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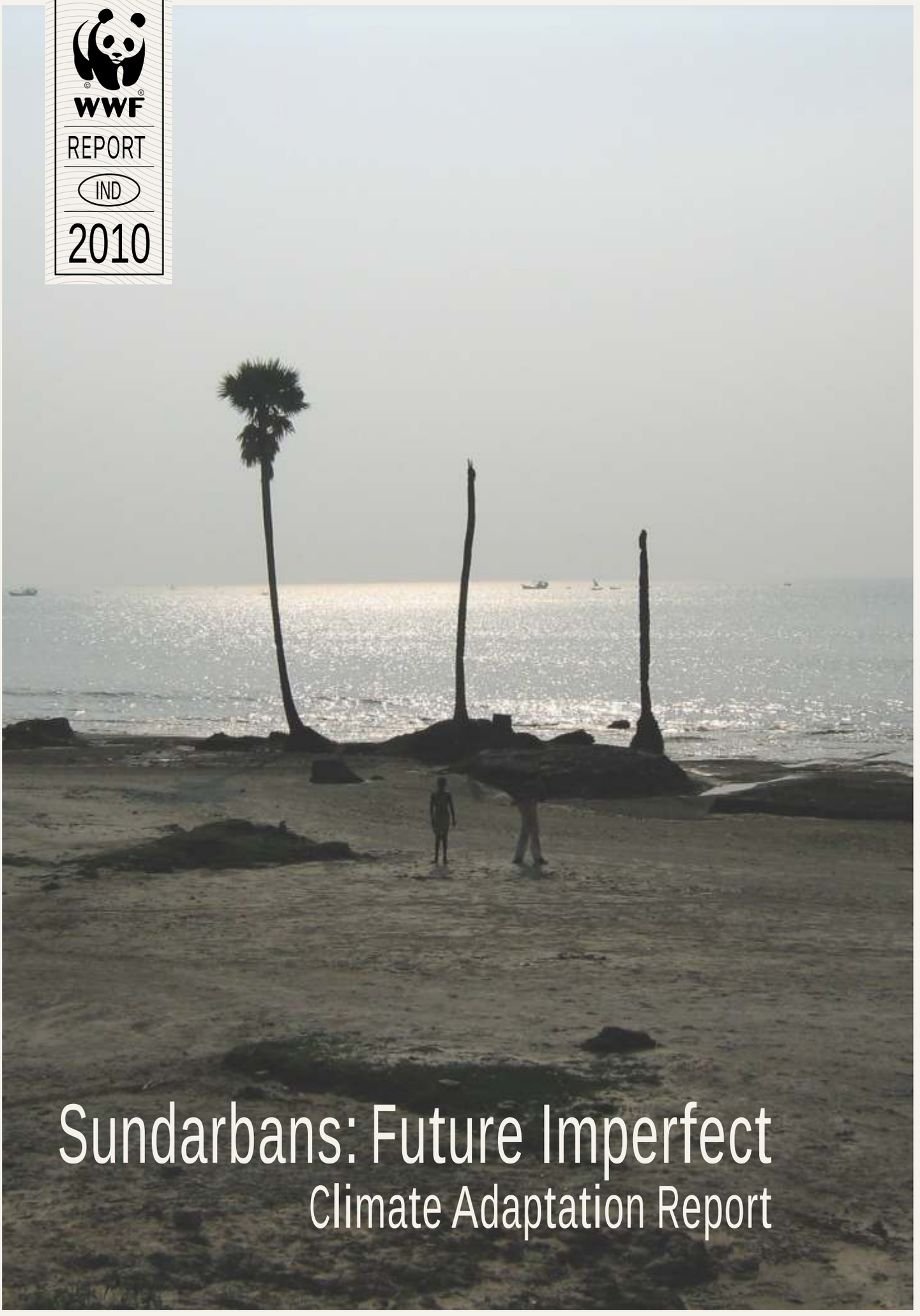

Sundarbans: Future Imperfect

Climate Adaptation Report

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Preface

This report has been prepared as part of the WWF-Netherlands supported project 'Climate Change Impacts on Freshwater Ecosystems in the Himalayas'. This report captures WWF's experience in the Sundarbans on climate change. Beginning in 2005, WWF-India has conducted dozens of personal interviews to record how climate change impacts people's lives *here and now*. These perceptions demanded that scientific studies be carried out to ascertain the veracity of the claims. The School of Oceanographic Studies, Jadavpur University not only readily agreed to undertake these studies both at the micro level as well as across Indian Sundarbans, but also shared reports of its earlier studies in the region. Ashrujit Bhattacharjee painstakingly compiled the information from these reports. This report draws heavily from that compilation. The studies by the School of Oceanographic Studies, Jadavpur University made it possible to design initiatives that enhance risk preparedness as well as adaptive capacity of vulnerable communities that ensure physical and livelihood security, and reduce sensitivity in case of exposure to high intensity weather events. Not all of these were successful, for example, attempts to raise mangrove plantation; the successful ones are briefly described in the last chapter of the report. A range of projects supported by different donors, WWF-Netherlands and Hewlett Packard in the main, have helped implement the initiatives.

Without the cooperation of the people of the Sundarbans, Mousuni Island in particular, this report would not have been possible. WWF as a network has gained from the untiring efforts of the team in the Sundarbans, amongst whom Subhro Sen and Arjun Manna deserve special mention.

FOREWORD

The Sundarbans delta is part of the delta of the rivers Ganges, Brahmaputra and Meghna, spanning about 350 km in width in southern Bangladesh and the state of West Bengal in India. It is home to one of the largest contiguous blocks of mangrove in the world, with very high species diversity (25 true mangrove and 30 mangrove associates). This coastal wetland is also within the Central Asian shorebird flyway, and is the only mangrove wetland tiger habitat in the world.

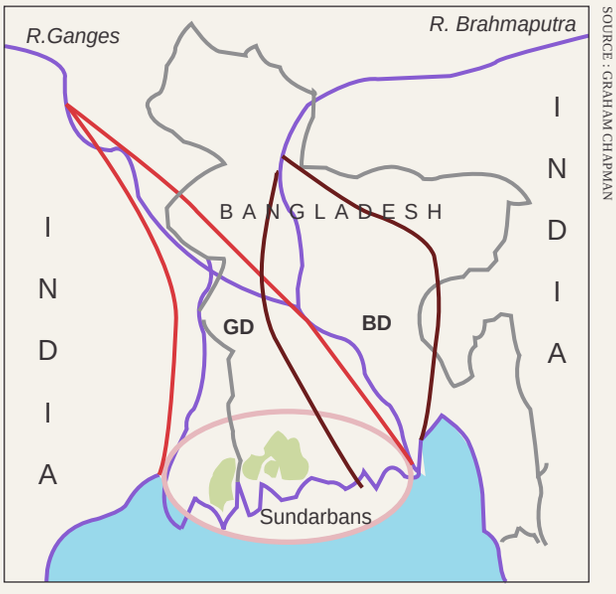
The Sundarbans is home to a large human population, 4.5 million in India (the inhabited northern part of the Sundarbans has a human population density of about 1000 persons per sq km) and about 7.5 million in Bangladesh. The region is characterised by developmental constraints in terms of rapidly growing population, lack of appropriate transportation, modern energy services, adequate healthcare delivery, and education. The mainstay of the economy is agriculture, primarily paddy cultivation, made possible by raising embankments along the periphery of inhabited islands to keep saltwater at bay. Fishing and fishery related enterprises, particularly prawn farming are other major economic activities. People in the Sundarbans live a precarious existence at the best of times, but now global climate change is making matters worse for the Sundarbans and its inhabitants, both human and wildlife.

Sea levels are rising faster than the global average and high intensity events such as severe cyclones and tidal surges are becoming more frequent. Loss of islands is now a reality, causing human dislocation. An assessment carried out during 2001-2002, showed that of the remaining 100 islands on the Indian side, 12 of the most vulnerable are prone to accelerated erosion and are likely to lose on an average 15 percent of their land area by 2015. Seven of these are forested with no human habitation and the rest are inhabited. Humans apart, Sundarbans is teeming with life forms about which very little is known as regards climate change impacts and the vulnerability thereof.

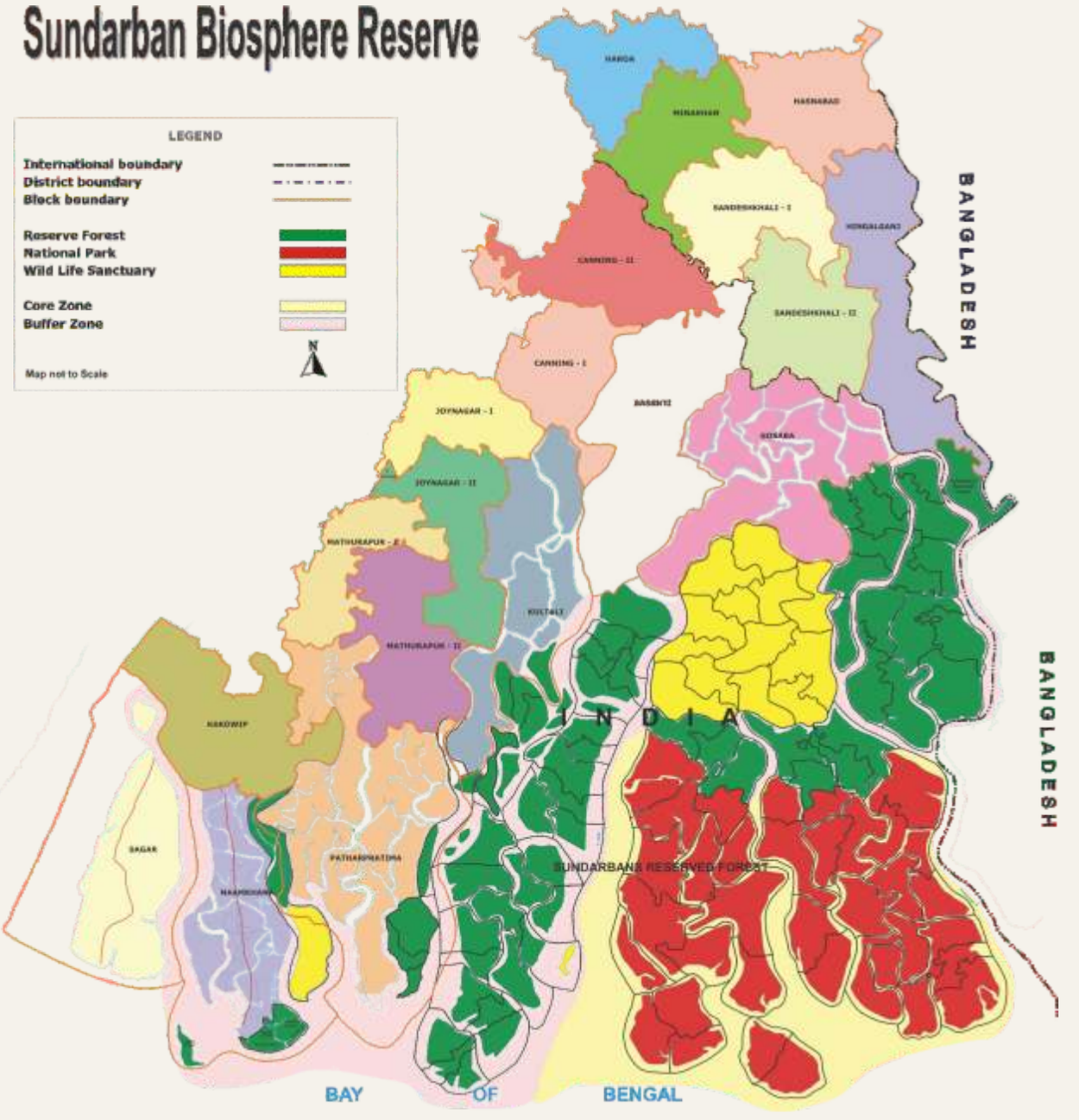
As land-based livelihood activities get impacted due to rising sea levels, coastal erosion, loss of mangrove cover, and saltwater incursion, more and more people are exploiting the living resources of the ecosystem in a manner that will be difficult to sustain over the long term. The situation has the potential to erode ecosystem integrity due to over exploitation of natural resources. This report highlights the attempts made by WWF to assess climate vulnerability and undertake adaptation measures, although these may be mainly in terms of "buying time" for the people and the ecosystem. For WWF, Sundarbans is one of the 13 priority tiger conservation landscapes as well as an important area for climate adaptation and renewable energy/energy efficiency projects. The Sundarbans on the Indian side is a Biosphere Reserve a part of which is also designated as World Heritage Site because of its natural endowments.

Bengal Delta(s) and the Sundarbans

The Ganges begins its delta (GD) in northwest Bengal. This is at the apex of the red triangle (the third side is the sea).The Brahmaputra delta (BD) is marked in brown. The two rivers have continually shifted courses, and continue to do so. Their confluence changes and this change is reflected in the merging of the two deltas. The Sundarbans region is shown in pink ellipse, the western portion of which is termed as the Indian Sundarbans in this document.



SOURCE : GRAHAM CHAPMAN



Indian Sundarbans is a part of the world's largest contiguous mangrove forest. The northern part of Sundarbans region is densely populated. The forested southern part is classified as reserve forest. Within the reserve forest there are three wild life sanctuaries and a national park. The national park has been declared as a UNESCO World Heritage Site in 1987.

1. INTRODUCTION

The eco-region that forms the Sundarbans is both unique, and uniquely fragile. Unique because it is one of the most extensive mangrove forests in the world, existing in a vast deltaic region where freshwater and seawater mix. The mangrove forests of the Sundarbans are one of the most significant strongholds of the Royal Bengal Tiger, an endangered species, and the national animal of India. Also unique, because the human population that exists on the fringes of the coastal forest, in land that has been slowly adapted to cultivation over the last two centuries, confront challenges from both land, air, and sea that few other local populations have to contend with. And further unique, because the flora of the Sundarbans, the mangrove, presents a natural buffer, a bulwark against coastal erosion and seawater ingress into one of the most densely populated regions of the world.

Ironically, the Sundarbans' fragility stems from its uniqueness. This report is an attempt to highlight that fragility in the context of a fairly recent global phenomenon – human induced climate change. The delicate balance that has for many centuries existed in the Sundarbans between land, air, and sea, is today under threat, and indeed, in certain areas, the effects have been disastrous.

This report attempts to present a short ecological history of the Indian Sundarbans, one covering only two decades, to show how climate change is, within even this smallest of timeframes in ecological terms, causing exaggerated and sometimes irreversible damage. It is an attempt to explain how the Sundarbans is changing, both through the voices of the people who live there, and the scientists who are working there. And it is also a call for urgent action to all, to address the very issue of survival of the landscape we call the Sundarbans, the animals and people who live within it, and the mangroves which sweep at present, only intermittently broken, from the southern part of West Bengal to Bangladesh.

WWF has been involved with conservation of this eco-region for over three decades. The activities lie in three main areas – applied research, field implementation, and advocacy/communication. This report will also explain the nature of these activities, and their effectiveness. Certain studies have been carried out, certain measures have been taken, and these have all pointed towards the need for more concerted efforts towards addressing the problems of the Sundarbans under an emerging climate change scenario.

This report describes the Sundarbans region and the impacts of climate change by bringing you evidence from the people who live there, scientific data collected over the years by scientists, and efforts to address the problems. The attempt has been to look at issues from both the micro and the macro level, including issues of people's livelihood as well as those of regional changes in weather patterns. This will give the reader a clearer understanding of the imminent threats and vulnerabilities to this fragile ecosystem.

Spanning across India and Bangladesh, Sundarbans is amongst the world's largest contiguous blocks of mangrove forest. Less than 40 percent of Sundarbans is located in India and the rest is in Bangladesh. On the Indian side, forest boundaries have changed very little since 1943.

2. THE SUNDARBANS TODAY

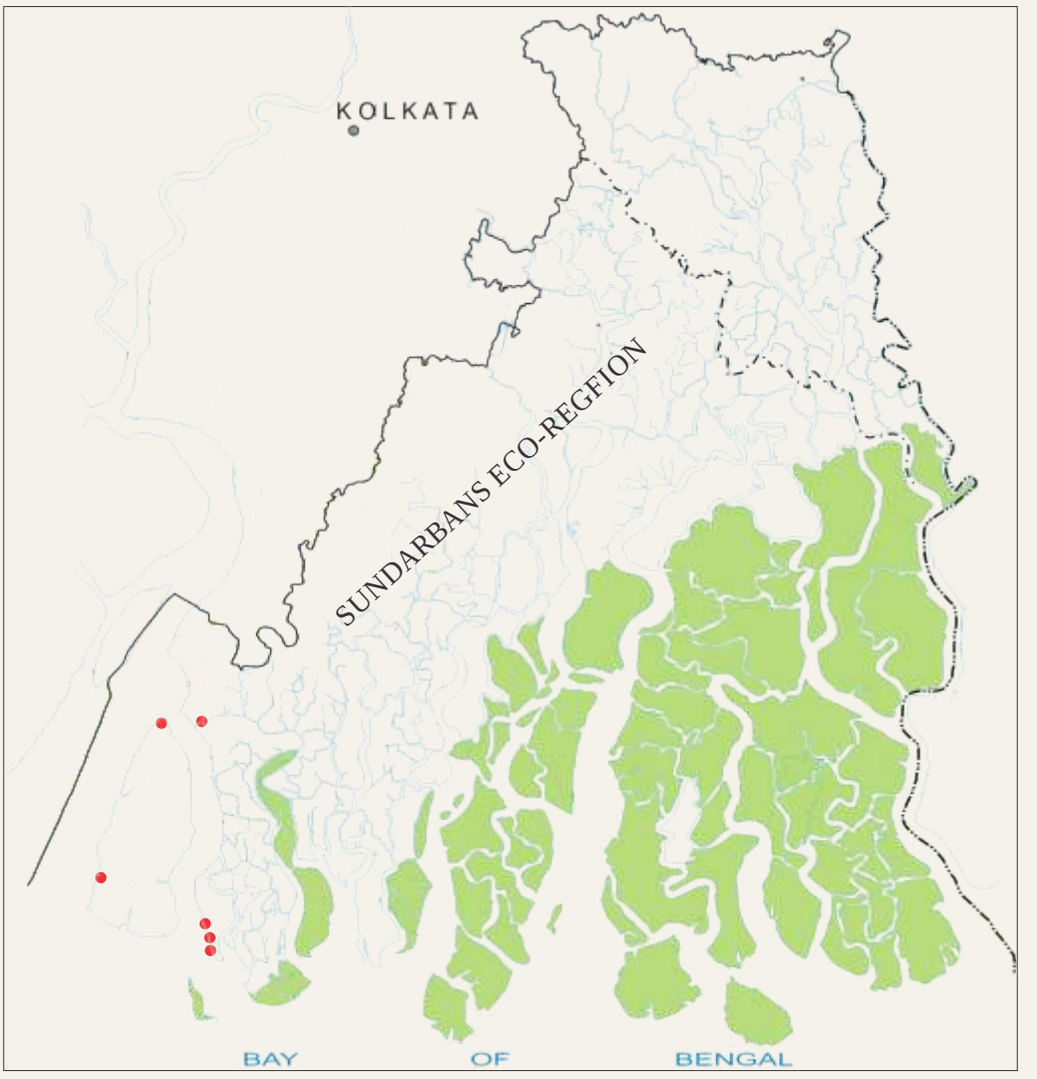
The Sundarbans is a stretch of largely impenetrable mangrove forests lying at the southern tip of the Indian state of West Bengal, and stretching into southern Bangladesh. Extending about 350 kilometres along the Bay of Bengal from the Hooghly River estuary to the Meghna River estuary, the Sundarbans are a part of the world's largest delta formed by the rivers Ganges, Brahmaputra and Meghna. The whole tract stretches inland from the sea for almost 130 kilometres.

Within this geographical area, forests cover nearly 10,000 sq km, of which about 6,000 sq km are in Bangladesh. Interlinked by a complex network of tidal waterways and dotted with small islands of salt-tolerant mangrove forests, this area is most famous as the last surviving coastal habitat of the Royal Bengal Tiger.

In the 4,267 sq km that constitute forests within the Indian Sundarbans, 2,585 sq km form the Sundarbans National Park, set up to preserve the globally dwindling population of the Royal Bengal Tiger in its natural habitat. The area outside the National Park has been subject to human use for centuries, and mostly converted for agriculture. Close to 4.5 million people live in the Indian Sundarbans with about 85 percent subsisting on a single paddy crop. Other occupations include fishing, and honey and crab collection from the forests.

However, to those people who live in the Sundarbans, as well as to the local flora and fauna in the area, special vulnerabilities apply. Since the entire area is low-lying, and parts of it are regularly submerged by the tidal ebb and flow of the ocean, any change in sea level means a direct threat to life and property. Similarly, changes in the salinity of the sea and the soil immediately and adversely affect fishermen and farmers alike. Changes in ambient and sea surface temperature, will likewise have a more dramatic and exaggerated effect on the Sundarbans than elsewhere. The ecosystem and the lay of the land in the Sundarbans are such that the impacts of climate change phenomena will have a comparatively widespread fallout. Therefore, the region and its health are an important guide and a reliable barometer to changes in climate, and its effect on humans and nature alike.

Over the years, there have been persistent reports from the people who live in the Sundarbans, of many changes in observed natural phenomena. In order to understand these changes, field interviews were conducted with the people of the Sundarbans. The first part of this report is an account of these interviews.



Climate witness initiative was launched in the Sundarbans in 2005. Through this initiative, WWF, connects with people around the world and provides them with an opportunity to share stories about how climate change impacts their lives *here and now*. This map shows the location of 6 out of 28 climate witnesses from this ecoregion whose abridged testimonials appear in the following chapter.

3. VOICES FROM THE GROUND

Reports of climate change from within the Sundarbans have tended to fall into certain specific areas. Broadly, these are changes in rainfall, changes in fishing patterns, rise in sea level, frequency and intensity of extreme climatic events, and heightened land erosion. During the field interviews, these were the recurrent issues, and we concentrated on them, since they had the maximum impact on the lives and livelihood of the people.

A) Unpredictable rainfall patterns

There is widespread agreement that rainfall patterns are changing over the Sundarbans. Almost all of those interviewed agreed that rainfall has decreased during a certain phase of the season, and the pattern of rainfall has changed, making conventional cultivation of crops difficult for farmers. Traditional methods of cultivation have been put at risk, and today the farmer in the Sundarbans does not know what to grow when. The most puzzling part of the rainfall changes cited by the people indicates that most of the rains do not come in the monsoons. Rainfall has shifted to the post-monsoon period. This has severe implications for agricultural productivity. The people of the Sundarbans sustain themselves mostly on rain-fed paddy cultivation. Any change in the rainfall pattern means that the rains do not come when seeds are sown. They come when the harvest is to be reaped. As a result, a large percentage of the standing crop is lost. And since most of the farmers in the Sundarbans are single crop farmers, this means a direct loss of livelihood and threat to food security.

To illustrate the change in rainfall pattern, we bring you an interview conducted with Sheikh Kalimuddin, a resident of Mousuni Island.

Sheikh Kalimuddin, Testimonial 2008
Age-45
Gangapalli, Mousuni Island

'I am Sheikh Kalimuddin. I have been living in Gangapalli Village of Mousuni Island since my birth. My father was born in Kanthi of East Midnapore District. Looking at the prospect of easy availability of cultivable land, my father shifted to this island long back. My parents died when I was only a year old. I just about managed to complete primary level education. During childhood, I was supported by my brother's family. Later, we had differences and got separated and I settled near the river. In the early days, I earned my livelihood repairing the embankment. Now, I am primarily dependent on agriculture and also work as a daily labourer. I practice agriculture over 0.3 hectares of land. My family of seven members include my wife, two sons and three daughters.

'Paddy and vegetable cultivation, poultry and cattle rearing provide me my livelihood. I have 4 cows and 10 hens. Agricultural patterns are changing due to the erratic behaviour of the monsoons. Today, there is more stress on cultivation of hybrid and high yielding varieties of crop. Traditional and indigenous crop varieties are mostly marginalised. We are now using more chemical fertilizers and pesticides as the productivity is falling and also due to increased risk of crop disease outbreaks.

'I cultivate paddy twice a year. This year's winter paddy crop fetched me 800 kgs of paddy from 0.13 hectare of land. However, low precipitation and extreme summer temperatures damaged my chilli pepper crop. Subsequent disease outbreaks killed the chilli pepper plants.

B) Impact on fisheries

After agriculture, fishing is the most common means of livelihood in the Sundarbans. In the interviews conducted, most fishermen complained of lower volumes of fish caught. Although the reasons attributed to this are many, including the entry of deep sea trawlers which sometimes violate territorial waters, there is a feeling among the fishermen in the Sundarbans that the quality of water has also changed. They acknowledge the increase in levels of salinity in the water, which has caused the migration and/or virtual extinction of some kinds of fish along with the once familiar dolphins. Along with the decreasing yields in agriculture, fisheries too have been hit throughout the Sundarbans.

We bring you a firsthand account of the changes in fishing patterns in the Sundarbans from Srikrishna Bhuina, who runs a deep sea fishing business out of Kakdwip.

Srikrishna Bhuina, Testimonial 2009
Age-40
Steamerghat (West), Kakdwip

'I am associated with the deep sea fishing industry for last 20 years. We operate fishing trawlers in Bay of Bengal. Two decades back the number of deep sea fishing crafts were very few and the fish catch was excellent. Mechanized boats were cheaper and the operational cost was low. However, things started changing drastically during the 1990s when large numbers of mechanized crafts started operating in this region. These boats, equipped with a spectrum of fishing nets, started indiscriminately exploiting the ocean.

'It was the beginning of changing fishing practices in this region. Fishing was becoming more of a professional activity than a traditional activity, and also becoming more capital intensive. Almost two decades back the cost of buying a new mechanized craft was about 0.3-0.4 million Rupees but now it costs around 2.5-2.7 million Rupees for a craft which comes with navigational, weather, communication and fish finder devices. Mechanized crafts spend more in the ocean – it costs anything from Rs 30,000 to Rs 50,000 per fishing trip.

'Till two decades ago profit margins were huge which helped the existing players to expand their fishing fleet of mechanized crafts. The market was very generously extending credit to meet their day to day operational costs which was very important to keep the entire fishing fleet afloat.

'However, during the present decade we started witnessing the decline in fish catch. Fear of getting into a debt trap pushed these mechanized crafts further down south in the Bay of Bengal. Many of these crafts started violating state as well as international boundaries to get a good fish catch. The effort proved to be futile and now the fishing craft owners/leaseholders are bankrupt.

'This part of Sundarbans has four major fishing harbours and Kakdwip harbour is the busiest one. Around 150 registered mechanized crafts used to operate from these harbours some 20 years back, but today there are more than 1000 registered mechanized crafts operating from just these four fishing harbours. So, it's really hard to imagine how many more are operating from the entire region.

'I have witnessed more than 50 species of fish being caught during our regular fishing operation in high seas. However, now I find many of them are rarely getting trapped in our fishing gears. Maybe there is a shift in their habitat and they are going deeper into the ocean, and we do not have any fishing gear which could reach so deep.

'Falling fish catch and increasing operational costs are making it difficult for us to survive in this sector. Credit sources are drying up and we are finding it hard to meet regular operational expenses. The fisheries sector supports the livelihood of hundreds of thousands of people in this region and they are also under stress now.

'I believe the primary reason of falling fish catch is somehow related to over exploitation of fishery resources over the past decade. We are also witnessing changes in navigational depth and water current. Changes in salinity and water temperature are also witnessed. I believe this is somehow related to the falling fish catch.

C) Rising sea level

Most of the islands in the Sundarbans are low lying, and even the mainland does not have any sharp elevation near the seafront. This means that any rise in sea level has a direct impact on the people living there. The impact is twofold. Firstly, land is lost to the sea and landholdings decrease, putting more pressure on agriculture on ever smaller landholdings. Secondly, the land lost to the sea is difficult to reclaim for agriculture in the near future, since salinity destroys the productivity of the soil. Therefore, even a small rise in the sea level is a calamity for people on low-lying land fronting the sea, and there is unanimous agreement among people in the area, that over the years, the sea has been rising, and sometimes not very slowly. Entire islands have disappeared under the sea causing mass scale human dislocation. We bring you a story from one of these refugees, Jyotsna Giri, who is now a resident of Sagar Island. Her original home was on Lohachara Island which disappeared in 1996. More than 4000 inhabitants were all compelled to relocate.

In the past two decades, four islands (Bedford, Lohachara, Kabasgadi and Suparibhanga) have been permanently flooded and 6,000 families have been made homeless. The loss of land has created thousands of refugees in the area.

Jyotsna Giri, Testimonial 2008
Age-55
Kastala, Sagar Island

'I am 55 years old and married. I have five daughters who are married, and three sons who are staying with me in the same house. I got married at the age of twelve to Pashupati Giri. My husband had a house at Lohachara Island where we settled after marriage.

'Lohachara had three adjoining islands namely Sagar, Ghoramara and Suparibhanga. Lohachara and Suparibhanga islands do not exist anymore, while Ghoramara is almost on the verge of disappearing due to erosion.

'During the 1960's Lohachara Island was divided into 5 administrative zones and the total population was almost five or six thousand. Agriculture and fishing were our main sources of livelihood in those days.

'Lohachara Island did not have any source of drinking water. The only tube well we had was eroded away by the river and after that the local administration never installed another one. So, we used to cross the river and fetch drinking water from a nearby island.

'High sand content in the soil made this island prone to erosion during regular tidal action. The river was slowly eating away the entire island and later we were only left with our homestead land and some domestic animals. We had 20 cows, 150 sheep, 35 goats and some poultry.

'I still remember that fateful day, when I lost everything. I was in the neighbouring island to fetch some drinking water. My husband was not present that day and hence I locked the house and took my son along with me. While coming back, I found that the only ferry service available was cancelled for the day due to some kind of engine snag. So, I decided to stay back at my parent's house for that night. The ferry service started the next day and I boarded the morning ferryboat. When almost near Lohachara Island, I suddenly noticed that my sheep were all drifting in the river. I panicked and rushed to rescue them. I was about to jump into the river when some fellow passengers stopped me from doing so. I felt helpless and started crying. After landing at Lohachara Island I found that half of my house had been washed away by the river. Slowly the entire island got submerged. We were rescued and rehabilitated at Gangasagar refugee colony, which is on the south of Sagar Island. We stayed there for few days and then shifted to northern part of the island where we constructed a new house. We are now living here for last 15 years. We no longer have any agricultural land and have to work as daily labourers.

In addition to islands that have completely disappeared, rising sea levels bring the problem of decreasing landholdings and soil salinity as well. Many who live on larger islands, or on the mainland suffer from this. Such a person is Jalaluddin Saha from Mousuni Island.

Jalaluddin Saha, Testimonial 2007
Age-60
Baliara, Mousuni Island

'I am Jalaluddin Saha. I was born and raised on Sagar Island, the largest and westernmost island in the Sundarbans. I have been a school teacher since 1971 on Mousuni Island, east of Sagar Island, and have lived here ever since. Alongside my profession as a teacher, I have been farming a small plot of land.

'Mousuni is a small island, about 24 square kilometres with a population of 20,000. Rice cultivation is the main activity on the island, although a sizeable population is engaged in different forms of fishing.

'Human settlement on the island is fairly recent; vegetation was cleared in the early years of the twentieth century and earthen embankments erected to keep sea water out. There are sand beaches on the western and southern sides while the rest of the shore is mud. Shore erosion is a normal phenomenon in an active delta but takes place very gradually. Human interference does hasten the process due to clearing of vegetation and alteration of water flow but in the past 20 years the process has become rapid. I have been a victim twice over of environmental changes on the island.

'In 1975, I built a house on the western fringes of Mousuni Island. I had ten neighbours. We were protected by a seven metre high earthen embankment on the western side erected by the government during the 1920s. There was mangrove vegetation along the embankment on the outer side. My house was about 10 metres inland from the embankment. I had about half a hectare of agricultural land, two freshwater ponds and nine cows. A few of my neighbours also had some agricultural land and others were wage earners or workers of fishing boats.

'As more and more people settled near or along the embankment, the mangrove vegetation started thinning because people used it for fuel wood and the plants were not regenerating. Gradually soil slipped away from below the trees and eventually the remaining trees were washed away around 1985. The embankment

started to erode as well. In 1992, the earthen embankment gave away. About 100 of us lost our homes and land.

'After 1992, I built another house 60 metres inland. The new embankment was higher than the previous one by four metres. This new one was not only higher but stronger than any that had been built earlier. I managed to buy half a hectare of agricultural land again. The embankment collapsed again in 2005, displacing 60 families.

'Since 1985, we have been raising the height of the embankment but tidal waters, too, keep rising. By 2005, the height of the embankment was raised five times to 17 metres but to no avail. I have noticed that the frequency of tidal water overflowing the embankments has increased, as have the height of the waves, which has resulted in our agricultural fields being flooded with sea water more frequently. Either our island is sinking or the sea is rising.

'In 2005, I built another house about a kilometre and half inland from where my first house stood. Over the years, I had bought two hectares of land but now I am left with only a little over one hectare. There is not enough space for cattle anymore so I have just one cow now. We are not only losing land but also agricultural productivity due to frequent salt water incursion. Every time salt water comes in, the land becomes useless for a few years and since 1969 this has affected five square kilometres of our land.

'I do not think I will have to build another house due to the embankment moving further inland but would not be surprised if my sons and grandsons are forced to move again.

D) Changes in frequency and magnitude of extreme weather events

Cyclone *Aila* of 2009 was the most dramatic of the climatic disasters to have recently hit the Indian Sundarbans. Residents say that the storm incidences are on the rise over the years, both in frequency and in intensity. Although the months of July to October were always the season for storms, the storms now come more often, and do much more damage than before. The people of the Sundarbans feel much more vulnerable, and they have little to protect them when these storms strike. Nitai Chandra Maiti from Mousuni Island who is sixty years old and born in the Sundarbans, talks about his experience of extreme climate over his skies, and how it has gotten worse over the years.

Nitai Chandra Maity, Testimonial 2009
Age-60
Baliara, Mousuni Island

'I completed my pre university studies in the year 1975. I have 5 family members, two daughters and a son. My primary occupation is agriculture and I own 0.5 hectare of agricultural land.

'Due to flooding and erosion I lost my first house almost 25 years ago and now I am living in the second house. I have seen many extreme climatic events during my lifetime but these days we live under a regime of constant fear of losing everything. Till the 1970's the magnitude of the impact (due to extreme climatic events) and subsequent loss of property was very low but for last three decades we are finding it really hard to cope with the magnitude as well as frequency of impacts. Storm cyclones, tidal surges and consequent flooding have become recurring events now. Moreover, we used to enjoy six seasons in a year but

it is hard to comprehend seasonal changes anymore. Expected climatic conditions during a season and what now prevails during that season are different.

'We know the climate is changing and along with that the agriculture pattern as well as practice is changing. Summers are hotter, winter is hard to find and rainfall is scanty. This year many of us are going to lose our crops and that is the primary reason of our suffering.

'It is quite visible that the navigational depth of river has drastically reduced which makes the situation even worse. Events of high wind speed coinciding with high tides have increased the risk of embankment collapse. This is the time when the tidal surge damages the embankment most. The months between July and September are the most vulnerable period for our island. During this period our lives and livelihoods are under constant risk of flooding. Now, almost 60-70 percent of the youth are leaving this island in search of better jobs in neighbouring states and even migrating to other countries.

E) Coastal erosion

The loss of land due to the rise of the sea level is but one factor in the decreasing size of the Sundarbans landmass. The other is the constant erosion of embankments built to stop the seas from invading islands. This is again a recurrent theme throughout the islands of the Sundarbans where there is a constant battle between man and sea to stop large chunks of land being dragged away, and islands, once capable of supporting hundreds of people, now lie uninhabited. Although land erosion affects everyone in the Sundarbans, here is the account of Panchanan Gayen from Sagar Island (the largest island of the Indian Sundarbans). He is sixty years old and having lived his entire life on this island, has seen it washed away, bit by bit, in front of his eyes.

Panchanan Gayen, Testimonial 2008
Age-60
Beguakhali, Sagar Island

'I was born and brought up on this island and educated till college level (bachelor's degree in arts). I have five family members and my children are presently studying. I have 0.6 hectare of land which includes 0.4 hectare of agricultural land. Agriculture is my primary occupation. Apart from agriculture, I have tried my hand as fish whole seller, wood whole seller, and as medicine supplier in the past.

'My village is known as Beguakhali. In the past it was quite a big village. It is located at the south western side of Sagar Island. The river is fast eroding our village and it has already lost 26 hectares of land in last three decades. The river has already washed away 35 houses in the recent past. My house was almost one kilometre away from the river but now it is on the river side. Affected families have been relocated and resettled on the northern part of this island.

'I am witness to immense changes which took place during the last three decades. Our village had huge stretches of sandy beaches and dense mangrove jungles along the coast. These jungles were stocked with a variety of mangrove species and wildlife. We lost these unique vegetative features and wildlife after 1980. Even the Kolkata Port Trust offices in our village got washed away and the remains of the old light house is still visible.

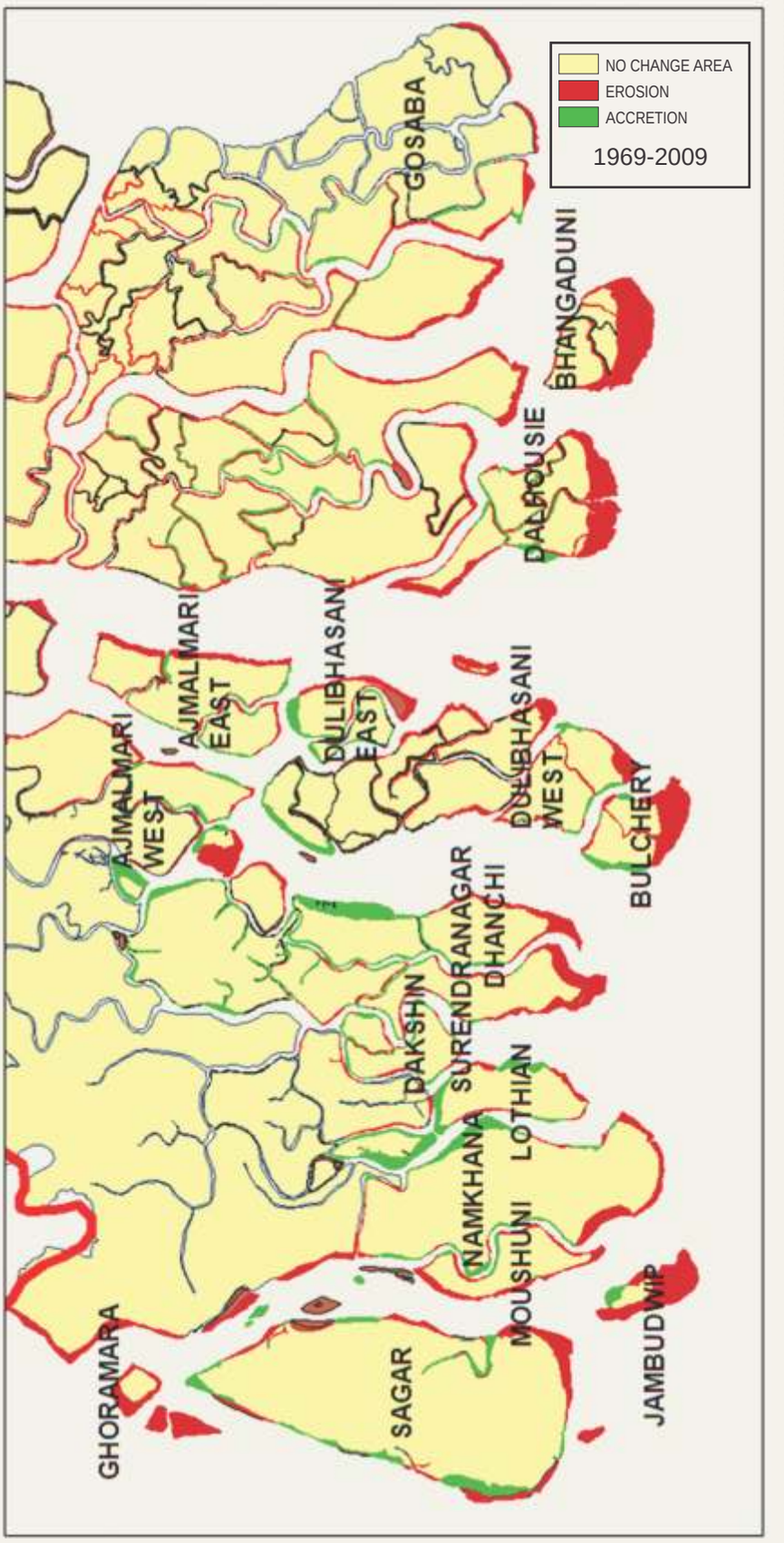
'I believe coastal erosion is a natural process in a deltaic region like Sundarbans. However, I have noticed that for past few decades there have been changes in river flow system. The settlements which are near the point of confluence of the river

with Bay of Bengal are mostly affected due to accelerated phenomenon of land erosion.

'There is lot of discussion going on regarding abnormal changes in the climatic system and I agree with that. While in school we learnt that there are six seasons in a year and we remember enjoying every season for at least two months every year. Now we don't even have the privilege to enjoy the monsoon, winter and summer seasons in the true sense. The river course is also changing and the water level seems to be much higher than earlier. I think it's almost one meter higher than the earlier water level. My house shakes violently when the tides strike the coasts. I am busy finding an alternate location to resettle as I am not sure how long this place can hold in the face of changing tides. I may lose my house with the next tide. Every year the embankments are damaged and breached by tidal action.

‘Subsequent flooding devastates many households by taking lives, washing away cattle, damaging standing crops and ultimately rendering agricultural land unproductive or underproductive. The Irrigation Department of the State Government either repairs or builds these embankments afresh. The soil used for building embankments are excavated from nearby land which aggravates the situation as further tidal action weakens the base of the new embankment, which subsequently collapses. Sometimes they even bring boulders from outside to strengthen these embankments, but that too is not working.

These are the recurrent themes from the voices from within the Sundarbans – erratic rainfall, rising sea levels, disappearing land, fewer fish, and more violent storms over the horizon. All these stories, some from those who have spent their entire lifetime in the Sundarbans, and some from those who have had the benefit of education in larger towns and cities – are all from people who depend on the land and the sea for their and their families' livelihood. These stories deserved to be verified, their truth tested against scientific studies. Was there indeed something changing in the Sundarbans that these people could see and feel but could not quantify or prove scientifically?



SOURCE: SCHOOL OF OCEANOGRAPHIC STUDIES, JADAVPUR UNIVERSITY

Between 1969 and 2009, Subdarbans has lost 210.247 sq km of land, of which 44 sq km has been lost in the current decade.

4. THE MACRO VIEW

In trying to verify the climate witness accounts scientifically, we have two reports – one dealing with the period from 1990 to 2000[1], and the other with the period from 2001 to 2008[2]. Together, these reports form eighteen years of data regarding the Sundarbans. Both of these studies have been conducted by the School of Oceanographic Studies, Jadavpur University. The second study, for the period 2001-2008 was commissioned by WWF. Both these studies are readily available and can be consulted for a more detailed analysis of the issues discussed here. This report summarises these two studies in order to validate the field interviews conducted and the concerns raised in these interviews, with scientific data which substantiate these concerns.

A) Environmental factors affecting farming:

Farmers in the Sundarbans complained of decreasing rainfall. They also complained of extreme and extended summers, short winters, and erratic monsoons. They say that this has affected both the productivity of crops, and has made them more disease-prone, requiring larger amounts of pesticides and fertiliser to ensure adequate harvest.

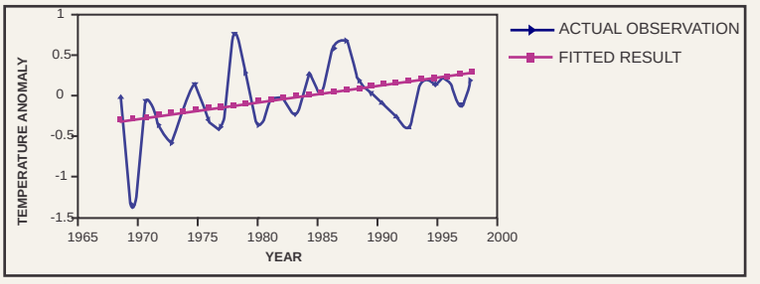
The contributing factors to these atmospheric changes can be measured in the following manner:

1) Ambient temperature change over land
2) Change in rainfall pattern

In addition, we can also look at change in forest cover and land use as the third factor which may be contributing to temperature and rainfall patterns in the Sundarbans.

1) Ambient temperature change over land:

The 1990 to 2000 study actually tracks changes in temperature in the Sundarbans from 1965 to 2000. It finds that there is a clear rise in air temperature over both land and sea. The observed rise is 0.019 degrees Centigrade per year over the Bay of Bengal, and a similar rising trend is also observed in the Sundarbans. The study estimates that if this trend continues, temperature in this area is expected to rise by one degree Centigrade by 2050. Unfortunately, there is no comparable study of the period from 2000 to 2008.



Surface Air Temperature Anomaly Data Over 20°n-25°n and 85°e-90°e reveals an increase of Temperature @ 0.019 °C/Yr.

[1] Hazra, S., Samanta, K., Dasgupta, R., and Sen, G. (2004). A Preparatory Assessment of Vulnerability of the Ecologically Sensitive Sundarban Island System, West Bengal, in the Perspective of Climate Change. *Proceedings of the workshop on vulnerability assessment and adaptation due to climate change on Indian water resources, coastal zones and human health.* MoEF, GoI, New Delhi.

[2] Hazra, S., Samanta, K., Mukhopadhyay, A., and Akhand, A. (2010). *Temporal Change Detection (2001-2008) Study of Sundarban*. Unpublished report. WWF-India

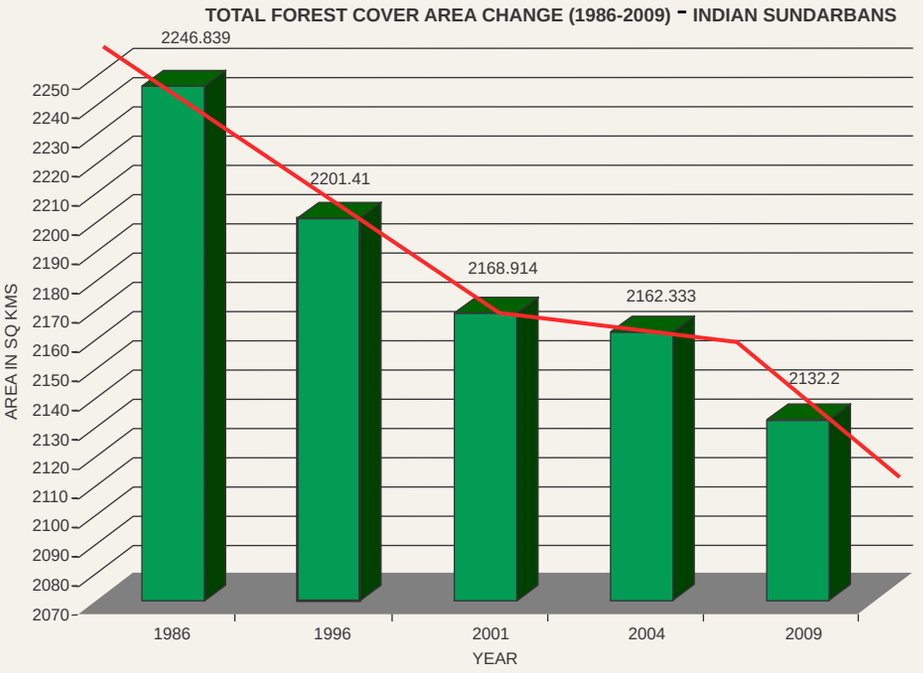
2) Change in rainfall:

When it comes to rainfall, both the study from 1990 to 2000, and the 2001 to 2008 study show that there has actually been an increase over the Sundarbans. The earlier study shows that between the years 1990 and 2000, there has been a marginal increase in the monsoon and post monsoon rainfall. The annual average rainfall of the Sundarbans is 1625mm. However, in high rainfall years it goes up to 2000mm and in low rainfall years it falls to 1300mm.

The 2001 to 2008 study shows a similar pattern. It concludes that in the years under study (2003-2009), overall rainfall as well as monsoonal rainfall has increased over the Bay of Bengal. Therefore, at first glance, it does not appear that the complaints of decreased rainfall over the Sundarbans are borne out by scientific data. However, the marginal increase in the monsoon and post monsoon rainfall may actually be making it difficult for cultivators because they are yet to adjust to the temporal shift in precipitation which might have adverse impact on agricultural productivity as Sheikh Kalimuddin points out in his testimonial. This issue needs further investigation.

3) Change in forest cover:

According to the 1990 to 2000 study, until 1770, the total area of the Sundarbans in India and Bangladesh combined was 36,000 sq km. In 2000, it was 25,000 sq km. The Indian part consisted of 9,630 sq km out of which 4,264 sq km constituted reserve forests. This was made up of 2,168 sq km of mangrove forest and 2,096 sq km of tidal river. This means that an area of around 5,366 sq km has been cleared of forest and used for human settlements since 1770.



According to the later 2000 to 2008 study, forest area has reduced from 2,168 sq km to 2,132 sq km. However, the report shows a marked increase in the level of saline blanks which has grown from 38.93 sq km to 74.79 sq km, completely denuded stretches of mud banks, and growth of water bodies. The report argues that the reduction of forest area is mainly due to two reasons, erosion and conversion to saline blanks/salt pans. The increase of water areas is also attributed to the slow invasion of the sea.

Both natural as well as human factors are responsible for the reduction of forest cover. However, a general trend of decline in both the area and density of the mangrove forests of Sundarbans could be observed in spite of serious conservation efforts and plantation programmes. Interestingly, some of the areas that appeared as saline blanks in 1989 have witnessed natural regeneration with high salt tolerant mangrove species such as *Ceriops decandra (Goran)*. Such regeneration may imply change in the level of tidal inundation due to sea level rise, possibly linked to the phenomena of climate change.

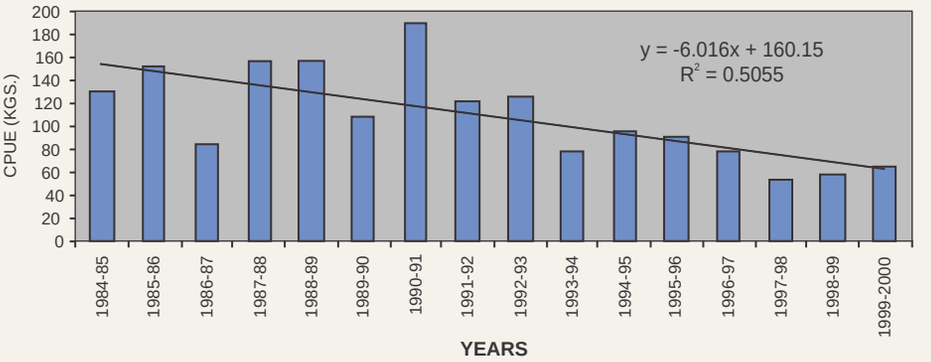
Therefore, the major problem in the Sundarbans appears to be that while the ambient temperature is increasing resulting in thermal expansion of water, more and more land is being degraded and eroded by the sea. The major obstacle to sustainable farming comes not so much from the higher temperatures and decreased rainfall, but from a continuous encroachment by the sea leading to less and less land being available.

B) Environmental factors affecting fishing:

Fishermen in the Sundarbans complain of lower catches. While there may be factors such as deteriorating water quality and over fishing by deep sea trawlers, as well as a larger population of fishermen exploiting the same fishing grounds, change in water salinity may also be a major contributing factor here.

The 1990 to 2000 study has shown a steady decline in the catch per unit effort of fish from 1984 to 2000. The 1990 to 2000 study finds that the salinity pattern of the Sundarbans depends upon the flow of freshwater as well as the tidal seawater in the estuary. The freshwater flow of the Ganges has been reduced, and this has led to the increasing salinity in the estuarine water and soil. According to the study, there have also been numerous reports regarding drying up of fresh water rivers and increase of soil salinity in the Sundarbans, leading to depletion of freshwater fish species.

VARIATION IN THE CATCH PER UNIT EFFORT OF WINTER MIGRATORY BAGNET FISHERY IN THE LOWER HOOGLY-MATLA ESTUARINE SYSTEM



This study, based on comparison of the salinity data collected from different estuaries and rivers of the Sundarbans over the period of 5 years (1996-2001), indicates an intriguing pattern. In every estuary, salinity values recorded during the dry season shows a decrease while salinity values recorded during the monsoon

months shows an increase. The average trend however shows a notable rise particularly in Matla, Saptamukhi, and Thakuran while Hoogly and Ichamati show a fall in salinity. This has the potential to disrupt fish migration, and a consequent decline in fish catch. The latter study of 2000 -2008 unfortunately does not throw light on changes in water salinity.

C) Sea level change and coastal erosion:

In almost every interview that was conducted,the inhabitants of the Sundarbans mentioned the rising sea that constantly thwarted every attempt at keeping it out of fields and farmlands. In addition to this, the constant erosion of land by the sea continued to be a lingering fear of all landowners in the area. While rising sea levels raise the threat of the sea inundating valuable farmland, the erosion reduces landholdings physically, leading to loss of livelihood and food security.

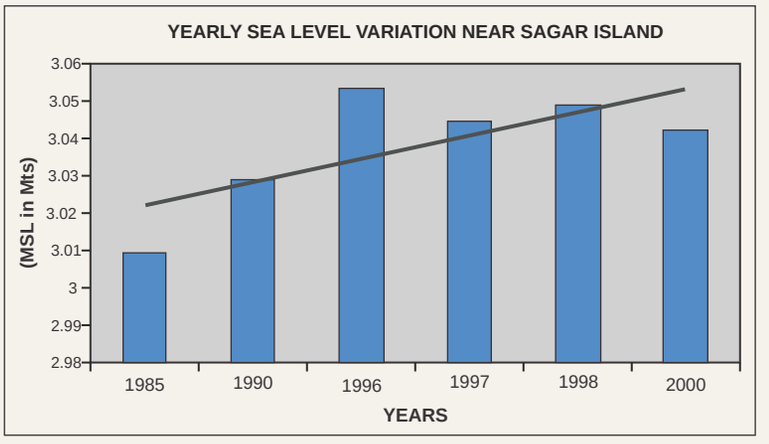
There have been many reports of submerged islands in the Sundarbans, and we had mentioned four earlier (Bedford, Lohachara, Kabasgadi and Suparibhanga). Many other islands have been greatly reduced in size by erosion. In order to find out what exactly is the extent of damage, we need to look at the data on the following factors:

1) Study of sea level change
2) Rate of coastal erosion
3) Study of erosion/accretion of the Indian Sundarbans

Both the studies have dealt extensively with issues of sea level rise and coastal erosion. Therefore, it is possible to see how changes in sea level and coastal erosion have taken place in the two time periods, 1990 to 2000, and 2000 to 2008.

The 1990 to 2000 study has compiled data from the Sagar Island observatory between the period 1985 to 2000. The study concluded that the relative mean sea level in Sagar and adjoining areas of the Bay of Bengal was rising at 3.14mm /year; the global estimate of sea level rise was between 0.5 to 3 mm per year.

According to this study, such a rise in the Sundarbans area will lead to a 20 cm rise of sea level by 2050. However, in the event of any further rise in temperature and rainfall there is a strong probability that the sea level will rise by 50 cm instead of 20 cm. This, over a foot and a half rise in sea level, would well submerge large parts of the Sundarbans delta.

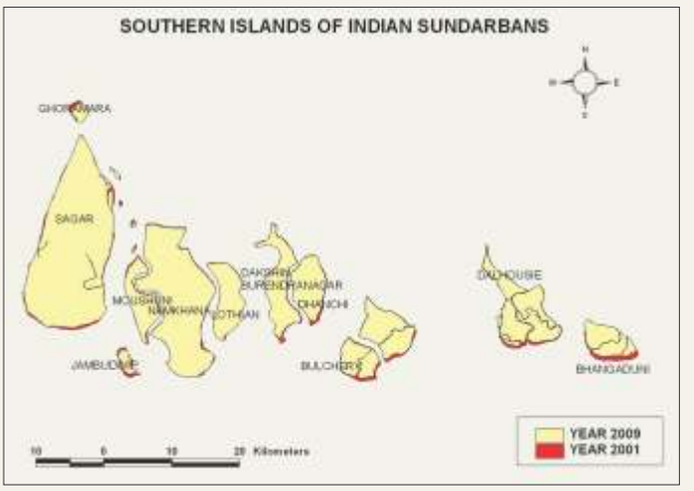


This study also reported a land loss of 97.16 sq km from some of the most vulnerable southern islands of the Indian Sundarbans. These islands are Dakshin Surendranagar, Sagar, Namkhana, Moushuni, Lothian, Ghoramara, Dulibhasani, Dhanchi, Dalhousie, Bulchery, Ajmalmari West, Ajmalmari East, Bhangaduni, and Jambudwip.

The later study covering the years 2000 to 2008 studied the relative mean sea level of the Sundarbans, also from the Sagar Island observatory and found the rate of rise to be 12 mm/year. The general trend showed a rise every year from the previous year except in 2004 and 2006. For the period 2003 to 2006, the mean tide level showed a decreasing trend at the rate of 9.73 mm per year and a contrastingly high figure of 4.71 cm per year during the period 2006 to 2009.

The study then goes on to find the rate of coastal erosion in the Indian Sundarbans to be about 5.50 sq km/year within the time frame of 2001-2009. A total land area of 6402.09 sq. km of the Indian Sundarbans in the year 2001 was reduced to 6358.05 sq km in 2009. This amounts to net land loss of 44.04 sq km which includes erosion of 64.16 sq. km and the accretion of 20.12 sq. km.

Maximum erosion was found to be occurring in the south western part of the Sundarbans. Even islands with dense mangrove had been found to be substantially eroded. Most vulnerable islands identified by this study are Dakshin Surendranagar, Sagar, Namkhana, Moushuni, Ghoramara, Dhanchi, Dalhousie, Bulchery, Bhangaduni and Jambudwip.



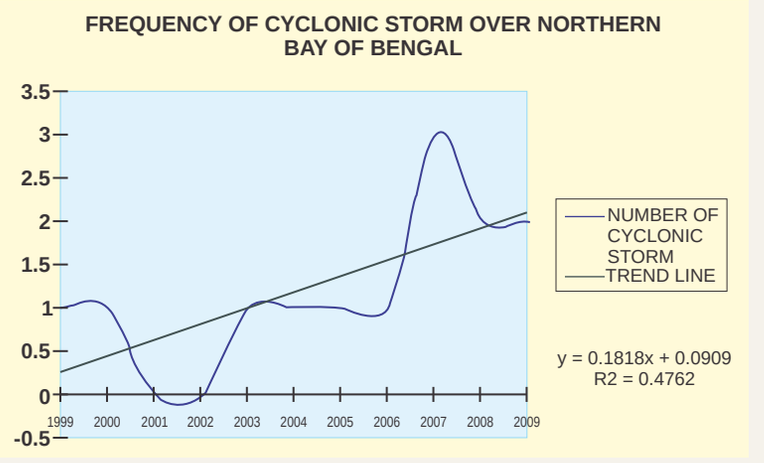
Both the studies show that that sea level is rising in the Sundarbans and the rate of erosion is increasing. The earlier study (1990-2000) estimated that about 69,000 people are already displaced from six different islands and the later study (2001-2008) predicts that more than 1.3 million people will be affected by sea level rise, storm surges and coastal flooding across different blocks of Sundarbans belonging to the high risk area by the year 2020.

D) Change in high intensity events:

SEVERE CYCLONIC STORMS HAVE BECOME MORE FREQUENT OVER THE PAST 120 YEARS

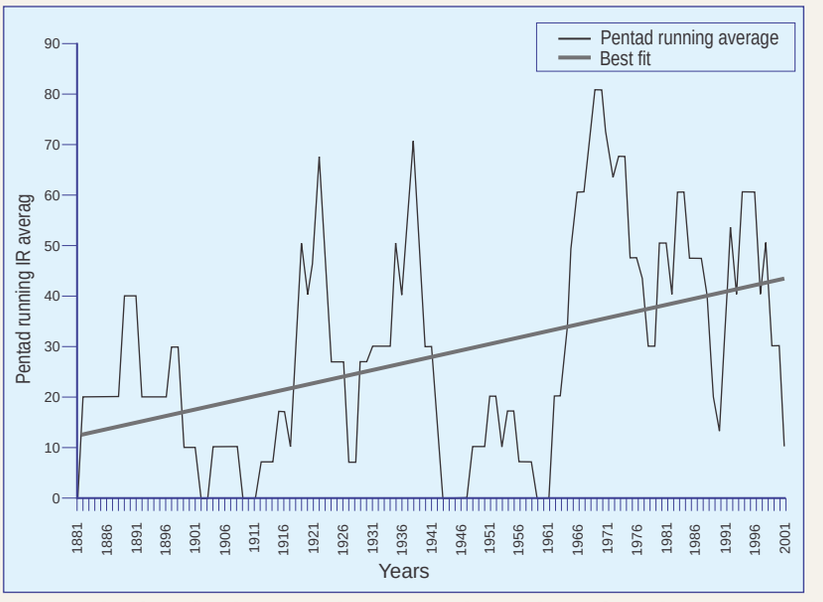
The frequency and intensity of extreme events were a large factor in many of the stories emerging from the Sundarbans. They were said to have increased in number, to be much more ferocious, and happening even outside the July to September danger period. Both farmers and fishermen reported experiencing more bad weather than they had previously been accustomed to. In order to find out the incidence of storms and cyclones, both the studies mapped the various disturbances in the Bay of Bengal throughout the year, and came to somewhat similar conclusions.

The 1990 to 2000 study found that frequency of storms and cyclones were actually on the decline in the Bay of Bengal over the period from 1970 to 2000. However, the magnitude of cyclones had gone up. Therefore, although storms and cyclones were rarer, they tended to do more damaging when they occurred. In effect, although the overall frequency was lower, the frequency of high to very high intensity cyclone in the region was higher.

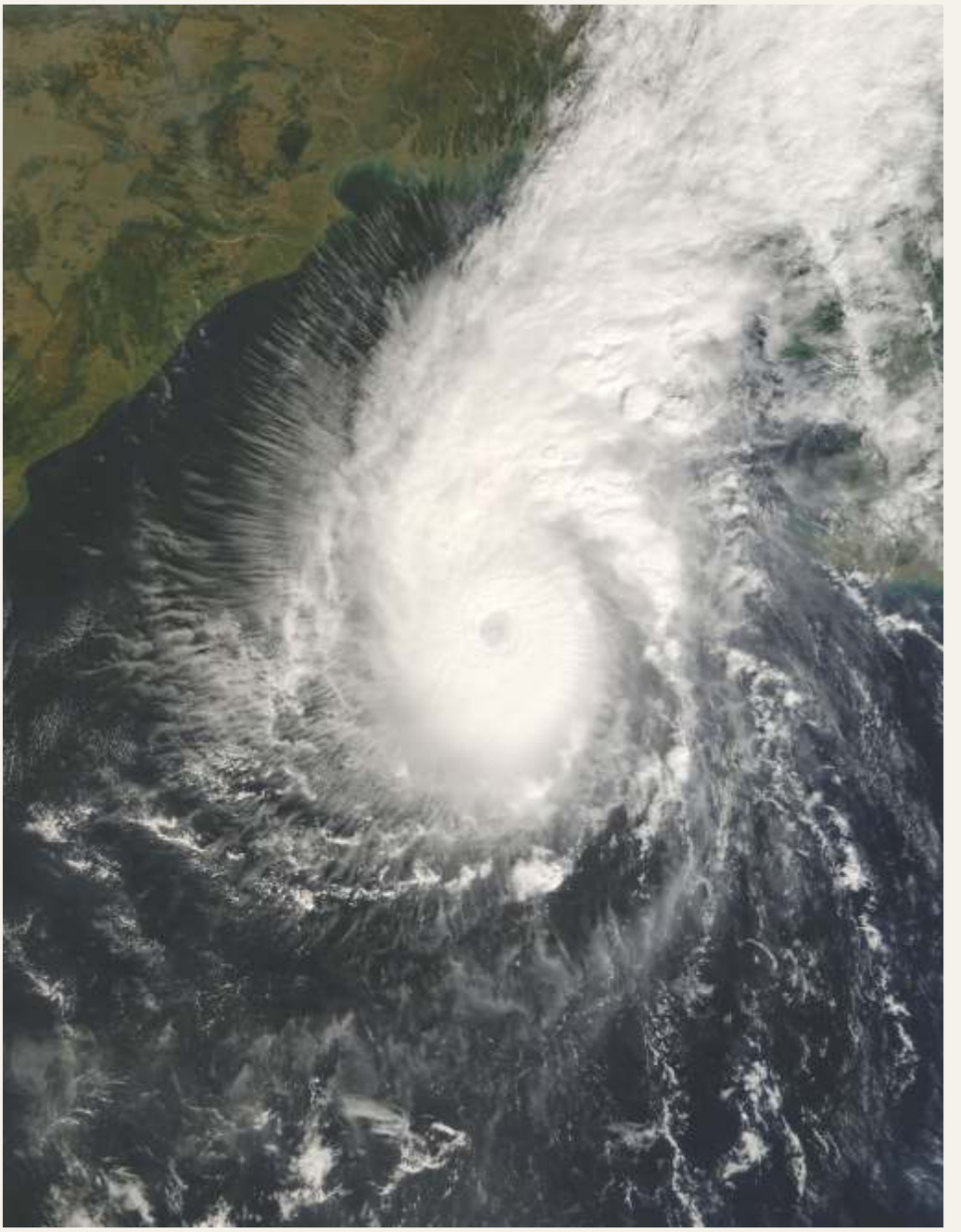


The later study (2000 to 2008) found that the trend of severe cyclones over the Bay of Bengal registered a 26% increase over last 120 years. The frequency and intensity of severe cyclonic storms increased in the Northern Bay of Bengal. Pre- and Post-monsoon storms were found to be more violent than the storms of the monsoon season. During 1999 to 2005, there were a number of depressions, but only three developed into severe cyclonic storms. However, in the next four years, seven such cyclonic storms were formed in the Northern Bay of Bengal. According to the study, it appears that severe cyclonic storms are definitely increasing in frequency, in tandem with rise in sea surface temperature.

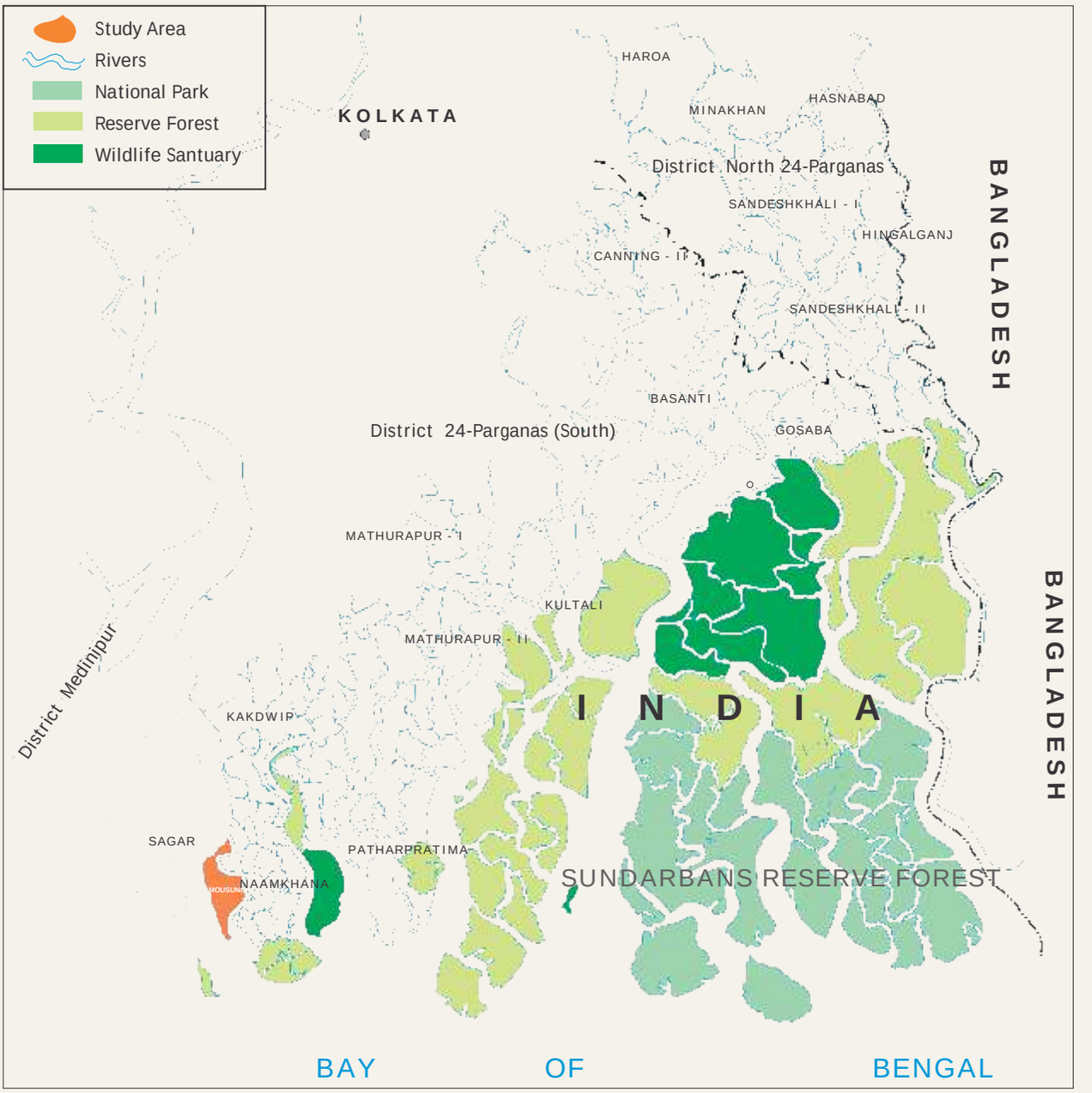
Rise of frequency of severe cyclonic storms over Bay of Bengal during the past 120 years.



The trend is found to be quite alarming as the tendency for a depression to develop into a severe cyclonic storm seems to be on the rise. Cyclones bring strong wind, heavy rainfall and flooding, resulting in severe coastal erosion and embankment failure. So, even though the overall frequency of storms may not have gone up, their severity is definitely a matter of great concern.



Low lying densely populated coastal areas of Sundarbans are highly vulnerable to extreme weather events such as cyclone *Sidr* in the photograph.


Study Area
Rivers
National Park
Reserve Forest
Wildlife Santuary
KOLKATA
HAROA
MINAKHAN
HASNABAD
District North 24-Parganas
SANDESHKHALI - I
HINGALGANJ
CANNING - II
SANDESHKHALI - II
BANGLADESH
BASANTI
District 24-Parganas (South)
GOSABA
MATHURAPUR - I
KULTALI
MATHURAPUR - II
District Medinipur
I N D I A
KAKDWIP
SAGAR
PATHARPRATIMA
NAAMKHANA
SUNDARBANS RESERVE FOREST
BANGLADESH
BAY OF BENGAL

5. THE MICRO PICTURE

After having studied the scientific data regarding the unnatural weather phenomena reported in the Sundarbans, and having found most of them grounded in scientific fact, let us now take a look at one specific island in the Sundarbans, one of the most vulnerable, and see how these different climatic events affect it. Our purpose is to demonstrate how vulnerable and at risk certain sections of the population in the Sundarbans are. Taking a closer look at the island of Mousuni, will also help us understand how interventions can be usefully implemented to help people at risk to successfully empower themselves.

The Mousuni Study:

WWF-India commissioned a vulnerability assessment study on Mousuni Island in the western Sundarbans during the year 2007. Covering 24 sq km, the island, according to 2001 census figures, is home to 3340 families and 20,013 people. The island is encircled by the Muriganga/Bartala River in the west and north-west, Pitt's Creek/Chenayer River in the east and the Bay of Bengal in the south. The island is administered by the Mousuni Gram Panchayat consisting of 4 revenue villages (*mouzas*) - Mousuni, Bagdanga, Kusumtala and Baliara under Namkhana Community Development Block, South 24 Parganas District, West Bengal. The main focus of the study was at Baliara *mouza* which is the southern most of the four.

The aim of the study was to identify vulnerable zones and communities in the *mouza*, and outline a framework for disaster management under a climate change scenario. Interviews were conducted with 600 of a total of 1551 families of the village Baliara, to assess the nature of disasters in the area, and their impact on the villagers. The questions were related to house location and type, type of disaster, loss of property, the kind of relief shelters and disaster warning systems.

Along with this, an assessment of the amount of erosion happening in the area, the state of embankments around the village, and a topographical survey of the area (in order to determine ground elevation) were also undertaken. After an assessment of these and other factors, a micro-spatial vulnerability report was prepared. This report would serve as a guide and a snapshot of the vulnerability of similarly placed islands in the Sundarbans. The assessment in Baliara *mouza* would help us understand how people are affected by disasters in the area, what the nature of their losses are, and how to enable them to protect themselves more effectively in the future.

Findings of the micro-spatial study:

A) Socio-Economic Profile

- Over 68 percent of the families in Baliara *mouza* were below the poverty line.
- About 51 percent did not own agricultural land, amongst those who did almost 40 percent owned less than two acres, while less than 3 percent owned between 4 and 6 acres.
- Over half of the families depended on seasonal or marginal livelihoods, and only about 35 percent worked on their own agricultural land.
- Almost 99 percent of the families live in mud houses.
- Less than 3 percent of the families owned any form of life insurance.
- About 13 percent of the families live in homes with solar electricity (for other islands barring Sagar which has a number of micro solar power stations this figure is not more than 5 percent).

B) Disasters and the Community

- Almost a quarter of the households experience annual erosion of their land.
- Almost 13 percent of the families are impacted by storm surges on an

annual basis while about 18 percent are impacted at least once in five years.

- About 2.4 square kilometres of Baliara *mouza* (157 holdings) has been lost to coastal erosion since 1942; every villager complained of losing some land to the sea.
- About 89 percent of farming families are affected by the salinisation of their soil by seawater incursion.

C) Early Warning Systems and Relief Shelters

- Radio announcements provide disaster warnings to the inhabitants of Baliara.
- Three quarter of the respondents said they get to know of an impending disaster only about six hours in advance, insufficient to adequately prepare themselves in the current situation.
- Almost 76 percent of the families of Baliara take refuge in the local high school, which is on elevated ground, and has never been inundated in recent memory.

D) Condition of Embankments

- The coastal stretch of Baliara is 11.06 km long while the length of the embankment is 8.49 km of which only 1.8 km is brick paved and the remaining 6.69 km is just exposed earthwork.
- The embankment height ranges from 4 to 6 metres.
- Breaches in the embankment are a frequent threat to the islanders. In August 2008, a 400 metres stretch of embankment along the western border of Baliara was breached affecting 26 hectares of agricultural land. (In May 2009, Baliara lost 900 metres of the embankment while its northern neighbour, Kusumtala lost 1200 metres).

MOUSUNI ISLAND HAS LOST MORE THAN 14% OF ITS LAND MASS SINCE 1969

E) Natural Resources

- Agricultural land constitutes 52.10 percent area of Baliara *mouza*.
- Rice varieties are extensively grown in the monsoon-fed *kharif* season. Oilseeds, pulses and vegetables are grown during *rabi* (dry winter) season. Watermelon and chilli pepper are important cash crops. Potato and sunflower are grown in small patches for domestic consumption.
- The inland creeks have been converted into fish farms. Water from domestic ponds/tanks is used for *rabi* crops. A well built canal system in the village has been developed for discharging flood or heavy rain water during the monsoons but most of the canals are silted and sluice gates are non-functional.

F) Elevation

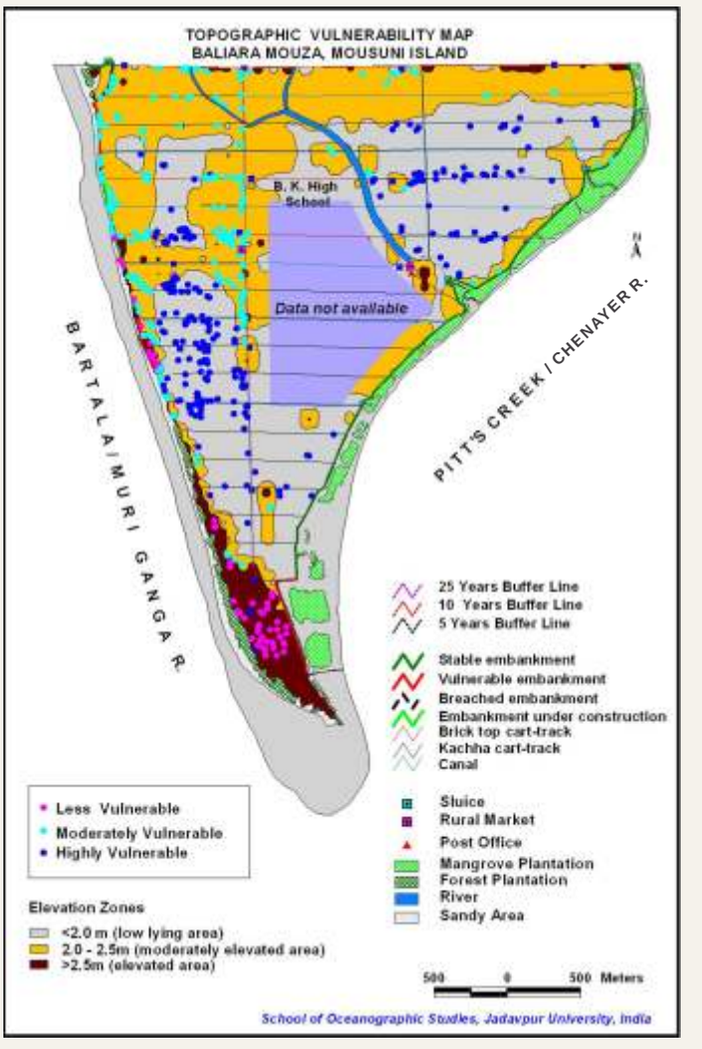
- Mousuni Island is mostly flat with a very gentle slope towards the south and south-east. The highest altitude is 3.90 metres.
- Three micro-elevation zones have been identified. These elevation zones are 1) Elevated area: >2.5m high from M.S.L, 2) Moderately elevated area: 2.0 to 2.5m high from M.S.L, and 3) Low lying area : <2.0m high from M.S.L.

G) Vulnerability Assessment

- About 80 percent of the families in Baliara live in the most vulnerable houses.
- About 51 percent of the families live in low lying (highly vulnerable) areas, while about 37 percent live in moderately vulnerable areas.
- About 11 percent of the families live in erosion prone areas.
- In economic terms, about 64 percent of the families are highly vulnerable and about 33 percent are moderately vulnerable.

Recommendations from the micro-spatial study:

- A two-storied disaster shelter should be built on high ground (possibly an extension of the existing school).
- Establish a Resource Centre to disseminate information regarding existing and foreseeable vulnerabilities, to provide early warning, and disaster preparedness training, as well as information on coping options.
- Establish disaster management teams consisting of local youth and provide training in disaster preparedness.
- Install a WLL phone with text message receiving facility at the Resource Centre to receive early warnings and public address system for dissemination of early warnings.
- Undertake mangrove plantation in erosion prone areas.



Vulnerability map of the study area

WWF for a living planet

Meeting Climate Challenges: WWF in Indian Sundarbans

Salt tolerant paddy

Salinity shock resistant fish

Disaster Risk Reduction: Shelters, Response teams and Relief

Climate Adaptation Centre

Climate Change Policy Papers

6. IMPLEMENTATION EXPERIENCE IN THE SUNDARBANS

Extreme weather in the Sundarbans is a reality. The feedback from the people, the scientific data, and the study of the people living on Mousuni Island make it abundantly clear that the Sundarbans is already in the midst of a heightened state of danger. A fragile ecosystem now stands in the path of dangers aggravated by climate change with possibly more disasters in store for the future.

WWF-India has been carrying out adaptation and capacity building in the Indian Sundarbans since 2007 through small scale demonstration projects to enhance risk preparedness and adaptive capacity of vulnerable communities. The focus of these initiatives has been to enhance capacity and reduce sensitivity in case of exposure to high intensity weather events, and ensure physical and livelihood security.

The key goals of the adaptation and capacity building initiative are threefold. Firstly, to develop a better understanding of current and future climate challenges.

Secondly, to develop and implement pilot adaptation strategies at selected sites. Activities such as attempts to regenerate mangrove patches, construction of a disaster relief shelter, and installation of early warning system and establishment of effective disaster response mechanism have already been undertaken on Mousuni Island – all of which are geared towards enhancing physical security of the vulnerable population. Meanwhile, re-introduction of salt-tolerant paddy and pisciculture using specific fish species that survive in wide salinity gradient is aimed at reducing livelihood risks.

Thirdly, to raise the awareness of climate change impacts in the Sundarbans and incorporate climate change concerns in development planning. We have successfully engaged local communities as well as policy makers through various outreach and demonstration activities and urged for appropriate action.

Following are the list of project activities successfully implemented by WWF-India to reduce climate vulnerability and build resilience of the vulnerable communities in the Indian Sundarbans:

1. Establishment of a knowledge centre: The Mousuni Climate Adaptation Centre (MCAC) acts as a nodal point for exchange of information, data and services for the benefit of the local communities. The major focus of this resource centre is to increase the capacity of vulnerable communities to deal with the impacts of climate change and to promote climate adaptive livelihood options. It is managed by the elected representatives of the local community (resource centre managing committee) and serves as Early Warning Station, nodal centre for Disaster Response Teams, Adaptation knowledge centre/training centre, computer and internet centre, seed bank, book bank, community centre, temporary relief shelter and a revenue generating guest house.

2. Introduction of climate resilient agricultural and pisciculture practices: Indigenous salt tolerant paddy and fish varieties have been successfully re-introduced. This provides an opportunity for those affected by saline water ingress to harvest a crop despite salt water incursion. The produce is comparable to what farmers get through conventional farming practices during incident-free periods.

3. Disaster relief shelter: WWF-India successfully completed repair/augmentation of a local high school including sanitation facilities to double up as an effective disaster relief shelter. This disaster relief shelter can provide refuge to 1200-1500 individuals.

4. Early warning and disaster response teams: WWF-India has helped form disaster management teams and augments their capacity through trainings and equipments. More than 200 volunteers from five villages constitute the teams. Now, there are 5 teams officially recognised by the local administration and will receive state support when disasters strike.

5. Research reports: Findings of a vulnerability assessment report for the project site has been prepared in collaboration with a premier research institute and is readily available with the stakeholders for reference.

6. Policy dialogue: WWF-India engaged policy makers, senior administrators and local administration quite successfully. Active support was received from all the concerned agencies.

7. Partnership and networking: WWF-India is a member of the local network of disaster management agencies and other humanitarian groups. They contribute with training modules for disaster response teams.

Successful adaptive strategies have a direct bearing on the health of the ecosystem because as more people get displaced and lose livelihood, they begin to extract resources from the ecosystem, which over a period of time could become unsustainable in ecological and socio-economic terms.

Through all our activities we are trying to convey the message of great climate risk to the Sundarbans ecoregion and its inhabitants. Often, we are asked about climate adaptation strategies for the Sundarbans in light of predicted future changes. In trying to answer such a question we are increasingly realising that what we are currently doing is essentially “buying time” for the people of the Sundarbans. Climate adaptation for a place like the Sundarbans beset with development challenges emanating from inadequate infrastructure, lack of period-appropriate education, health care, and modern energy services needs not only a robust methodology for vulnerability assessment but also a future looking basket of options for the people as well as the State.

Towards this end, WWF-India along with other experts is finalising a vision document for the Sundarbans that argues for early, proactive, highly informed and bold changes in policy and governance with the aim of stimulating reasoned public discussion. The Vision 2050 scenario which envisages implementation in four phases is indicative and aims at improved quality of life of the human population with reduced threats from extreme events and restoration of the ecosystem. This is a work-in-progress and the next steps involve undertaking a cost-benefit analysis of suggested action versus *business as usual*, engage in dialogue with key decision-makers on the vision, and hold wider consultations with the population of the Sundarbans on their vision of the future.

WWF-India Sundarbans Programme

The Sundarbans is a priority eco-region for WWF-India, and it has been working in the Indian Sundarbans since 1973. The first tiger tranquilisation and rescue in the Sundarbans was carried out by WWF in 1976. Since 2003, WWF has made significant investments in tiger landscape conservation in the form of strengthening of infrastructure and seeking active community and development agency participation. The enhanced involvement in the eco-region demanded a dedicated Sundarbans Programme to aid halt degradation of Sundarbans' natural environment and to help build a future in which humans live in harmony with nature in the eco-region.

The Sundarbans Programme came into being in 2005 and works in three major but non-exclusive thematic areas – biodiversity conservation, climate change and energy, and sustainable livelihoods. The Programme strives to a) develop better understanding of current and future challenges, b) implement pilot projects to demonstrate what works and how, and c)raise awareness of issues in order to influence policy and incorporate the pressing concerns into development planning. Towards these ends, the Sundarbans Programme collaborates with leading institutions and agencies and prepares reports (e.g. State of Art Biodiversity Report), develops and implements pilot projects (e.g. solar power station), and engages with a wide cross-section of stakeholders through policy documents (e.g. Delta Vision: 2050).

The Sundarbans team now consists of 10 members.

THE TEAM

Subhro Sen, *Assistant Coordinator*

Specialisation: Natural Resource Management

Subhro joined the team in January 2006 and has been instrumental in implementing wide ranging projects such as sustainable shrimp farming, climate adaptation, and renewable energy solutions. Anything technical is of interest to him.

Mohan Chandra Dolai, *Field Officer*

Specialisation: Social Cultural Anthropology

Mohan has been with the team for nine months and spends most of his energy on energy projects, particularly on building community institutions and conducting surveys. Tribal populations are of interest to him.

Soma Saha, *Assistant Coordinator*

Specialisation: Community Dynamics

Soma joined the team with few others in 2007 when the Programme underwent a significant expansion. She has a very clear understanding of sustainability issues and works closely with communities. She has keen eyes for birds.

Chiranjib Chakraborty, *Field Officer*

Specialisation: Social Cultural Anthropology

Chiranjib came on board in the middle of 2008. The Programme's grassroots connections have been significantly strengthened since then.

Ratul Saha, *Coordinator*

Specialisation: Natural Resource Management

Ratul is a wildlife enthusiast and has strengthened the biological side of the Programme. He joined in the first quarter of 2010.

Anurag Danda, *Head*

Specialisation: Sustainable Development

Anurag has spent the better part of his formal working life in the Sundarbans. He joined the Programme in 2005. Issues of environment and development are of interest to him.

Isita Ray Chakraborty, *Programme Manager*

Specialisation: Research Methodology

Isita is the newest member of the team having joined in the middle of 2010 but has 14 years of experience working in the Sundarbans. She has special interest in gender issues.

Kousik joined in 2007 and is responsible for financial management of the Programme. He is an avid chess player and likes to travel.

Kousik Chakrabarti, *Accounts Officer*

Specialisation: Accounts

Arjun Manna, *Assistant Project Officer*

Specialisation: Environment and Sustainable Development

Arjun had previous involvement with WWF's work in the Sundarbans. He formally joined the team in April 2007. Livelihood related issues are of major interest to him.

Upendra is an old hand at WWF having put in all his working life of 29 years for the organisation. He joined the Programme team in 2007.

Upendra Rao, *Office Assistant*

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