the decentralized solar power plant being used by the customers?*

During the most difficult times on Moushuni the powers of nature are immense and it might be impossible to imagine that the little electricity access from the solar power plants on the island can have any role at all helping the people to adapt. However, this chapter will reveal that there are some links between electricity supply and climate adaptation. The empirical data material on electricity usage can be divided according to usage in three different sectors of society on Moushuni Island; 1) residential electricity usage, 2) electricity usage by the public and in public space and 3) electricity appliance on the markets. This division structures this chapter. Together with the presentation of the empirical data on electricity appliance usage in these three sectors, the analysis looks at how the different ways that electricity is being used may influence climate adaptation by targeting either the direct climate risk, reducing vulnerability and/or increasing the adaptive capacity.

The role of residential electricity usage for climate adaptation

This section presents how electricity is being used within the residential households of the interviewees. The role of this residential usage of electricity for climate adaptation will also be analyzed. The households constitute the biggest group of the customers of the two power plants on Moushuni. A WBREDA official that has been strongly involved with the electricity projects on Moushuni for years said that supplying electricity to the households for residential use was the main purpose of the solar electricity projects on the island (BI 8). Theory divides rural electrification into two main groups, productive and residential, where the purpose of the

residential usage is considered to improve quality of life and/or rural living standards (Cabraal et al. 2005).

The household connected to the power plants used to have 5 hours electricity supply daily from 6 pm to 11 pm. As mentioned, the interviewees had no electricity supply from the power plants when interviewed and they had to answer the electricity related questions by remembering how the situation used to be when they had an electricity supply. The main domestic usage of the electricity from the solar power plants consisted of light and sometimes fan and/or a TV. Observations done during fieldwork indicate that it was the women, children and elderly who usually stayed at home in the evenings when the electricity was supplied from the power plants. Many of the men went to the markets to be social, drink tea and just relax in the evenings. A female informant verified this observation; by saying that "The men spend the evening in the market. We do not go to the market. We go to each other's houses" (GI 1). Since the women stay at home in the evenings they constitute a significant part of the consumers of electricity in the households. The analysis therefore starts with analyzing the effects of domestic lighting for climate adaptation from the women's perspective.

Electric light keeping the insects away from the food

Cooking is one activity mainly done by women that is being illuminated by solar power in the connected households connected to the solar power plants. The light from the electric lamps gives a much stronger illumination effect compared to kerosene. The findings show that the electric light helps women to do their cooking faster and tidier as they could use both hands and the light kept the bugs away. Geckos, fireflies and cockroaches were insects that they mentioned as poisonous to humans if they got into the food. One of the group interviews gave good insights into how access to electricity has influenced these women's cooking routine.

> "In the rainy season there are many insects. It is difficult to see them when using kerosene. In the bright light we see. We also put the light away from the cooking, so the insects go there and they have light. The gecko is very poisonous. Last year it fell into the sweet a market man was cooking, and many people got ill. This happened across the river. If a gecko falls in the food they must start all over again. You get ill with stomach problem and must have medicine, or you can die" (GI 1).

During my fieldwork most women were cooking in kerosene light again, except for those having a SHS. This has made it more difficult for the women to cook, as one of the informants in a group interview explained:

> "We used to cook with electric light. Now it is very difficult to cook with kerosene again. Bugs attract to the light, and insects fall in the food. We must hold the kerosene lamp with one hand. We just have to manage" (GI 3).

From these findings it seems possible to draw a link between cooking with electric light and the health of the family, as electric lights keeps the dangerous insects out of the food and improves the kitchen hygiene. However, it is necessary to look a little closer at these bugs and see if they really are a dangerous to eat as these informants believe. The gecko is wrapped in legends in the Bengali culture. The Bengalis say that "if a lizard falls on the body or passes urine or ordure thereon, then it beckons illness. Sprinkling the body with Ganges water averts the evil (Mitra 1892: 585, in Frembgen 1996). If a gecko falls in a pot, the pot must be broken before thrown away, and if someone tries to drink from the pot they will get sick (Frembgen 1996). According to Dag Dolmen (Personal communication 21 March 2010), one of Norway's leading experts on amphibians, the gecko is harmless to eat and it cannot cause sickness or death. According to him, the gecko is tied up in myths in several areas of the world and it is worst for the gecko if it happens to fall into a pot. It can bite, but the bite is not poisonous but can be a little bit painful. The firefly contains toxins, but I found no evidence of fireflies causing human sickness or death. They taste bitter, however, and can possibly ruin the taste of food.[8] The cockroaches on the other hand, carry loads of bacteria with them. For example is the enterobacter, that can cause infections in the urine ways of humans, and klebsiella, that can lead to pneumonia and soft tissue infections, a part of the normal flora of cockroaches. Salmonella is found in the gut of some cockroaches, which can spread to humans through their nightly feeding, wandering and defecation habits (Denvi & Murrag 1991). Even though research indicate that two of the tree insects are harmless to people, it is an important value for the women to keep them out of the food, because they fear them and connect them to illness and bad tasting food.

The women in one of the self help groups agreed with each other that light reduced the risk of having "spice-accidents." It was easier to put the right amount of spices in the food and the number of incidences where the food was destroyed by too much salt or chili was reduced when cooking with electric light. The food also tasted better and became more delicate without insects in it. Research done in Afghanistan showed that cooking with solar light resulted in better tasting food, something that again influenced the social status of women positively (Standal 2008). This supports my findings of light improving the food by keeping the bugs away and "spice accidents" to a minimum.

My findings indicate that keeping the bugs away from the food and increased kitchen hygiene by cooking under electric light is found to be one way to reduce the possibilities of getting

[8] http://helios.hampshire.edu/~nlNS/mompdfs/FireflyToxins.pdf available April 2011

sick. Bad health is one condition that result in inability to cope or secure well-being in the face of climatic challenges, hence one factor that influence climate vulnerability. Because of this is it probable that electric light contributes to climate adaptation on Moushuni through reducing vulnerability by limiting the opportunities of getting sick. As we saw in the last chapter, there are poor health facilities on Moushuni Island and the state of the communication facilities make it difficult to receive proper assistance if they get sick. This increase the importance of the inhabitants to stay healthy and it seems like cooking under electric light can contribute to improve the health of the inhabitants on Moushuni.

Electric light bringing new opportunities for domestic income generating opportunities and improves betel leaf processing

Female informants said that with electricity they could cook at a later hour and go to bed later, if they wanted. One woman who had electricity access before when the power plants were working explained that:

> "Now we just go to bed earlier. Children cannot read as long in the night. Now we cook before dark. With electricity we cooked at 7- 7:30" (GI 1).

Based on many of the interviews, electricity access seemed to give the women more hours in the evening in addition to more freedom in how to organize their evenings. Cabraal (2005) understood the residential use of electricity as important and productive. My findings indicate that the extra time women were given by electric light was spent on helping their children with homework, conducting income generating activities such as sewing or sari making, or just "gossiping with other women (HI 5)" as one of my informants said. One woman explained how the women used their evenings when the electricity was on:

> "We spent some time cooking. Sometimes we helped our children with reading. We took training in different activities. I am using the home lighting system so I can only use the sewing machine in the night. Sometimes, when it is cloudy weather, we have no light. In night time I can do the job if light is available. But in day time I am mostly busy with household work" (GI 3).

Since the women often are busy with household work during the day, the opportunities for income generating activities outside the household are limited. Some of the women interviewees said that since the power plant stopped working in Bagdanga, they had not been able to do these income generating activities. A similar story was told by three women sowing sequins on a sari outside by the road in daylight on the outskirts of Baliera. The women lived in an area that had an illegal connection to the power plant. The closing of the power plant had directly affected these women's income. "We worked at night when the solar power plant was working. It took 4-5 days with solar to make one sari. Now it takes 8-9 days" (BI 9). The

work is tiring for their eyes and proper light is essential. Using kerosene is difficult for this work since they must use both hands for sewing on the sequins and cannot hold the kerosene lamp with one hand. They are paid 200-300 rupees (25-37 NOK) pr sari they finish, and they share the money between them. The longer time they spend on making one sari, the less money the make a day. These women said they spent their money on the household, books and clothes. So the female income is also benefitting the whole household.

These stories show that light at home during the evenings increases the possibilities for women to make an income. Their arena is at home and it is at nighttime that they have extra time they can spend on these kinds of activities. During the daytime, they are busy with household chores and farming. Women interviewed who did not have access to electricity imagined that access to electricity could increase their opportunities to make an income:

> "If electricity was available we could do something at night time after cooking, like making jewelry or beedis [Indian cigarettes]. In the day we are mostly busy with the agricultural work. We could increase our income with electricity" (GI 4).

These findings indicate that residential electric light can directly increase the income of the household as women (and men) get more options to work from home. This is something which the others who live without electricity recognized as an advantage. The extra female income can benefit the family in many ways. Female income is found to have a positive effect on the caloric intake of the household, something that again affects the health situation of the family (Rathnayake and Weerahewa 2005). This can have an impact on health of children and adults in the Sunderbans. The current health situation is rather poor. A study found that 52 % of the children between 0 and 5 years old in Sunderbans are suffering from chronic malnutrition. This is higher than both the state and national average and it mirrors a high rate of chronic poverty and food insecurity on the islands (Kanjilal et al. 2010). In the previous chapter it was identified that climatic challenges such as cyclones, floods and droughts influence peoples harvest and income and therefore also their food insecurity and nutrition. After the cyclone Aila, for example, many families lost their harvest and the food they had stored to the tidal wave that followed. It took some days before everybody got access to emergency relief dry food from government and NGO programs. Other research has found that women who were breastfeeding had trouble producing milk to their children due to low nutrition levels themselves. Kids were much affected by the shortage of food after Aila (Kanjilal et al. 2010). Extra money can be crucial in times during and after extreme climatic challenges, in order to be able to buy some food and repair property.

However, it must be said that the impression when meeting the people of Moushuni is that the people are healthy. The islanders are very beautiful, hard working with straight backs and good mood. A schoolteacher I spoke with had the same opinion about the people of Moushuni:

> "Moushuni has a healthy population. We are saved by God. We eat healthy vegetables and there is no pollution and we work hard" (BI 9).

The data on how the informants experience their own food situation is a little weak. Some mentioned that they relied on dry food from the government right after Aila and others had to buy vegetables and rice on the market because their own harvest was destroyed by saline water floods. However, they never mentioned hunger or malnutrition as a problem, even when asked the open question about what they found difficult on the island. Still, there is reason to believe that increased female income leads to better health also on Moushuni, since malnutrition is a problem in the region and other research has found that that female income contributes to increasing the daily income of calories for all family members (Rathnayake and Weerahewa 2005).

Since electricity plays a crucial role for women's ability to conduct income generating activities, and there is a link between income and health, there is reason to believe that electric light can reduce the vulnerability to climate challenges. Residential electricity also increases the options for diversifying income. Lacking opportunities for diversifying income was recognized in the previous chapter as a factor contributing to climate vulnerability and people that only depend on agriculture were identified as vulnerable to climate related stress such as floods and droughts. Diversifying income is also recognized by others as a factor that reduces climate vulnerability (Agder 1999). My findings indicate that domestic electricity access directly targets one factor contributing to vulnerability on Moushuni by giving people more opportunities to diversify their income. Electricity thereby influences climate adaptation positively.

Domestic betel leaf production was also found to benefit from electricity supply from the solar power plants. One informant that owned three and a half betel leaf plantations explained how electricity is being used in the process packing of betel leaves.

> "We have a connection from the power plant. It is not working now. We use kerosene [for light]. It is difficult to stack the betel leaf with kerosene. We do it at night time twice a week, until 2:30. We have had the betel plantations the last 13 years and electricity from the beginning of the power plant [2000]. Electricity does not affect production. Price depends on quality of leaf. Good quality means good price. We used electricity for packing. First we make stacks of 50 to 150 betel leafs, after washing them. The stacking is important. It is difficult to

> make a fancy stack in kerosene light. A stack that is not fancy means lower price. So the lack of el affects the price of the stack" (HI 4).

Electricity is not essential for the packing and stacking, however, it improves the process, and makes it easier to make fancy stacks of betel leaves that they can sell on the market for higher prices. This is another example of how residential electricity supply in the evening can increase the income for households on Moushuni. Increased income, from both income generating activities at home and from betel processing, strengthens the adaptive capacity of the household as the household has more resources with which to handle the impacts from the climatic challenges with.

Doing homework under bright, electric light

During the interviews reading was repeatedly mentioned as an important area of application of the electricity domestically. For some of my informants it was even the decisive factor for why they got a SHS in the first place.

> "We got the solar home lighting system two months ago. Kerosene is not available. It is 13 people here and the kids need to read" (HI 14).

Another family that had a connection to the power plant mentioned reading as one of the most important activities done in the electric light:

> "When the kids were younger they read under the light. […]. Our daughter in law knows how to read and she used to read when she helped the kids with their homework. She read stories and novels. She does not read anymore as they have no good light. She used to read Tagore. She is now very busy with her own kids, has no time to read" (HI 10).

Cabraal (2005) presented growing evidence showing that proper lighting domestically is related to an improvement in education levels. A study from the Philippines concluded that children from homes with electricity studied many more hours when electricity was available and gained about two years of educational achievements compared to children from homes without power (World Bank 2002). Based on the data material, it is difficult to say something about improved education levels on Moushuni as a consequence of the electricity supply. A local school teacher who has been working at the local primary school in Bagdanga for 15 years said that "solar cannot provide electricity to all; just a few people is affected. But yes, some students are preparing their homework more comfortably" (BI 9). He did not mention anything about education levels, but rather highlighted that electricity made reading more comfortable for those with electricity in their homes. It is important to remember that most of the people on Moushuni have no electricity access at all. Domestic light is for the few only.

Knowledge and education strengthens the adaptive capacity of an individual, as the person increases the job and income opportunities. Knowledge is also important for knowing how to prepare for and handle climatic challenges, as highlighted in the previous chapter. In this way electric light can contribute to increasing adaptive capacity, that is, if it leads to increased education levels. This is, however, something that is difficult to see from the data.

Improving the life of the weakest and other benefits of domestic electricity

The data revealed another possible benefit for the household that used electricity domestically. Living and working under a poor light source, such as kerosene, can be challenging for everybody, and especially for the elderly or people with bad eyesight. An old man, who claimed to be 105 years old, told me that "it is difficult to live in the dark for an old person" (HHI 3). The old man had bad eyesight. Another informant, an old man who worked as a priest on the island, also depended on the light due to bad eyesight:

> "We cannot return back to sorrowful life, when we started to use electricity the happy time started. We cannot return to the dark times now. It is very difficult. I have some problem with eyesight, it is extra important with light" (HI 9).

Based on the interviews with these two old people I got an understanding of electric light being important for them in order to be a part of family life in the evening. Since there is kerosene shortage on the island, most households also relay on candles as a light source, and this gives even poorer light than the kerosene lanterns. As explained in the previous chapter, electric fans can also benefit the old and sick people by making the hot evenings more comfortable.

One informant had a baby who was less than one month old. The baby was born at home, which is often the case in Moushuni, and the electric light from their SHS was used during the delivery:

> "The baby is less than 1 month and was born at home. We used solar as light source during the birth. He was born at 7 pm. It is normal to give labor at home, in emergency situations they can go to the hospital. There is some women here who assists labors and give medicine and advice them [mother and child] to go to the health center. It is very important with the light during labor" (HI 14).

The facilities during child birth are poor, as both nurses and doctors are lacking. However, the bright light contributes to improving the situation a little bit. There is no reason to believe that light is the matter of life and death, but it brings more comfort to giving birth.

The link between the exposure to certain types of fuel used for cooking, such as cow dung and fire wood, and the chances of getting chronic obstructive pulmonary disease and acute

respiratory infections during childhood has been established by other researchers (WHO 2007). Kerosene is considered a cleaner fuel, but can still contribute to more indoor pollution than gas and electricity (Smith et al. 2000). The women on Moushuni still use firewood or cow dung to cook; some have their stoves outside while others cook inside. Electricity is not being used for cooking since it would require a much larger capacity of power supply than what is available on the island. However, the fact that some households use electricity instead of kerosene for light, might give small health benefits due to better indoor air quality.

Since electricity is being used to increase the quality of life for the elders, making childbirth more comfortable and even might increase the indoor air quality, there are reasons to believe that electricity brings small health effects worth including as impacts of electricity on domestic usage. The effect would have been much higher if electricity was used for cooking, but this is not the case on Moushuni. As explained earlier in this thesis, increased health can be analyzed as a factor that reduces climate vulnerability. Having good health is important when faced with the climate related risks.

Television, causing changes in society

Among the informants who had a connection to the power plant, few had a television sets. Some of the informants got electricity from their own SHS or rented batteries at the market to run their televisions. A survey conducted on Sagar and Moushuni in 2010 found that 39 % of those connected to the power plants had a television and 38.8 % of those with their own SHS had a television (Ulsrud et al. forthcoming). One of the informants used to have a television set, but sold it to her father who had a SHLA as she did not use it anymore due to little electricity from the power plant.

Cabraal (2005) claimed that watching television should be included as a productive way of using energy, due to its positive effects on the household's knowledge about gender issues, for example. I discussed the relationship to television with both women and men, in order to explore the effects of watching television. The informants watched movies sometimes, especially traditional Bengali movies. One of the interviewees liked to watch romantic movies, but she said that:

> "… Some people do not like this openly. There might be some gap, our culture do not support that someone hug a women on the road. In the movies they do accept this. When the family watches the movies in the house, it is very difficult to see it with our kids" (HI 5).

A self help group consisting of women agreed that they disliked the effects of modern movies. They mentioned modern movies as one of four factors that had created changes in their

society. The change they thought of was the increasing trend of women moving to their in-laws without being married first. Modern cinema, they said, "shows so many things, as adultery, and it is not good for the kids and students" (GI 3). Other factors that they mentioned to cause this change was that women went more outside of the household and even off the island to go to school. Local dances have emerged where youth have played music and danced. These informants referred to the dancing as "bad movements" and "adultery." A last factor contributing to the changes in society according to them were the mobile phone, which made young people interact more with each other.

The only informant who used to watch TV every day in the period the fieldwork was conducted blamed the modern movies for being one reason for suicides on the island.

> "The young ones want to have relationships and they are forced to separate by their parents. This can lead to mental problems and suicide. Relationships are increasing. Not all parents agree, but they are scared of their child taking suicide. This has been increasing during the last 10-11 years. Modern movies are helping the kids understand that this is possible. Some in the movies have relations from childhood. Modern songs are also not so good" (HI 8).

His statement is similar to that of the women above, as he also blames modern movies for people having relationships before marriage and even leading the young people to commit suicide if they are not allowed to have these relationships.

An employee at Sagar Rural Hospital said that they experienced four to five suicidal attempts every month. Sagar has a population of 200 000 people. The most common way to do it, according to the employee, was by eating pesticides. It seems like the inhabitants blame the television and modern movies for what they consider negative developments in society. However, both the man and the women interviewed represent a rather conservative and moralizing attitude when it comes to modern movies. Unfortunately I did not get the opportunity to discuss these matters with the youth, who most likely would have represented a different perspective. Television, however, might affect societies. Research has found indications of a link between watching sex on television and early adolescence sexual initiation (Collins et al. 2004). There is reason to believe that watching modern Hindi and Bengali cinema can influence changes as those mentioned above. My data on this matter is weak and these issues are very complex, this making it difficult for me to do anything more than just presenting this data. I regret not speaking more to the youth about these issues. The observation, however, is interesting and should be investigated more in the future.

Another finding is that people, in general, watch very little television. An old farmer told me why he did not watch so many movies, "most of the time we are busy to earn, it is an endless

demand" (HI 5). People work hard and have little free time to watch television. With the power plant not working, the opportunities watching television are even less. The few that have a television gets visited by neighbors coming to watch. As one female informant said: "the rich have television and the rich are not always happy because the neighbors come every night and intrude their privacy" (GI 4).

The informants blamed the television, among other things, for negative and unwanted change in society, however, this can also be considered a change towards women and youth were getting more freedom and them liberating themselves from the traditional society. It is difficult to tie these findings to climate adaptation. However, it might be possible that increased freedom can lead to increased capacity to handle challenges as it can make people think untraditionally regarding finding solutions to their problems. This could possibly enhance the adaptive capacity; however, it is difficult to say anything sure about this matter based on the data material gathered for this thesis.

Electric light used while preparing for cyclone and flood

Electric light has being used during preparations for flood and cyclones. Some of the informants who had electricity supply from the power plant said that they used light while packing and storing food away in high places, in order to save it from the flood water. Light is not at all essential to do this, but it can make the stressful situation easier to handle. As my previous chapter showed, most preparations carried out prior to cyclones and floods are not dependent on electricity, but rather muscles and cooperation. People use their hands while securing houses and property and while strengthening the embankments and roads. In addition is electricity from the power plants rarely available during and after extreme climatic events such as cyclones. When the cyclone Aila occurred in 2009 Baliara power plant was shut down for 3 days during and after the cyclone. Having the electricity for the packing of food can be understood as something contributing slightly to the adaptive capacity because it becomes a resource people can use in order to prepare for climatic challenges.

Electricity usage by the public and in public spaces and its influence on climate adaptation

Here the empirical data concerning how electricity is being used by the public and in public buildings and space will be presented. The findings are structured under the headings of electricity usage for warning and spreading information, in education and health facilities and in public space. They data will also be analyzed to see if and how this usage of electricity in

public space can influence climate adaptation either through reducing the risk posed by climatic challenges, reducing climate vulnerability or increasing adaptive capacity.

Warning and spreading information

The local Panchayat uses instruments for getting and spreading information about upcoming climatic challenges, such as a loud speaker system and cell phones. Radios and an early warning system are also instruments used for getting and spreading information, but these are used by private households. These instruments were presented in the previous chapter as technical resources that contribute to strengthening the adaptive capcity of the people on Moushuni and reduce the climate risk. Several of these instruments depend on electricity from other sources than the solar power plant.

The Panchayat gets information about storms from the Block Disaster Management Officer at the Block Development Office. His role is to look after the matters regarding disaster and get in touch with the Panchayats if something special is occurring. This communication relies on cell phones. The cell phones are also used by the average islander before, during and after a cyclone, in order to get in touch with relatives and friends, as explained in the previous chapter. The solar power plant is usually not used to charge cell phones as most people charge their phones in the market from diesel generators or from private SHS. The planned early warning system owned by the WWF was intended to run on a SHS. The loud speaker system used by the Panchayat to warn the inhabitants and the radios the islanders use themselves in order to hear about the weather are both run on batteries. One informant who lived close to the embankment said that he "heard about Aila from the radio, but then it was already started. Everybody who heard it on the radio told their neighbors" (HI 11). The word of mouth might still be the most important way to spread information about storms and cyclones on Moushuni.

These findings show that the instruments identified as resources contributing to the collective adaptive capacity rely on electricity, but from other sources than the solar power plants. Having these instruments might influence climate adaptation by reducing the impacts of climate risk, as they give the people a chance to prepare. Solar energy is not being used to these measures. The technological attributes of the solar technology and the related socio-technical system are probably reasons for this, as the hours of day when the electricity is available is limited and people are allowed to have only 3 or 5 electrical outlets in their homes. This indicates that the solar energy from the solar power plants at Moushuni is not

contributing to strengthening adaptive capacity through supplying important instruments information with electricity.

Lit up schools

Public schools are some of the few public buildings that have electricity supply on Moushuni. The boarding school in Bagdanga has its own 4 kWh SHS on the roof. The school hosts both boys and girls who use the electricity in the evening for studying and other activities. Bagdanga primary school has a small standalone solar system, which is being used for light in the evenings and fans during the day. The local school teacher expressed that they want to use electricity to run computers too; however, they have no funding to buy machines. Other research has found examples that show schools in the rural areas of the developing world benefitting from electricity as electricity connection has given them the opportunity to provide their students with clean water, warm food, light, computers, audio/visual equipment etc (Cabraal et al. 2005). This has not happened on Moushuni due to little funding in general, and not only because of poor electricity facilities.

This show that the electricity from the power plants has no influence on the schools, however, the school and boarding school benefit from stand alone solar systems. These systems improve the studying environment in the evening in the boarding school and during the day at the primary school as fans are applied. This might improve education levels and by that increasing the adaptive capacity, as discussed above, however, my data is too weak at this point in order to conclude on this matter.

Electricity's influence on public health facilities

As explained in the previous chapter, the health facilities on Moushuni are poor. This poor condition was recognized as one factor contributing to climate vulnerability. I will here investigate how electricity is used in these public health facilities and how electricity can be found to influence the quality of them.

As mentioned there is no electricity connection at the four health centers and the hospital is closed and not supplied with power. The dry cell battery plays an important role, however, as it is necessary in order to listen to the radio program where the ASHA health workers get their training. By that electricity from dry cell batteries is important and improves the quality of the service these women can provide. Another, more indirect link between electricity and quality of health facilities was highlighted by an employee at Sagar Rural Hospital. He said that the lack of modern facilities, such as electricity, makes it unattractive for trained health personnel

to live in the region. He said "Everybody knows that this is an unelectrified area, which means they will face some problems after coming here. Staff would come here if it was 24 hours supply" (BI 7). Sagar is in the same situation as Moushuni, with only limited access to electricity from decentralized solar power plants. There is no connection to the main grid and no 24-hour electricity supply, not even for the hospital. The hospital on Sagar gets electricity from solar power and a diesel generator, however, only for certain hours a day. The blood bank and operation room is not in use due to the lack of electricity. Cabraal (2005) found similar connections in his research when analyzing several rural electrification research projects. He found that electricity access made regions more attractive for trained personnel as doctors and teachers. The electricity access on both Moushuni and Sagar is, however, seemed to be viewed too little for the trained personnel as the island still is regarded as an unelectrified area by most people from the outside. However, the electricity facility is still better there than on other locations with no electricity at all. This might be one reason for trained personnel to choose Moushuni or Sagar instead of other completely unelectrified areas as their place to work. In addition to the public health service, there are "quack doctors" operating on the island, and these have benefitted from the light provided by the power plants. Other research has found that electricity access has increased the hours that a quack doctor treated patients at home. Electricity in his house made him able to receive patients in the evenings (Ulsrud et al. in progress).

My empirical evidence shows that electricity from the solar power plant has little positive influence on quality of the health facilities on the Moushuni. The little electricity might, however, increase the attractiveness of the location a little compared to the totally unelectrified areas. Due to this there is reason to believe that the solar power plants have not reduced climate vulnerability by strengthening public health facilities. Electricity from the dry cell battery and SHS might, on the other hand, have improved the skills of the ASHA workers and increased the opening hours of the quack doctor and this can have reduced climate vulnerability.

Illuminating public space leading to increased mobility

Despite the lack of electricity in public buildings, the electricity from private houses and businesses has illuminated public space. I will discuss the consequences of the market illumination in the next section. Here I will focus on other public areas and discuss how this illumination might have influenced climate adaptation.

Bright electric light from houses and businesses does not only illuminate the inside of the house or business, but outside as well. May of the households do for instance have a lamp outside on the balcony. These lamps throw light on the pathways and roads and other transport veins that people move along. Some female informants participating in a group interview, electricity meant extra freedom to visit other people at night.

> "When electricity was available, people went to neighbors' house in the night time. Now we feel fear when we go out in night time because of snakes. We do not go out so much in the night time as there is no light. We are also scared of being attacked" (GI 3).

The lamps illuminating the otherwise dark night represent a sense of security for these women. The dark night can otherwise hide poisonous snakes and attackers. As mentioned do people die from snakebites on Moushuni every year, and one of the women in one of the self help groups had recently experienced being attacked in the dark. The women put the attack in a political context and explained it as this:

> "It is due to political issues. The Marxists are losing power, and they do not like that we women are meeting. They think it is political meetings. But here there are members from both political parties here and only women in this group. It is not much violence against women"(GI 3).

Having the opportunity to meet other women is important for several reasons as visiting friends and family, entertainment, generating income, nurture social networks and maybe even for political purposes. The electricity made these women visit each other more often and the lack of electricity now increases their fear of moving outside in the dark. Other research has found similar effects of electric light on mobility at night. The in depth assessment of the economic and social impacts of the rural electrification program in Bangladesh found that the security of mobility at night was increased for all the respondents, whether they had electricity in their homes or not (Barkat et al. 2002). Research carried out on Zanzibar found that people referred to the electric street lights as "security lights," which made them less scared of walking out at night time (Winther 2005). Standal (2008) even found the increased mobility caused by solar light leading women to meet in empowering settings.

Linking the increased mobility with climate adaptation is interesting. The women in this self help group said they as women feel safer visiting each other's houses. It is in the evenings they have the time to meet to learn and carry out different crafts, such as tailoring and sari making. Increased mobility can lead to more opportunities for diversifying income, something which reduces climate vulnerability. Increased income can also strengthen the adaptive capacity of the household as the household gets more resources to draw from when during and after climatic challenges.

Electricity appliance in the market and its influence on climate adaptation

The findings regarding the electricity usage at the markets in Baliara and Bagdanga villages will here be presented and towards the end of this section the findings are linked up to climate adaptation by analyzing if and how the electricity usage at the markets has reduced the risk posed by climate change, targeted the processes and factors causing climate vulnerability or/and increased adaptive capcity.

Changes in the market caused by electricity access

The findings indicate that the markets both in Baliera and Bagdanga village are two of the places on the island that have benefitted from the solar energy supply. There was some electricity supply from privately owned diesel generators on the markets before the solar power plants opened. When the power plants opened, the price per connection per business owner dropped significantly and the opening hours of the businesses in the market expanded. Today the market areas in both Bagdanga and Baliara are getting some electricity from the private diesel generators again, as the power plants have stopped supplying. When the power plant opened a three point connection was charged a 1000 rupees start up fee, in addition to 150 rupees a month. Today the price of one connection to the generator is 10 rupees per day. So the market customers pay more for less light in their shops.

During fieldwork several businessmen who were interviewed talked about the importance of light for running their business. A retail shop owner selling bangles, cheap jewelry, bindi marks and other decorating items at the Bagdanga market explained the significance of electricity for his business:

> "I had 1 point connection from the generator from 1990. Then I got 3 point from the power plant in 2000. I need bright light to attract the customers for his shop. 1 point is not enough to light up this shop and the diesel generators sometimes do not work, only until 9 in the winter and until 10:30 in the summer. The power plant supplied until 11-11:30 pm. Using the 3 point connection has increased my income from this shop. It was a change in market after 2000 [when Bagdanga solar power plant opened]. People came from different corners of the island in the evening" (BI 6).

Another salesman who bought fish from Moushuni fishermen and sold it to Kolkata also experienced great changes as the electricity came. He started to have his business open in the evenings and people came to him to sell fish after dark, something they did not do before. He also claimed it to be easier to wash the fish clean in electric light compared to kerosene light. A tea-stall owner, an old woman, also found the light important for her business. She said light is "very important. As people come here for light. Without light, no customers" (BI 2).

Some businessmen, who do manufacturing or deliver services in the market, use electricity in more ways than just attracting customers. A pensioned hairdresser told that he started to use a "hair heater" when the power plant opened, something that gave him the opportunity to improve his services. The local confectioner at Bagdanga market also explained how electricity influenced his work:

> "We experienced increased sale after the power plant opened. In the dark kerosene light, people avoided going to the market. When the light came more people came to the market. We only use the light to make sweets in the shop, and we mostly make sweets in the night time. […]. Bright light makes it easier to make sweets. In brighter light we can protect the sweets from insects" (HI 14).

The consequences of insects in the food were discussed earlier in this chapter and insects in the food are also a concern of those making sweets and food for sale in the market. Bright light can increase the hygiene and limit the number of insects in the food and improve the service of hairdressers, and probably others selling services in the market too, such as tailors and jewelers.

The socio-technical system limits what kind of appliances that can get electricity from the solar power plants. The customers cannot use the electricity for other things than light, fans, cell phone charging and television. Electricity access is highly appreciated by the shop owners; however, the limitations to usage are sometimes frustrating. A tailor explained his opinion:

> "I cannot work as much as I want due to the heat. Work from 6-12:30 and from 14-11 pm. Electricity can help to remove heat with a fan. It will also decrease the time spent on cutting and sewing. Now I use a stove for the iron. I want to use an electric iron. But I am not allowed to use the power plant connection for electric iron" (BI 5).

His frustration reveals how the limitations related to the solar power supply as a technological system. The limits to when the customer can use electricity and the restrictions to which appliances they can use, influence their business. If this tailor could use a fan during the day, he could work the whole day through. And if he could use an electric iron, he would improve his work and reduce his kerosene expenses, he pays 20 rupees a day for kerosene to the stove he heats up his iron with, improve the indoor air quality and do his job more efficiently. Using solar electricity for an electric iron is possible technologically; however, an iron draws 1000 W and is therefore not allowed to be used due to the amount of electricity it requires.

These findings indicates that light is important for attracting customers, displaying the merchandise and being able to have customers in the evenings. Electricity usage also improves services and work conditions for some business owners. Electrified markets have

caused the number of shops and customers to increase. Several of the informants reported a significant increase in income after the power plant opened. However, the blooming markets have also made the situation more difficult for some of the business owners. The increase in number of shops has brought more competition. One of the two tea stall owners interviewed reported about 6 to 7 new tea stalls in Bagdanga market since the power plant opened. A barber at Bagdanga market also reported about increased competition after the power plant opened. The number of barber shops has increased from 3 to 5, and he has fewer customers now, due to increased competition. For the business owners located in other locations without power, the power plants have led to fewer customers in their shops, as the islanders tend to draw to the electrified markets in the evenings.

One of the market informants experienced a significant loss in market activity when the solar power plant shut down. The retail owner at Bagdanga market explained the impact of closed solar power plant on his business:

> "Now they [the customers] do not come as 60 % of shops are closed in the evening. I have my shop open in the evening and I have a one point connection from the diesel generator. My income has decreased 25 % as the power plant has shut down" (BI 6).

The tea stall owner said that "Power plant dysfunction gives fewer customers." Another businessman, a tailor owning a big shop with fabrics and a sewing machine had a similar understanding of the situation with and without electricity:

> "After the power plant started there was an increase in income and some new shops. When the power plant worked, 90 % of the shops were open at night. Now, only 60 % are open at night because the connection from the diesel generator is so expensive compared to the income from the shop. Sometimes we have light only for 2 hours .In my shop the activity is 50 % less when the power plant is not working" (BI 5).

There might, of course, be other processes and factors that have affected both the growth in the market after the solar power plant opened and the decrease in business as the power plant shut down. However, the fact that power plant dysfunction has lead to closed shops, strengthens the claim of the positive effects caused by the power plants on the local markets, such as increased opening hours, more customers and shops, more activity on the market and increased income for some businesses.

The market as a meeting point

The market place is also used for politicians to spread information and by groups of people to get together and share experiences. A man said that

> "…different groups of people, like the farmers and the fishermen, come here to talk to each other and have meetings about the problems they face. Like the farmers talk about how to use

> the new seeds and fertilizers from the government, or which medicines they use. There are different problems for different groups. The conversation is increasing in these groups during the last years, as the pattern of agriculture is changing. They do not know how to use the new stuffs. The market is a very important part of these peoples life" (GI 2).

The illuminated space of the market facilitates these meetings and makes them easier to conduct. The market is also a place where people get information about daily labor jobs that are available. They are announced at the market. Blooming markets and longer opening hours increase social interaction and can also strengthen already existing social networks or stimulate new ones to be created. I also observed people reading newspapers and books under the electric light in the markets. It gives an opportunity for those who lack electricity at home to benefit from electric light in the evenings.

The possible role of the changes on the markets for climate adaptation

It is now time to discuss how the above mentioned changes in the market activities caused by electricity have influenced climate adaptation on Moushuni. In the previous chapter, the dependency on agriculture and the limitation on diversifying income were discovered to be factors contributing to climate vulnerability. Cheaper electricity access and more customers due to light for longer hours each evening can be one reason for the increase in the number of shops. This shows that more people have started businesses and maybe even diversified their income making their household less dependent on agriculture. This indicates that electricity supply in the markets has increased the opportunities to diversify income for the households on Moushuni and thereby reduced individual climate vulnerability. The changes on the market might also have strengthened the adaptive capacity as the islanders have increased opportunities for coping with climatic challenges.

Electricity access was found to increase the income of some business owners, but not all, as the competition has gotten harder. Research from other studies show the close link between electricity and income in small sized enterprises (Kirubi et al. 2009). His findings are based on research done in rural Kenya, where they found an increase in income due to access to new productive tools. My findings indicate that even though there are restrictions that limit the use of special tools, there is still an experienced growth in the market, due to light alone. Several of my informants struggle through their daily existence and extra income is welcomed dearly. Even though they own a business, they often also own land and depend on the harvest as well as the income from other family members. One of the tailors I interviewed described his income situation as this:

> "I moved here the last 5 years, the first shop was far from the road. I own the shop. I have a family with 6 members and 1.33 acres of land. There I grow patty and vegetables. We do not produce enough for the family, so we buy from the market. I, my father and brothers work on the field. The shop is closed in harvesting time. Women usually do not work in the field. The land was fully affected by saline water after Aila and 1 acre was destroyed. Because of this we have no paddy this year" (BI 5).

Increased income from the shop plays a significant role in the everyday struggle of these people, and especially after cyclones such as Aila. It is at that time very important to have the extra savings to buy food and repair property, if one was so unlucky to lose the harvest or get property destroyed by the tidal wave. Due to this is it possible to link electricity supply to blooming markets and extra income which reduce individual climate vulnerability.

Other ways the solar energy supply influence climate adaptation

In this section the other ways the presence of the solar power plants and the solar electricity supply might have influenced climate adaptation will be presented.

The solar power plant as a flood shelter

The solar power plants not only supply energy, but the physical buildings also function as flood shelters during cyclones. The people living in mud houses were afraid of staying at home during storms and cyclones, since they know it can be dangerous to stay inside. People living in brick houses also went to the power plant for protection during severe cyclones, such as these informants:

> "Aila started at 7 in the morning. We went to riverside to see the condition. The wind came from east and we got worried that the riverbank would break. The wind turned to west. We went to the power plant for protection (HHI 4)"

The power plant contributes to limiting the damages on human beings during cyclone or flood, and by that reduces the risk posed by climate risk. In addition, the solar power plants can be regarded as a resource that the community has access to in difficult times, and thereby it also acts as a factor that strengthens their adaptive capcity.

Mitigating emissions, reducing the problem?

Renewable energy has received a role in the global climate change discussion as one way to mitigate the effects of green house gasses, and by that limiting the negative outcomes expected as a result of climate change (IPCC 2007). As mentioned are climate change believed to cause much impact on Moushuni because of rising sea levels and more saline floods. The reductions of global climate gasses caused by the two solar power plants on Moushuni Island are extremely small, however, the power plants does at least not contribute

to the problem. And the findings do indicate that the solar energy supply makes the inhabitants use less kerosene and the markets to use the diesel generators less.

Discussing analysis part II

This chapter has been dedicated to the empirical findings regarding how electricity is being used in households, in public and on the markets. These findings were analyzed in order to see if there were any linkages between how this electricity was being used and climate adaptation. Relevant issues for the main research question has been discussed: *"Which role, if any, does electricity from the local solar power plants play for climate adaptation, through handling the direct impacts of climatic challenges, reducing the climate vulnerability and/or increasing adaptive capacity for households, businesses and the community, on Moushuni Island?"*

Residential electricity usage was found to reduce climate vulnerability by giving more options for diversifying income and reducing agricultural dependency. Increased income from both the domestic income generating activities and from betel production can also be considered to strengthen the adaptive capacity, as people get more resources to use when faced with climatic challenges. Residential electricity usage might reduce climate vulnerability by improving health through limiting the number of disease bringing bugs in the food, through playing a significant role during child birth and possibly improving indoor air quality. Weak possible connections were found between climate adaptation and improved education and changes in society caused by television and modern cinema. In public buildings and space the electricity supply from the solar power plants has had little influence, however, separate SHS were found useful for the schools. The public health and education facilities have no electricity supply from the power plants and neither did the instruments used for spreading information before and after cyclones and storms. The solar power plant might, however, make the area more attractive for trained personnel compared to completely unelectrified areas. The mentioned increase in diversification opportunities seems to be strengthened by increased mobility after dark caused by illuminated public areas such as paths and roads as people more easily can go to places to receive training and carry out income generating activities after dark. By this electricity can reduce climate vulnerability as well. For the markets electricity supply was found to cause significant changes such as increasing the number of customers and shops, the opportunity to use some new machines and longer opening hours. This has increased the income for some of the business owners and given more people the chance to start a business. This can have a significant effect on the climate

vulnerability and adaptive capacity of individuals, as people are given more opportunities to diversify and increase their income. The solar power plant buildings are also used as a flood shelter, reducing the possible risk posed by climatic challenges by protecting the people.

The findings on how electricity influences people's lives and which role it plays for climate adaptation must be considered regarding to scale. First of all, only 600 customers are connected to the power plant, the majority of these are households. This leaves most households on Moushuni unelectrified by the solar power plants. The characteristics of the socio-technical system and the technology per se, limit the number of customers and the hours of electricity supply. The others, unelectrified, however, were found to benefit from electricity supply in their community in some ways. For example can they use the electrified markets in the evenings to read and be social, and the illuminated public areas also influence their mobility.

The theory from the poverty, energy and development literature has been helpful throughout this chapter for suggesting ways in which electricity can influence people's lives. The more recent literature that presented a wider perspective on productive use of energy was especially useful. Some of the findings from this research can, however, possibly add to this literature, for example were the remarkable changes seen in the markets in Moushuni were mostly caused by electric light only and not by small enterprises being able to use new tools, which was the main cause of market growth discovered in rural Kenya (Kirubi et al 2009). This chapter has also shown that the trisection approach of climate adaptation can be applied when investigating the impacts of electricity supply or other technological changes on adaptation. The socio-technical change literature has contributed with understanding the limitations of the solar power supply. The system includes rules regarding how people can use the electricity and technical limitations that influence the number of hours the electricity can be used. These insights contribute to understanding why people did not use electricity to reduce the impacts of heat during the day to limit climate risk and why electricity was not applied after cyclones and floods when fixing damages. Ley and Corsair (2008) identified the human actor as important for the success of a technology. The human actors in the socio-technical system that the solar power plants are a part of played an important role in why the power plants were not functioning during the time of the fieldwork. Poor maintenance of the batteries due to lack of distilled water on the island is a problem that can be rooted in human actors. Similarly, the electricity customers in Baliara used more electricity than they were allowed to, resulting in the closing of the power plant. The introduction of a meter system that could have made the

customers pay regarding to the amount of electricity they used and more information regarding how their electricity usage influences the technical installations, are adjustments to the socio-technical system that possibly could have limited this problem.

7. Conclusion

The people of Moushuni Island in the Sunderbans have been in the center of this research. The stories and insights from a community of humorous, hard working and fantastic people who creatively have found ways to survive and live good lives on their small island which is under constant threat of floods, cyclones and droughts have been presented and analyzed. This research shows that there are many processes and factors contributing to the inhabitants of Moushuni being vulnerable to the climatic challenges they are exposed to. Factors such as poverty, deforestation, lack of options for diversification of livelihoods and slowness in governmental processes are some of the factors that have been revealed. It was also discovered that people had developed strengths and strategies over time in order to better deal with the challenges they meet, also the climatic ones. They had created impressive interventions in the landscape of the island in order to reduce the risk imposed on them from climatic challenges, and their local knowledge and experience, their strong social networks and their feeling of acceptance of the harsh climatic conditions of their place were some of the tools they used in order to improve their lives on the island once they faced disasters. This relationship between the nature and the people has developed through decades in order for them to coexist in the best manner possible.

This thesis has investigated how access to electricity has influenced this delicate relationship between people on Moushuni and the forces of nature. A wide approach for investigating this issue has been necessary. In order to attempt to isolate the effects of one intervention, the solar power supply, on climate adaptation, it has been necessary to understand as much as possible of the complexity of factors and processes that influence these people's lives. At first it might seem unrealistic that a limited and somewhat unreliable electricity supply could have had any affect at all on how the inhabitants deal with the severe climatic challenges they face. The results from this research, however, indicate that there are several ways in which the electricity from the solar power plants has changed the lives of people on Moushuni, and some of these changes have contributed to strengthening the islanders' adaptive capacity. The main research question will here be concluded upon. The conceptual framework will also be discussed and transferability of the findings to other geographical contexts and to theory will be reflected upon.

The role of decentralized renewable energy for climate adaptation

"Which role, if any, does electricity from the local solar power plants play for climate adaptation, through handling the direct impacts of climatic challenges, reducing the climate vulnerability and/or increasing adaptive capacity for households, businesses and the community, on Moushuni Island?"

When seeing the two chapters of analysis in light of each other, it is evident that the climate risks are still severe for the islanders, even though electricity has caused some improvements. The inhabitants frequently face cyclones and floods and these weather events influence the life of the people severely by causing damages to houses, households, ponds and agricultural land. Drought was less common; however, 2010 was one of the driest periods that the interviewees had experienced. This has lead to ponds drying out and people losing their water source for irrigation and household chores. Several of my informants lost a large part of their harvest to drought, which again influenced their income. Heat was a less severe climatic challenge, however, it was found to constitute a risk on the well being especially of the elderly. The electricity supply from the solar power plants was found to influence the risk caused by climatic challenges in a few ways only and the risk posed by climatic challenges is still high despite there being a power supply. The direct impact of heat was reduced by electric fans by a few of the informants; this reduced the discomfort connected to heat, especially for the elderly. The power plant buildings were also found to reduce the risk of cyclones causing damages to the human body, as the power plant buildings were used as flood shelters during cyclones. The most important measures that reduced risk, the embankment, elevated roads and ponds were found to be unaffected by the electricity supply. Other measures that were found to contribute to reducing the direct impact from climate risk on the island, such as early warning system, radios and cell phones need electricity to function; however, this power was not derived from the power plants. One reason for this can be the nature of the socio-technical system that the solar power plants are a part of, which limits the electricity amount that can be applied and what appliances that can be used, in addition to the time when electricity is available. The instruments are crucial in order to spread information, and might because of their importance be powered by other, more reliable energy sources such as the dry cell batteries, diesel generators and private SHS.

In chapter five, several factors and processes were identified that contributed to people's climate vulnerability on the island. Poor health facilities and infrastructure, limited access to kerosene, few irrigation options, slowness in the bureaucratic system, debt and little

opportunity to diversify income were some of these factors. Elderly, women and disabled were also found to be more vulnerable to climatic challenges than others. Identifying these factors and investigating if and how they have been influenced by electricity usage was a challenging task since so many mechanisms influence the complex reality of people's vulnerability. Even though several of these vulnerability factors remain unaffected by the solar electricity supply, it gradually became evident during the research that electricity access impacts some of these processes and factors. Electricity supply was found to improve the opportunities for diversifying income domestically, especially for women, as light created extra time and better work conditions to carry out these activities in the evenings. Light also contributed to illuminated public spaces which made it easier for women and others to visit each other to both learn and carry out income generating activities. The impacts of on the market were more people in the markets in the evenings, longer opening hours and cheaper electricity connection for the businesses than from diesel generators. These changes have given new people the chance to start a business and diversify their income. Increased opportunities for diversifying income can make the household less dependent on agriculture and therefore less vulnerable to climatic challenges, such as saline floods. Fewer bugs in the food, increased comfort while giving birth at home and possible increased indoor air quality might be other ways electricity impact people's life. This link is more insecure as the data material regarding these issues is rather weak. If there is a link, however, these positive effects on health caused by electricity can be considered another way that electricity reduces vulnerability.

The factors found to influence the adaptive capacity of the inhabitants of Moushuni Island were sheer muscle power, a strong social network, diversified income, the feeling of acceptance of the climatic conditions and local knowledge of how to prepare for extreme weather, to mention some. Most of these strategies and strengths have developed on Moushuni over time and have remained rather unaffected by the solar power supply. However, the increased diversification of opportunities created by electricity which was discussed above might not only be viewed as something that reduces climate vulnerability. More diversification options was also found to increase the income of the households and the informants also reported about increased income from businesses caused by electricity and light at the market. Savings and money are an important resource people have access to after extreme weather events which strengthen their ability to secure their own well being and thereby enhance their adaptive capacity.

Based on these findings I conclude that electricity supply from decentralized solar energy power plants can strengthen climate adaptation in some ways as explained above and presented in detail in the previous chapters.

The conceptual framework has been fruitful in order to guide this research in an exploratory way and it has provided many useful insights for understanding and analyzing electricity's impact on the different aspects of climate adaptation. Eriksen and O'Brien's (2007) framework became a suitable backbone for the conceptual framework after being simplified to fit with this research project. Because of the trisection of climate adaptation as a concept, it has been possible to become aware of and investigate the width of how electricity has influenced different aspects of people's lives in general and their climate adaptation in particular. The trisection is complex, however, and it was at times difficult to identify within which of the three categories an identified change caused by electricity fitted. The increased livelihood diversification options created by electricity access can for example be seen both as a measure reducing vulnerability and a measure strengthening adaptive capacity. By applying this framework when analyzing the role of electricity for adaptation, I showed a new way in which this trisection can be applied. This research strengthens those approaches within the climate adaptation literature that emphasizes the need to have a wide and comprehensive approach when analyzing the effects of adaptation measures, because climate adaptation is a matter that is tangled up in many complex factors and processes in both society and nature. This conclusion, which shows that even a small electricity source can contribute to climate adaptation, suggests that the electricity situation of a community should be taken into account when climate adaptation is discussed and adaptation measures planned. This approach to investigating the role of electricity supply for climate adaptation could also possibly be useful for researchers studying how electricity supply influences a community in general.

The literature from the poverty, energy and development realm gave guidance in understanding how electricity has influenced people's lives and thereby also how electricity has influenced their climate adaptation. Having a broad understanding of how electricity affected people derived from the more recent literature on the topic, gave valuable insights into the analysis. Several of my findings can add to the understanding of electricity's role for poverty and development. My findings show, for instance, that the market grew regarding the number of shops, customers and income for some of the business owners increased mostly caused by electric light only. This research also shows the importance of considering the positive effects of blooming markets in a larger geographical context, as businesses located

outside the market had experienced a decrease in income when the markets in Bagdanga and Baliara got electrified. Some of the businesses at the market had also experienced lower incomes due to increased competition. In addition this research shows that electricity; poverty and development literature can be fruitful for investigating other topics than just electricity's role for poverty reduction and development, such as electricity's role for climate adaptation.

The last theoretical realm on socio-technical change was an important addition to the conceptual framework. The system perspective contributed with the understanding of the solar power supply as a part of a bigger system involving the customers, operators, rules, values and political conditions in addition to the technological installations to mention some elements. When trying to understand the role of solar energy supply for adaptation these insights became very useful. The reason why solar energy from the power plants not is being applied for early warning systems, cell phone charging, radios and other technical instruments applied in order to spread information prior storms, is that the supply is limited and there are rules regarding which appliances that can be used. The attributes of the socio-technical system of the solar power plants makes people rely also on other energy sources, such as dry-cell batteries and private diesel generators, for these important measures. Knowing the details of this specific socio-technical system surrounding the solar power plants on Moushuni contributes to understanding the potential that lies in solar power for climate adaptation. If some attributes of the system are improved, there is reason to believe that solar energy can contribute to climate adaptation in more ways. Allowing businesses using tools that can generate a higher income for the business owners for example could limit their reliance on agriculture and thereby reduce their climate vulnerability.

Combining three theoretical realms was challenging, because these realms are all comprehensive and have rarely been applied together before. The combination was fruitful, however. If only one theoretical direction had been applied, such as the climate adaptation literature for example, important perspectives regarding how electricity can influence people's lives would have been lost.

The question of what this research can be used for is just as important as the findings themselves. This research was conducted in a unique geographical context in rural India where the people were living under constant threat of climatic challenges. In addition they had some solar power supply. It is possible that insights from this research can be relevant for other similar contexts. There are many rural areas that experience climatic challenges where the people are electricity deprived and depend a lot on agriculture like they on Moushuni

Island. For these locations, some electricity supply might influence their climate adaptation in similar ways to those found on Moushuni. The insights and findings provided in this research might also be relevant and useful for the international climate change policy discussion as they shed light on the role of renewable energy to move beyond being a mitigation effort only. My research shows that renewable energy, if applied in poor unelectrified areas, can contribute to climate adaptation in some ways and if the organizational and technological solutions are improved so that the opportunities to use electricity for more purposes are increased, the contributions to climate adaptation can be even stronger. In the end it is the reader who can see how this research can be useful for him or her. A thorough description of context, method, theory and findings has here been given in order to give the reader a good fundament for assessing the transferability of this research to other contexts.

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