



**Caritas**  
INDIA

*The Joy of Service...*



# The Sundarbans

IMPACT OF CLIMATE CHANGE ON PEOPLE'S LIVELIHOOD;  
OPTIONS FOR ADAPTATION

# Acknowledgement:

This draft knowledge product is the outcome of CARITAS INDIA and School of Oceanographic Studies Jadavpur University joint effort to record important information and possible adaptation measures related to climate change impacts on peoples livelihood in the Sundarban. We are thankful to each and every individual, NGO Organizations and Govt Departments official who joined and helped us in undertaking the study and making out of this document





# The Sundarbans

The Sundarban is the world heritage and one of the largest mangrove forests of the world which is also the adobe of royal bengal tigers. Livelihood issues vis a vis the welfare of the inhabitants, are of serious concern.

The census of 2011 reveals that the Sundarban has total no. of households 954970 and total population of 44, 26,259. Percentage of SC and ST population is nearly 40% and gender Ratio (M:F) - 955 / 947, Net Cultivable Area-3.05 lakh ha, Multi-cropping Area-86010 ha (28.2%) Area under irrigation is-4448(14.6%) and per capita land is 0.069 ha (10 Cottah)

A dynamic delta, with erosion and sedimentation, raising of riverbed, degeneration of mangroves, change in monsoonal trend, breach of embankments, coastal flooding, salinization of lands, decreasing crop productivity, cropping intensity almost stagnant, affected sweet water aquifer in summer, greater incidence of water & vector borne diseases, human migration & displacement, together make Sundarban a global hot spot of climate change impact and pose a serious challenge for adaptation.

## **About the project and collaboration with School Of Oceanographic Studies, Jadavpur University:**

CARITAS INDIA with support from SCiAF (Scottish Catholic International Aid Fund) has initiated a research study to understand the impacts of climate change in the Indian Sundarban, West Bengal India in Feb'13. The research study is being carried out by the School of Oceanography, Jadavpur University, Kolkata, India. The objective of this study is to come out with important information and a set of recommendations for better understanding of the impact of climate change on people's livelihood in the Sundarban. Along with the study CARITAS INDIA team undertook an extensive effort to capture important perceptions of climate change and spontaneous adaptations measures across different stakeholders group (NGO/INGO, Academicians, Govt dept, climate change witness groups) over a period of almost 6 months. It is strongly envisaged that a combination of these above two will help in planning out effective advocacy strategies for action in reducing the vulnerability of the people's livelihood in the Sundarban.

## **Climate Change Indicators: (temp, monsoonal pattern, cyclone frequency and intensity)-research finding by Jadavpur University**

### **Temperature Rise:**

The IPCC observed that in the period between 1951 and 2012 the average global temperature has increased at the rate of 0.12oC per decade (5th Assessment Report, 2013). This implies

that the average global temperatures will increase between 1.8°C to 5.8°C over the next century, and the sea level will rise between 9 and 88 cm (IPCC, 2013).

The 1999- 2000 study (Hazra et al 2002), has tracked the changes in temperature in Sundarban. The study shows that there is a clear rise in temperature over both land and sea. The observed rise is 0.019°C/ year over the Bay of Bengal, and a similar rising trend is observed in Sundarban. The present study estimates that if this trend continues, temperature in this area is expected to rise by 1°C by 2050. A study using day time (11µ) AQUA MODIS level 3 sea surface temperature (SST) data (of 4km × 4km resolution) of Bay of Bengal shows that SST has a rising trend at a rate of 0.042°/ year and reached the highest level in 2009.

According to the study by Hazra et al (2010), the mean annual air temperature varied from 27.09385°C in the year 2004 to 28.14508°C in the year 2009. However, a more long term observation is needed before assessing the mean rate of local temperature rise.

It is observed in the West Bengal State Action Plan on Climate Change 2010/12, minimum temperatures over the 1969- 2005 period (37 years) has increased by 1°C, and maximum temperature has decreased by 0.250C to 0.50C within the same time window

### **Changes in Annual Rainfall Pattern:**

The West Bengal State Action Plan on Climate Change 2010

indicates that there are distinctive changes in observed pattern of rainfall between 1901 and 2003. In winter and pre monsoon seasons the rain fall has decreased in this region by -14.5mm and -6.7mm respectively between 1901 and 2003. In the monsoon season the increase in the rain fall in this region was about 91mm, and in the post monsoon season rainfall continues to show an increase by 25 mm. The most remarkable feature is the variability in the date of onset of monsoon. Through the last few decades, the onset date has been pushed back by 5-10 days.

*From the annual data (Hazra et al, 2010) it has been noticed that the rainfall has been increased over Bay of Bengal during monsoon season at the rate of 0.0041 mm/hr, along with SST.*

Future projections for 2021- 2050 indicates further increase in rainfall over Sundarban. This stands contrary to the overall predicted reduction of monsoonal rainfall in the state (West Bengal Climate Action Plan, 2012).

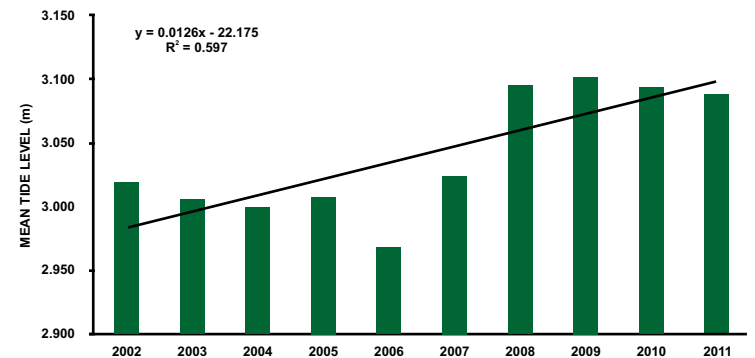
However, the major victim of climate change has been the arrival date of monsoons. While previously, the date could be predicted with ease; now the arrival date has been deferred by 7 to 11 days, fluctuating even up to 25 days. It is a serious concern for agriculture practice of Sundarban to adapt to the new situation.

### Mean Sea Level Change:

IPCC (2013) observed that between the 1993-2010 period, the global sea level has risen at the rate of 3.2mm/year. The average sea level rise has been 1.3 mm/ year along the Indian

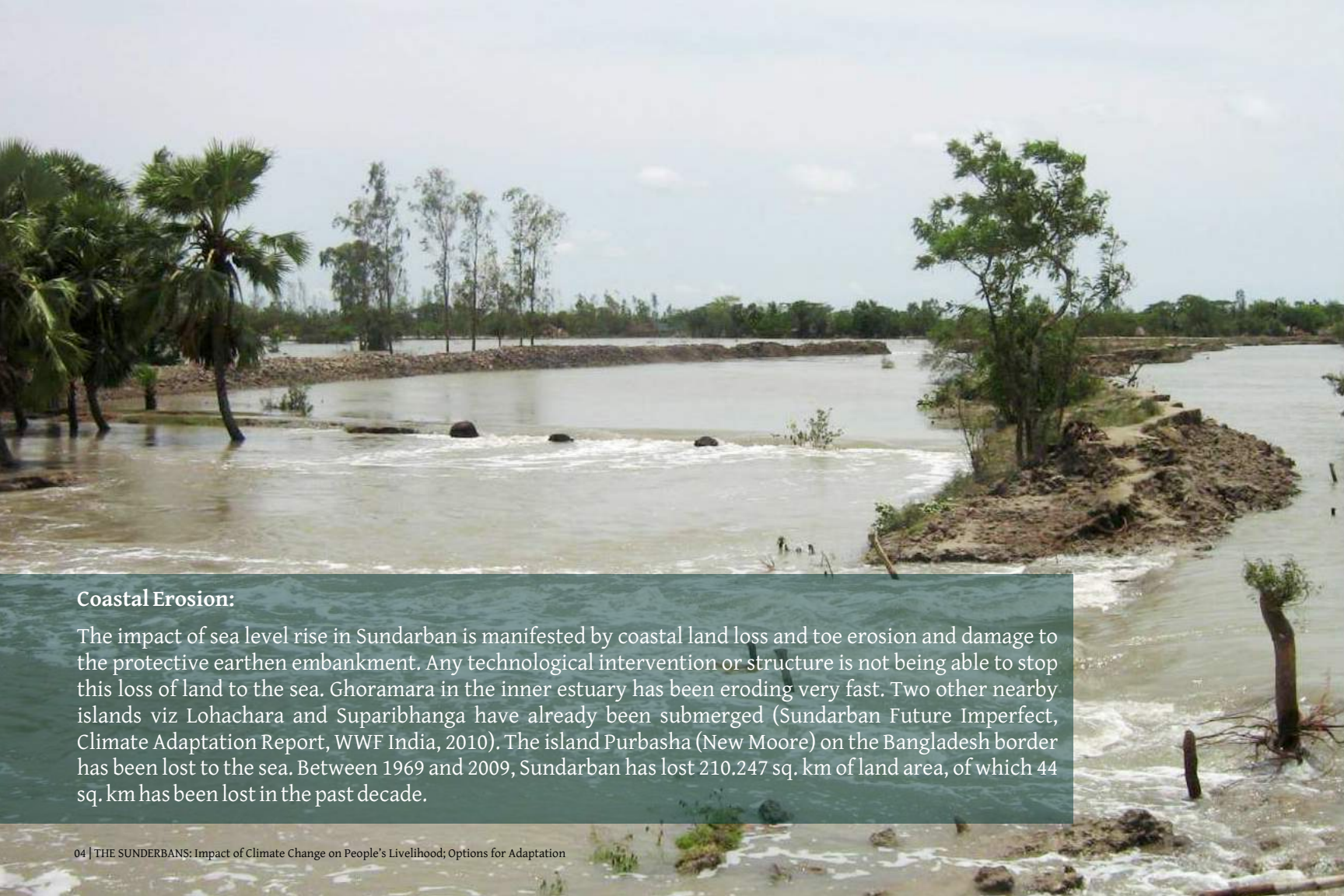
coast (INCCA, 2010), however, tide gauge observations at the Diamond Harbour port indicates a sea level rise of 5.7mm, which can be attributed to subsidence in the region at rate of 4mm/year (WB State Action Plan on Climate Change, 2012). However, the state of sea level rise at Sundarban needs to be visualized in terms of rise of the 'local' sea level relative to the land (that is relative sea level) as that, instead of a mathematical 'global' rate, affects the saline flooding in coastal areas.

Inter-annual change (2002-2011) of mean tide level (MTL) was studied at the Sagar Island station, which is the largest island of the deltaic system of Sundarban. Within this study period, highest MTL (3.102 m) was observed in the year 2009 and lowest MTL (2.969 m) was observed in the year 2006. A steady increase of the MTL was observed from the year 2008 to the recent years. The overall study revealed an increasing trend of MTL at a rate of 12 mm per year during the study period



Inter-Annual Change in Mean Tide Level at Sagar Station. (Source: School of Oceanographic Studies, Jadavpur University).





### Coastal Erosion:

The impact of sea level rise in Sundarban is manifested by coastal land loss and toe erosion and damage to the protective earthen embankment. Any technological intervention or structure is not being able to stop this loss of land to the sea. Ghoramara in the inner estuary has been eroding very fast. Two other nearby islands viz Lohachara and Suparibhanga have already been submerged (Sundarban Future Imperfect, Climate Adaptation Report, WWF India, 2010). The island Purbasha (New Moore) on the Bangladesh border has been lost to the sea. Between 1969 and 2009, Sundarban has lost 210.247 sq. km of land area, of which 44 sq. km has been lost in the past decade.

## **Changes in Intensity and Frequency of Cyclones over Bay of Bengal:**

Cyclones are rare in Bay of Bengal from January to March. Pre and post-monsoon storms are stronger than the monsoon season. According to the study, severe cyclonic storms over Bay of Bengal that are registered have increased by 26% over last 120 years, specifically during post-monsoon (Singh, 2007).

Sundarban and coastal West Bengal normally experience 4 cyclones of varying wind speed per year. The previous studies by the School (Hazra et al 2003) indicated an increase in the frequency and intensities of severe cyclonic storms over the Bay of Bengal. In the recent decade (2005-13) the Bay of Bengal experienced more than 20 such events. Though some of the super and very severe and cyclone varieties like Sidr (2007), Aila (2009) caused severe damage to life and properties in Sundarban, the rough sea during others caused coastal flooding and loss of fishing days and fish catch.

## **Climate change perceptions, impact and adaptations**

### **Vulnerability Assessment at Block level**

Vulnerability assessment at block level was taken up particularly to understand the relative vulnerability of different areas of Sundarban Biosphere reserve to climate change impact. This would help to prioritize action research towards reduction of vulnerability. There were no records of previous research in similar direction. We have improved on the methodology of micro level (village) study developed while working with Ramakrishna Mission in 2009 and WWF

India in 2010 and 2013. The present study, which is a regional one, covering 6000 Km<sup>2</sup> in a time frame of 6 months; secondary data has been more useful than primary one. However, primary survey data of 2100 persons distributed in 19 Blocks (120 persons from two Gram Panchayats in each Block) has been used to validate the observations from secondary data and to understand house vulnerability, economic & social vulnerability and migration patterns.

- Both physical and socio economic vulnerabilities have been considered for computation of Composite Vulnerability Index. Physical parameters like erosion, state of the protective embankments, kind of houses, percentage of inundation during Aila storm surge, road accessibility, level of electrification and availability of fresh water (% of agriculture land under second crop as proxy), social parameters like population density, number of people belonging to schedule caste and scheduled tribes, level of health services provided and sanitation and economic criteria like percentage of people below poverty line have been considered. Normalized values for each parameters were considered for each Block and ranked as high, medium or low (or 3,2,1) and finally was resolved in a GIS platform.
- **Erosion:** Gosaba, Kultali, Patharpratima, Namkhana and Sagar are found to be the most erosion prone Blocks in Indian Sundarban. Hingalgarj, Basanti and Kakdwip are moderately vulnerable Blocks.

**Embankment:** Hingalganj, Gosaba, Basanti, Patharpratima, Namkhana and Sagar are highly vulnerable as per the condition of the embankments. Canning I & II, Sandeshkhali II, Haroa, Jaynagar I & II, Kultali, Mathurapur I & II, and Kakdwip are moderately vulnerable in this respect.

**Dwelling units:** House types are classified as kaccha (made of mud), semi-pukka (made of mud and brick but roof made of burnt clay tiles, straw, tin, asbestos etc.), and pukka (made of brick). Blocks with more than 70% kaccha houses have been considered as highly vulnerable; those with 40-69% kaccha houses have moderate vulnerability, and Blocks with less than 40% kaccha houses have been considered as less vulnerable. Canning II (82%), Basanti (85%), Gosaba (85%), Sandeshkhali I & II (88%), Hingalganj (81%), Kultali (82%), Mathurapur II (77%) are found to be the most vulnerable blocks with respect to house types that are most susceptible to damage during storms and coastal flooding.

**Inundation and saline flooding:** Cyclone Aila, that hit India and Bangladesh in May, 2009, inundated a huge portion of Indian Sundarban with saline water. Hingalganj Block was totally inundated in that storm surge. Except Haroa, all the other Blocks were more or less inundated. Patharpratima (81.61%), Kultali (69.77%), Basanti (50%), Gosaba (68%) are the most vulnerable Blocks in Indian Sundarban from the point of view of inundation

**Road Connectivity:** Considering road connectivity, Gosaba, Patharpratima, Namkhana (especially Mousuni Island), and Sagar are highly vulnerable, while Kultali and Basanti are moderately so.

**Electrification:** Among 19 Blocks, 13 Blocks are completely electrified. Blocks that are partially electrified are Hingalganj (64.28% left), Gosaba (54% left), Kultali (13.95% left), Patharpratima (34.21% left), Namkhana (11.18% left), and Sagar (2.22% left). Blocks with 90% electrification completed are ranked as 'less vulnerable' (i.e. rank 1), Blocks where 10-30% electrification is still left are considered as 'moderately vulnerable' (i.e. rank 2), and Blocks with greater than 30% electrification remaining are marked as 'highly vulnerable' Blocks. Thus Gosaba & Hingalganj are highly vulnerable Blocks, while Kultali & Patharpratima are moderately vulnerable Blocks.

**Fresh water availability: Agricultural Area under 2nd Crop:**

- Among the 19 Blocks of Sundarban, 6 Blocks are highly vulnerable from the perspective of fresh water availability. Blocks with limited access to fresh water resources have lesser percentage of agricultural land under second crop. Blocks having less than 20% area for 2nd crop cultivation are considered as highly vulnerable with respect to fresh water availability. Blocks with 20-30% area under 2nd crop are considered moderately vulnerable, and Blocks with more than 30% area for 2nd



crop cultivation are marked as less vulnerable. Hingalganj (9.54%), Kultali (10.58%), Canning I (11.73%), Minakhan (12.27%), Gosaba (15.73%), and Sagar (18.02%) Blocks are found to be highly vulnerable. Canning II, Sandeshkhali II, Mathurapur II, Patharpratima and Namkhana are moderately vulnerable Blocks. Hugli River on the west is a major source of fresh water supply.

### Population Density:

According to Census 2011, the average population density of Sundarban is 1099.63 persons/sq. km area. Among the 19 Blocks, highest population density is observed in Jaynagar I Block, which is 1825 persons/sq. km area. Patharpratima shows lowest population density (676 persons/sq. km area). To assess the vulnerability of different blocks they were ranked in three groups, 'less vulnerable' (Blocks having population density less than 900 persons/sq. km area); 'moderately vulnerable' (Blocks having population density between 900- 1300 persons/sq. km area), and 'highly vulnerable' (Blocks having population density greater than 1300 persons/sq. km area). Depending on this ranking system, following blocks of Sundarban are found to be less vulnerable: Jaynagar I & II, Haroa, Hasnabad. Patharpratima (73%), Namkhana (76%) are most vulnerable. Canning I, Minakhan, Hasnabad, Mathurapur II, Jaynagar I, Kakdwip, Sagar are moderately vulnerable blocks.<sup>79</sup>

**Social Vulnerability:** Several parameters are generally considered in determination of social vulnerability, like percentage of female child and

elderly persons in the population; literacy rate, percentage of Schedule Caste (SC), Schedule Tribe (ST) in the population. But in the 19 Blocks of Sundarban, the percentage of female population ranged between 48.37% (Sagar) to 49.14% (Canning II) and the percentage of child population ranged between 10.82% (Hingalganj) to 15.60% (Kultali). That's why these parameters were not considered to estimate the relative social vulnerability of Sundarban.

- The highest number of SC population was encountered in Hingalganj (66.02%), followed by Gosaba (62.69%), Canning I (47.55%), Kultali (45.49%) and Sandeshkhali II (44.91%). The Blocks having a SC percentage of less than 30% are considered as less vulnerable, while those between 30% to 50% are moderately vulnerable, and blocks having more than 50% population belonging to scheduled casts are considered highly vulnerable. Depending on this ranking Hingalganj and Gosaba can be designated as highly vulnerable Blocks. Blocks having less than 1% of Scheduled Tribe population are considered as less vulnerable, while, while blocks with more than 10% ST population are considered as highly vulnerable. Sandeshkhali I & II are observed to be the most vulnerable blocks in Sundarban. Canning I & II, Mathurapur II, Kultali, Basanti, Gosaba, Haroa, Hasnabad, Hingalganj, and Minakhan are moderately vulnerable

**Level of Sanitation:** Sanitation can be considered as one of the several parameters for determination of the health status

of a population. The type of sanitation in Sundarban is classified as permanent, semi-permanent and open space (i.e. households having no sanitary toilet within/close to the premises). Blocks having less than 50% sanitation facilities are considered as highly vulnerable. Those with presence of 51-79% sanitation facilities are considered as moderately vulnerable, and blocks with less than 50% sanitation facilities are evaluated to be highly vulnerable. Kultali and Mathurapur I have been evaluated to be highly vulnerable blocks, while Canning I & II, Basanti, Hasnabad, Sandeshkhali I & II, Mathurapur II, Jaynagar I & II, Kakdwip and Patharpratima are found to be moderately vulnerable blocks.

### Economic Vulnerability:

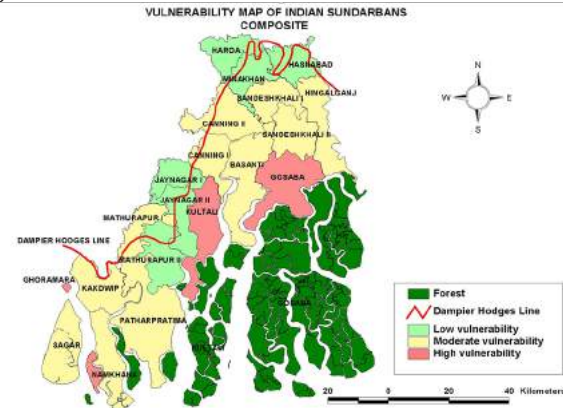
The economic vulnerability of different blocks of Indian Sundarban was calculated on the basis of the household surveys. First the family level economic vulnerability was calculated, and depending on this block level economic vulnerability was calculated. Several parameters were considered for estimation of the family level vulnerability, for example, whether the family belongs to Below Poverty Level (BPL) category, the average income of the family, the amount of agricultural land it possess, the assets the family own like live stocks (e.g. cattle, poultry etc.), cycle van, motorized van, motor cycle, TV, mobile, boat, mechanized boat, net, shallow pump, etc. depending on these parameters the economic vulnerability map or the 19 blocks of Indian Sundarban is generated, and presented here. The percentage under each

category obtained from the survey was subsequently compared and validated from the secondary data (Cen. 2011).

It is observed from the vulnerability analysis that Sandeshkhali I & II, Jaynagar I & II, Kultali, Mathurapur I, Patharpratima, Sagar are economically highly vulnerable blocks in Indian Sundarban. Except Minakhan, all the other 10 blocks of Indian Sundarban are moderately vulnerable. Though Sundarban is a well-known destination for national and international tourists, coastal tourism has no significant impact on the local rural economy.

### Estimation of Composite Vulnerability

Depending on the evaluations of the multi-dimensional aspects of vulnerability of the 19 blocks of Indian Sundarban, a composite vulnerability map of Indian Sundarban has been generated.



Composite vulnerability map of Indian Sundarban.

It is observed that Kultali and Gosaba blocks along with Mousuni and Ghoramara Islands are the most vulnerable places in Indian Sundarban. The Ghoramara and Mousuni islands belong to Sagar and Namkhana blocks respectively. As the other parts of these blocks have road connectivity to mainland, lesser percentage of erosion or inundation probability, they come in the moderately vulnerable category. But both of these islands emerge as highly vulnerable when considered in isolation. Therefore these two island have been evaluated on the basis of village (mouza) level data and shown as highly vulnerable in the composite vulnerability map.

### **Climate change perceptions of NGO and other stakeholders**

Climate change impact is being observed by the community with uncertain and erratic rains, warmer summers, different pattern of wind flow and short winter spells. It is highlighted by many technical experts who are constantly studying the trend that there is a severe threat on the geomorphology and ecology of Sundarban.

The changes in surface water temperature, SLR, salinity intrusion, and relevant climate factors would result in putting pressure on the aquatic ecosystem of the Sundarban region. One of the major challenges for the Sundarban would have to face is decline in agricultural production which may occur due to climate-related events including variations in temperature, rain fall, dry spells, flood, cyclone storm surge and salinity intrusion.

CARITAS team have taken an initiative to identify and record gaps in relation to practice, technology and policy impacting livelihood of people in the Sundarban. This report is the culmination of such an effort where CARITAS-I team has nearly spent 35-40 days on the ground across five vulnerable blocks in the Indian Sundarban recording the perceptions of local people/NGO's/Research Institutes working on climate change and its effect.

### **The entire process could be elaborated as below:**

#### **Step-I**

Interviews were conducted with key informants in different parts of Sundarban and Kolkata during May'13-Sept'13. The interviews were qualitative and semi-structured. The interviewees comprised academicians, policy actors, and representatives of Govt Dept, gram panchayats and non-governmental organisations. (Outcome details of which are available in the narration and graphical representation as below)

#### **Step-II**

The field visits provided a very good opportunity of understanding grass root problems and local way of life in the Sundarban. Also qualitative interviews of at least 60 residents (men, women and youth) across 28 households were conducted to understand the ground level concerns, issues and priorities. The interviews for household surveys were conducted in 15 remote villages across five blocks (Kultali,



Basanti, Mathurapur-II, Namkhana and Kakdwip) out of the 19 that comprise Indian Sundarban. Focus group meeting was organized with the help of some local NGO's that we visited. These blocks were selected to represent diversity within the Sundarban in terms of proneness to environmental hazards, adaptive responses, policy failures and geographical constraints.

A focussed questionnaire has also been used (developed by Jadavpur university) to get an understanding of important concerns and priorities of different stakeholders quantitatively.

### Step-III

Apart from the interviews, secondary data was collected from various government departments, human development reports, published articles. These data were critically reviewed with the experience of people on the ground and extrapolated with these focus group interviews.

### Conclusion:

The interview data, as well as the field observations have been triangulated with published literature, reports, policy documents and data obtained from various departments in the State of West Bengal

### Details of interview at different stakeholder's level:

28 NGO's across Sundarban was visited and structured interviews were conducted with the representatives (1-2) of these NGO's. Key questions were their acceptance or non

acceptance of the climate change issue and its impact, important sectors affected by the local level climate change process and sensitivity of various sectors, also important measures initiated with respect to the observed changes

Similarly opinion of 20 respondents (important Govt Dept officials, research scientists, eminent experts and Academicians from reputed University) was recorded in the structured format. Key questions were again about the climate change perception and its significant impact, sensitivity of different sectors affected by important climate change factors and important measures initiated at their level through research or other effort.

Interview of 19 respondents out of 28 households was recorded from 15 villages on local level climate change perceptions and its impacts and adaptive measures undertaken. A few interviews have been captured both in audio-visual form too especially from women whose voices are often unheard but they are found significantly affected by climate change impacts.

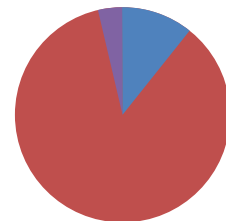
### The interview outcome is narrated as below:

#### NGO:

#### Water Resources

Highly Sensitive	3
Sensitive	24
Less Sensitive	0
Not Sensitive	1

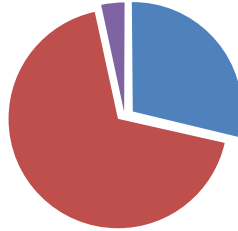
- Highly Sensitive
- Less Sensitive
- Sensitive
- Not Sensitive



### Fisheries

Highly Sensitive	8
Sensitive	19
Less Sensitive	0
Not Sensitive	1

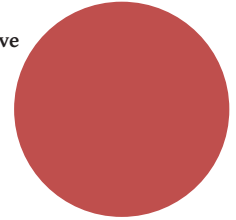
■ Highly Sensitive  
■ Less Sensitive  
■ Sensitive  
■ Not Sensitive



### Trafficking

Highly Sensitive	28
Sensitive	0
Less Sensitive	0
Not Sensitive	0

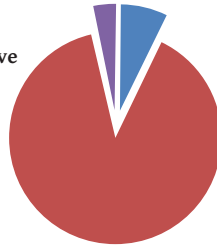
■ Highly Sensitive  
■ Less Sensitive  
■ Sensitive  
■ Not Sensitive



### Agriculture

Highly Sensitive	2
Sensitive	25
Less Sensitive	0
Not Sensitive	1

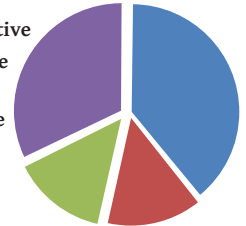
■ Highly Sensitive  
■ Less Sensitive  
■ Sensitive  
■ Not Sensitive



### Action related to Climate Change

Implemented	11
Planned but not implemented	4
Thinks important but not added in their agenda or planned	4
No Comments	0

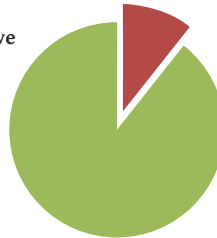
■ Highly Sensitive  
■ Less Sensitive  
■ Sensitive  
■ Not Sensitive



### Honey Collection

Highly Sensitive	0
Sensitive	3
Less Sensitive	0
Not Sensitive	25

■ Highly Sensitive  
■ Less Sensitive  
■ Sensitive  
■ Not Sensitive

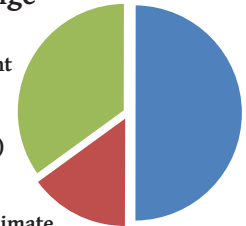


### Govt Department/ Research institute/University

#### Opinion on perception of Climate Change

Climate change impact significant	10
No direct correlation of observed with Climate Change	3
No comments on the issue (but change accepted)	7

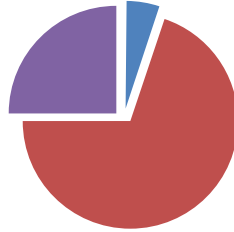
■ Climate Change impact significant  
■ No comments on the issue (but change accepted)  
■ No direct correlation of observed with Climate Change



### Water Resources

Highly Sensitive	1
Sensitive	14
Less Sensitive	0
Not Sensitive	5

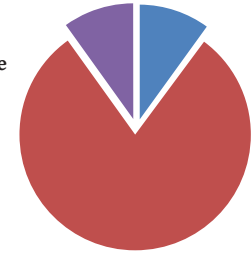
- Highly Sensitive
- Less Sensitive
- Sensitive
- Not Sensitive



### Agriculture

Highly Sensitive	2
Sensitive	16
Less Sensitive	0
Not Sensitive	2

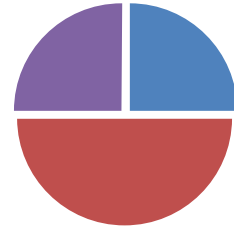
- Highly Sensitive
- Less Sensitive
- Sensitive
- Not Sensitive



### Fisheries

Highly Sensitive	5
Sensitive	10
Less Sensitive	0
Not Sensitive	5

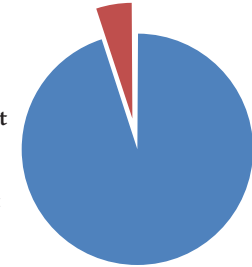
- Highly Sensitive
- Less Sensitive
- Sensitive
- Not Sensitive



### Action Related to Climate Change

Implemented	19
Planned but not implemented	1
Realized importance but not addressed	0

- Implemented
- Planned but not implemented
- Realized importance but not addressed





Climate change has affected people socio-economically, affecting their land, livelihood and health. Climate change in Sundarban has brought about a forced change in livelihood pattern also. It is observed in areas under North 24 parganas, land is being shifted from agriculture to fisheries or brick kilns because of increasing land salinity. Slowly over the years more land is being brought under aquaculture- salt water fish cultivation, and crab cultivation. The brackish water from the rivers is allowed into the land, where fish is cultivated. This can have its own negative impact over some years, but in the short term improved and commercial export variety crab, saline water fish cultivation is noticed in this water. But only few farmers have started it as their own initiative. Due to decreased productivity of land, agriculture has become less profitable.



More over farmers have low skills and knowledge on improved cultivation process, soil and water salinity testing adapting to the climate change effects. There is gap in availability of quality seeds, cultivation techniques of improved and salt tolerant varieties of paddy, pulses, oilseeds and vegetable crops. In Eastern part of Sundarban, Kakdwip, and Nimpith area vegetable cultivation is in practice, but due to poor market structure, and lack of knowledge or technology availability on value addition of products post harvest is not observant and farmers are suffering loss. Economic opportunity of the area has decreased on the whole, increasing dependency on forest and thus destroying the mangrove forest further. Also out migration has increased in search of work opportunities. This has led to other social vulnerability. Human trafficking has increased many folds from the region as women and girls are forced to go out in search of work. Women drudgery has increased with spending more time in river water catching fishing's and increased water borne diseases of family members and children

Specific problems related to Agriculture, Aquaculture and water resources are mentioned below:

### **Agriculture, Aquaculture and Water resources**

- a. Intrusion of saline water into the agricultural land increasing land salinity slowly, especially after cyclone Aila which still has its impact after 4 years.
- b. Agriculture and aquaculture are the two most important sectors largely dependent on the availability and quality

of water being used and at present both are at stake

- c. Production and productivity of paddy, and other vegetables fallen with the permanent intrusion of saline water causing loss of fertility of agricultural land.
- d. Also change in monsoon pattern causing severe stress and uncertainty on agriculture which is fully dependent on weather. Farmers are seen to be shifting their sowing pattern and time to adjust with this erratic rainfall.
- e. Also the change is seasonal pattern, delayed winter, is hampering the cultivation of Rabi crops and delaying sowing and harvesting time.
- f. Increase attack of insects and pests on crops is noticed by farmers. This can also be attributed to climate change as with increase in span of summer there are more attacks of insects
- g. Temperature influences metabolism, growth rate, total production of fish sp. Temperature changes which is happening much have an impact on the suitability of species for a given location and Sundarban is not beyond it.
- h. The cyclone Aila has affected loss to fishing equipments and aquaculture enterprises. Freshwater fishes in ponds were rendered ineffective due to salinity rise. Freshwater ponds became unusable due to salinity rise because of cyclone.

- i. Loss of indigenous species of fish like mourala, nados across sundarban. Great loss to aquatic ecosystem biodiversity. Some local fish markets do not exist even(nazat fish market)
- j. The region faces the impacts of recurrent cyclones which breaches the embankment often. It has problems of availing sweet water for drinking, agriculture, and other purposes, as the water is saline due to sea water incursion into the soil as well.
- k. Deep tube wells are being used to get sweet water from deep aquifers which are 300 m down. The only source of drinking water in the islands is deep tube wells ;( with water level going down in many areas) and there is limited piped supply system in the areas connected to the mainland. The region (especially north 24 parganas and some part of south also) also suffers from an acute arsenic problem in its groundwater.

### **Adaptations (area specific)**

#### **a) Spontaneous adaptations (common people/NGO)**

##### **Women and climate change**

CARITAS team met people who do not have agriculture land and specifically talked to women in those families in the remote islands. Ms. Pārbati Mondal and Kalyani Mondal are two such women from Gangadharpur village of Kultali block. They are women crab catchers. To these women life starts at midnight around 2 am when they move out from house and



goes to the nearby river for catching crabs. Pārbati told that at least 60-80 women from the nearby villages go every day. They return around 2 pm after almost 12 hours. They are exposed to many kinds of risk mainly lightening during monsoon, snake bites etc.in the jungle .The average income by each crab catcher normally ranges from 200-300/ day out of a catch of 20-30. It's a good source of supplementary income to the family in spite of lot of hardship and challenges. We noticed that they have developed serious skin problems. They were passionate to show us their catching instruments and the crabs that they caught.

What we were thinking terrifying, to them it's a regular chore and they believe that this is the only alternative that they have as there is not much to collect from the jungle. They are not



concerned much about their health or exposure to various kind of risks



### **Integrated land and water resources management-key to survival in the Sundarban**

Integrated land and water resources management-key to survival in the Sundarban now says Jibanda a farmer from Jharkhali gram panchayat

We met Mr Jiban Bera and his wife at Masjeed bati village of Jharkhali GP of Basanti block. He has adopted diversified land use practices because of increasing climate related risks and challenges affecting mono crop paddy and vegetable cultivation.

He got some training in land shaping from Palli Unnayan Samity an NGO and has seen a few models. In ridge area he cultivate creepers vegetables and climbers and furrow area they do small fisheries. Mr. Jiban Bera informed that he invested 10,000 Rs/bigha and got 22000/Bigha return by doing this. We found almost 1.5 bigha of the total land converted into such diversified practice. In this part of Sundarban the salinity is moderate therefore Jiban Bera has also tried out cultivation of fruit plant like Guava and Mango in 0.5 acre of land and the response is good

By seeing his model at least 10 more families in this village we found have adopted this diversified land use, as they all strongly believe that it will be sustainable in the wake of challenges related to monoculture and crop failure

### **b) Unplanned adaptations (without knowing the long term impact or technicalities)**

Traditional knowledge, seeds are more important in the changing climate context

CARITAS team visited Purba Gurguria village, at Kultali block and we met Sri Mrinal Samanta (a farmer) and a farmers group including some women too. They expressed their concern

about the changing climate and its impact on agriculture and fisheries. Mrinalda is a farmer and he does fisheries also in his agricultural land in an integrated system. He has two ponds. Most farmers in the area cultivates high yielding varieties of paddy and vegetables but now there is a makeshift, some farmers have started cultivating traditional desi varieties along with dudheswar rice variety but in a lesser area. According to him and the group important climate change perceptions and its impact are as follows:



- Rainy season extended for nearly 10- 15 days they have strongly felt
- Change in monsoonal patterns is affecting field and vegetable crops
- High yielding paddy and vegetables face great loss in changing monsoonal pattern and income or subsistence both are under stress
- Water logged condition are not at all suitable for vegetable nurseries which is happening these days till

October. Farmers have initiated nurseries of vegetables in early august but have faced losses at least 3 times

The group informed that they have already taken a kind of initiative and created awareness amongst people in the villages to keep and use more traditional seeds of paddy and vegetables as they all strongly feel that traditional seeds and varieties are sustainable under this changed condition though the yield of these varieties is less than high yielding varieties. At the same time they feel that they need to upgrade their knowledge about scientific ways of preservation and production of seeds. They also emphasized that local agriculture dept should help and promote these type of initiatives in wake of climate challenges

#### **Key research Outcome of SOS JU (Scientific adaptations)**

From the workshops, meetings, and survey conducted by the School of Oceanographic Studies Jadavpur University and CARITAS India, the problems as well as some workable solutions came up. Among the several recommendations of the Scientific Study by Jadavpur University few are listed here for immediate considerations

#### **Water System:**

- Linking of canals to areas outside Sundarban to ensure inflow of sweet water in the interior connected regions.
- Water of Hugli river can be diverted through lock gates at Kulpi and Karanjali to benefit 5-6 blocks.

- Reconstruction of the railway culvert at Mathurapur to ensure availability of more water.
- Setting up of a competent authority to regulate ground water extraction for Boro cultivation.
- The drainage congestion in the Sundarban needs to be resolved, as the brackish riverine water has no channels to exit in Canning I and II.
- Popularising water recycling and arrangements for



proper recharging of ground water

- Efficient Sluice gate operations to prevent submergence/water logging of crops , principally in the inhabited islands.
- Maintain Ecological flow of the fresh water for survival of the critically sensitive mangrove ecology
- Introduction of appropriate desalination system using saline ground water in a pilot scale to supply fresh water in water stressed areas.

### Issues on Agriculture

- Crop diversification: based on the experiences of farmers popularising bund cultivation as an alternative method for vegetable farming.
- Appropriate eco-system specific cost effective technologies for farming can be introduced to the farmers.
- Establishing soil testing facilities at block level to advice farmers on ecosystem specific crop selection and techniques of farming
- Sugar beet is an excellent salt absorber. It helps to reduce the salinity of the soil, and makes the soil tolerable to other plants. But sugar beet cultivation can be introduced and popularized in Sundarban, only when a proper market is developed for this crop.
- Introduction of Crop Insurance, particularly for Betel leaf

cultivators.

- Land consolidation is advisable forming co operatives. Ceiling on land fragmentation may be introduced as had been legislated in Maharashtra, Rajasthan.
- Establishing block level marketing facility and flexible marketing strategy for ensuring crop viability.
- Cultivation of Dudheswar variety of rice should be encouraged. This was one of the few varieties that survived saline flooding.
- Alternative indigenous rice varieties can be grown without use of chemical fertilizer and productivity per plot will be almost as high as high yielding variety (HYV). Recommended indigenous varieties are: Taalmari, Lal Ghetu, Matla, Hamilton, Jamainaru, and Lal Swarna.
- Aromatic varieties like Gandha Malati, Kanakchur, and on an experimental basis Badshah Bhog or Gobindo Bhog can be grown on about 25,000 hectares.
- Shift of at least 30 per cent of agriculture under organic system in a period of 5 years would be a useful strategy for improving soil quality and yield.

### **Fisheries**

- Real time mapping of marine and riverine fish catch to guide fishermen towards optimal and appropriate catch.
- 18,000 hectares of water bodies, approximately 36,000 ponds in Sundarban may be brought under culture

fisheries improving livelihood

- Technologies available in South East Asia, including Vietnam for farming crabs in hatcheries may be revived
- Brackish water aquaculture may be tried with subsurface saline water instead of tidal water endangering the embankments of agriculture fields
- Utilizing the Kulti canal as a resource, production of fish may be raised to 4000-5000 kilograms per year from the existing 700-1200 kilograms.
- Fish markets need to be modernized at Canning and





Malancha.

- Science Advocacy: banning of Hilsa catch and low mesh size nets during breeding season should be promoted.

**Proposed outline for future action:**

- Undertaking action research on water resources management with respect to salinity, appropriate agriculture and aquaculture practices
- Advocating for important policy change issues that will improve upon economy and ecology of Sundarban
- Marketing – support for small market infrastructure for produces of Sundarban
- Women and youth specific programs on climate change awareness, skill development on employable opportunities etc.
- Knowledge portal on Sundarban
- Strengthening GO/NGO/climate witness network as specific strategy

## Stakeholders consulted for the visit:

	Govt Organisation/research Institute Visited	Thematic Area Gap/Important issues	Comment
1	Dr. Tapas Ghosal, Senior Scientist, CIBA, Kakdwip	Fisheries and aquaculture	expansion of brakishwater aquaculture with more varieties of fish and crab farming
2	Dr. Manas Ghosh, Director,ATC, Narendrapur Lok Siksha Parishad	Agriculture and sustainable livelihood	Scope for marketing of Agriculture produce, market link and specific skill to entrepreneurs
3	Dr. B Bandyapadhy, Emeritus Scientist, CSSRI, Canning	Soil Salinity	Mapping of salinity zone in Sundarban in relation with crop productivity-can help in agricultural sustainability
4	Dr. B.K Chand,Professor,West Bengal University of Animal and Fishery Sciences,	Fisheries and aquaculture	Associated with National Initiative on climate resilient Agriculture and Aquaculture practices in the
5	Dr. Anurag Danda, Head, WWF	Energy and biodiversity	Energy pattern study of households in Sundarbans. Energy beyond electricity should be thought of. Information on critical habitat changes
6	Dr. Punarbasu Choudhury, Assc Professor Ballygunge Science College	Mangrove	Vegetation composiion and succession have been changed.Migratory birds are now coming in Kholakhali block, Jhingekhali block and not in Pakhiralaya.
8	Dr. Debal Deb, Famous Seed keeper	Ecology and Seed bank	right to seed and specific variety keeping in mind socio cultural identity, economic feasibility
			collaborative research could be tried out with like minded organizations on salinity issues
			expansion of brakishwater aquaculture with different tolerant species of fish
			good initiative and collaborative action on portal for sundarban much needed
			Two varieties of mangrove are less available- KRIPA and GARIA. Indian Skimmer and Adjutant -stork are not found in Sundarba area.

Govt Organisation/research Institute Visited	Thematic Area Gap/Important issues	Comment
9 Dr. Debal Roy, Secretary, Biodiversity Board, GoWB	Biodiversity	refer to biodiversity board work
10 Dr. S.P Sinha Roy, Retired director, Central Ground Water Board, Chairperson- Arsenic Task Force	Ground Water	feasible ground water modelling should be tried out for availability of sweet water . Water budgeting is important for Sundarban
11 Dr. Sailen Biswas, Joint Director of Fisheries, GoWB	Fisheries and Aquaculture	Use of Charpatta jal(net) for shrimp seed collection and fish catch destroys embankments and make them more fragile and for each shrimp seed collection 80 no. of other aquatic species is being killed
12 Mr. Subhas Acharya, Ex director , Sundarban Deveopment Board	Agriculture and livelihood	Agriculture production vis a vis marketing to be linked, strengthening mechanisms for increasing canal connectivity, prevent loss of important mother fish stock of traditional inland fishes as a result of opening of lock gates during rainy season
13 Dr. Jayanta Bandyopadhyay, Prof. IIM, Joka	Policy Maker	water important component for agriculture and aquaculture. Review of existing important policies affecting peoples livelihood,
15 Dr. Manas Das, Senior Scientist, CIFRI	Inland Fishery reasearch	perception of local level climate change impacts and understanding CIFRI could provide technical guidance if sought for

Govt Organisation/research Institute Visited	Thematic Area Gap/Important issues	Comment
16 Dr. Bijan Adhikari, Rice Research Institute	Rice research of overall vulnerabilities and accordingly measures is important. Local community groups should be oriented through suitable training etc. aromatic rice could successfully be promoted even in different stresses condition. However if we promote the cultivation in large scale market needs to be thought of as a priority.	development of model fish farms in such regions. He also told to refer all their important publications in this regard RRI could support farmers in providing site specific paddy seed varieties. Farmers of Patharpratima and Gosaba can contact block seed farm for details on cultivation of aromatic rice
17 Dr Pradip Sikdar, Indian Institute of Social welfare and Business Management	Ground Water modelling vulnerable area should be mapped... Policy and implementation gap is there in Sundarban	Under ground water - in threat due to over used. Climate Change is a burning issue... Intensity of flood and disaster increased... for GW issue (lowering of GW level) tube well design should be changed... We can think for artificial recharge upto 7-8 feet in monsoon season
18 Dr. Kumud Ranjan Naskar, Ex. Scientist Central Inland Fisheries Research Institute	Mangrove Policy is there but poorly implemented. To improve the livelihood pattern of Sundarban we should give importance on -Education, Population Growth, Economic development.	Climate change is obviously an issue but the embankment problem in Sundarban is really a devastating one. Total drainage pattern should be developed to protect mangrove.



Govt Organisation/research Institute Visited	Thematic Area Gap/Important issues	Comment
19 Sri Tushar Kanjilal, Secretary, TSRD and noted personality for Sunderbans	sundarban  In time of Dr Bidhan Ch Roy, one river scientist (Jenson) from Holland came to Sundarban and suggested to make a close delta system like Holland. They suggested to block Saptamukhi estuary and cost given nearly 55-58 crore (1968-69)	Increase in salinity will effect the growth of mangrove. Lack of understanding of the real problem of the Sunderbans, biggest issue is management of the embankments and loss of natural bio shield, ie specific mangroves, loss of biodiversity (traditional fish sp. Like nados, lata, chanda, mourala, foli, ban etc available in least amount)

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