



## CLIMATE CHANGE AND ENDANGERED LIVELIHOOD IN INDIAN SUNDARBANS- A BASELINE APPRAISAL

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### ABSTRACT

The Sundarbans island system in West Bengal India, is facing several natural changes under the situation of climate change. The Island system is undergoing natural threats in the form of relative sea level rise, coastal erosion and inundation, frequent embankment failures, salinity rise and increase in the frequency of high intensity events like cyclones in the last three decades under climate change situation. A tremendous growth of population size (287%) since Independence till 2011 in this fragile island system has further increased the social and economic vulnerability of the coastal communities through over exploitation of natural resources, wide scale reclamation and deforestation practices. The average population density in the region was 897 persons per sq' kms in 2001 which rose to 996 persons per sq. kms. in 2011(11.04% rise). Higher population growth is further anticipated in the coastal blocks of Sagar, Namkhana Patharpratima, Kultali and Gosaba (whose southern boundary is demarcated by Bay of Bengal) compared to the inland blocks.

The population dynamics in the five coastal blocks of Indian Sundarbans with the current livelihood options available to the highly vulnerable and endangered inhabitants of the island system are studied in detail in the present paper. Data analysis has revealed a sharp fall in the number of agriculturists in the region. Furthermore, the expansion of aquaculture farms replacing the agricultural fields for rising salinity problems may invite food insecurity to this poor less educated people of the island system. The present study has tried to assess the local livelihood scenario by household-level information collected from several rounds of surveys conducted over the last two decades in these coastal blocks.

**Keywords:** Climate Change, Natural Threats, Population Dynamics, Endangered Livelihood

### Introduction

Climate scientists working on climate change issues are of the opinion that the coastal areas are the worst affected locales because of climate change phenomenon. This is true for all climatic zones viz. polar, temperate, tropical and arid. However, the problem is much more severe in case of tropical coastal areas where population density is huge. Here in addition to open vulnerability issues the problems of social and economic vulnerability is rising day by day. People are getting increasingly exposed to such natural changes as relative sea level rise, coastal erosion and submergence, frequent embankment failures, rise of salinity in estuarine waters and soil and

increase in the frequency of high intensity events like cyclones. Rise in enormous population size also results in major environmental degradation and wide scale reclamation activities in the coastal zones making the zones extremely fragile. Mostly the coastal communities in tropical zones are poor, less educated, unaware and less skilled for which their coping capacity is also relatively low to face all these climate change natural issues. Therefore, immediate feasible management strategies are required to be designed and implemented to reduce the social and economic vulnerability of these poor coastal masses and to enhance their coping capacity for the future.

Sundarbans is one such vulnerable eco-region lying at the tropical coastal part and spread under both India and Bangladesh which is facing a major environmental degradation at present under the scenario of climate change. This is a unique ecosystem since this is the only mangrove tiger land in the world. This eco-region has also been designated as a World Heritage site by UNESCO because of its huge floral and faunal assemblage. However, at present both the flora and fauna are getting endangered gradually because of the occurrence of several natural changes like relative sea level rise, coastal erosion and submergence, embankment failures, rise in salinity at both estuarine waters and soil, uncertainty of rainfall, reduced sweet water flow and rise in the occurrence of high intensity events like cyclones. The present study is carried out in the Indian Sundarbans part covering a total area of 9630 sq. kms. that includes nineteen community development blocks covered under South and North 24 Parganas district of West Bengal State. Here, the major focus has been given to the coastal blocks facing Bay of Bengal as the southern demarcation and these blocks are Sagar, Namkhana, Patharpratima, Kultali and Gosaba – all included under South 24 Parganas district. The whole of the Indian Sundarbans has experienced a major rise in population size since Independence.

This enormous population size of 4.4 million (2011 Census) has resulted into wide scale reclamation activities, unsustainable resource exploitation practices and deforestation. Interesting to note that the coastal blocks in the Indian part are experiencing a higher population growth compared to the inland blocks in the last two decades inspite of the problems of open vulnerability.

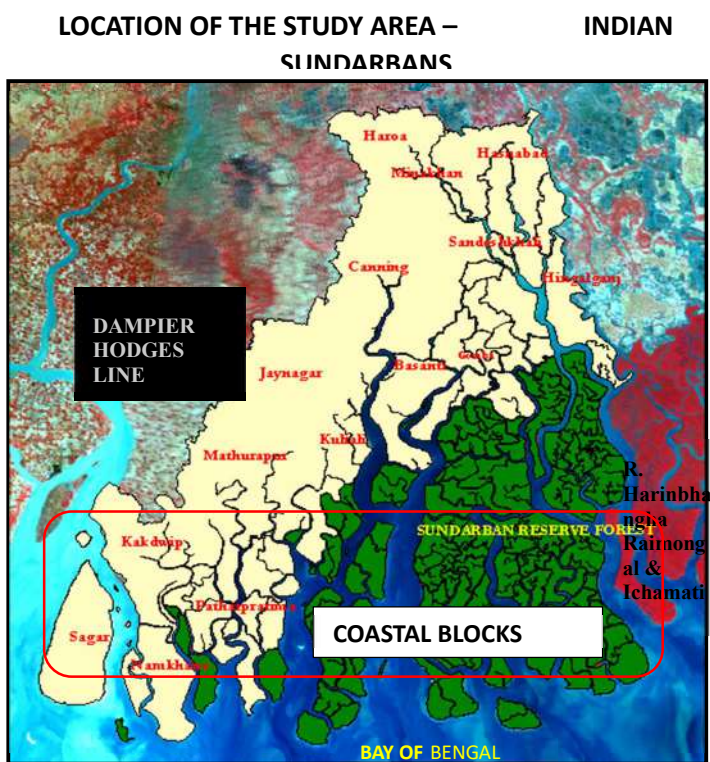
The appraisal made on natural and human induced changes in the Sundarbans currently reveals certain trends which are expected to continue in future under climate change situation and hence make the system further vulnerable to climatogenic impacts. It is evident that temperature is rising over land and sea in Sundarbans and if this same trend continues, the region is expected to experience a rise of 1°C in temperature by 2050. It has been found that the relative mean sea level is rising in this region @ 3.14mm /year- which is much above the global average of 2°C. Considering the present rate of rise only, the sea level might rise to 20 cms. by 2050. This pose a serious threat to flood and inundation in vast areas of Sundarbans and may lead to colossal loss of life and property in the locale.

### **Study Area Selected**

The study area primarily includes the five coastal blocks- Sagar, Namkhana, Patharpratima, Kultali and Gosaba of the Indian Sundarbans located in West Bengal state under South 24 Parganas

district. Indian Sundarbans is having a total area of 9630 sq. kms. and includes nineteen community development blocks, thirteen of which lie under South 24 Parganas district and the rest under North 24 Parganas district. The region is delimited in the north by the so-called ‘Dampier-Hodges line’ demarcating the northern extension of the intertidal zone marked by mangrove forests of 1830 (Chakraborty, P., 1991). The river Hoogly (in the west) and the river Harinbanga–Raimangal – Ichamati (in the east) demarcate the western and eastern boundaries respectively. The Indian Sundarbans has 4264 sq. kms. of wetland/mangroves covered under the reserve forests and the rest i.e. 5366 sq. kms. is under reclaimed area used for human settlements. A substantial part of Kultali and Gosaba Block comes under the Sundarban reserved forest which is uninhabited. The study area map is provided in Fig.1(below)

**Fig.1**



**Central Queries Framed**

The specific queries in the present study include :

1. To what extent the Indian Sundarbans region has become openly vulnerable to natural changes under climate change scenario?
2. What is the status of population pressure in the study region of the coastal blocks of Indian Sundarbans ?

3. What are the different livelihood options available to the coastal people in Indian Sundarbans ? To what extent these livelihoods are getting affected by the population dynamics and natural changes in the coastal blocks ?

4. What feasible management strategies may be undertaken to reduce the overall status of vulnerability in the Indian Sundarbans region ?

### **Methodology Followed**

This study relies both on secondary sources and primary information collected from household interviews across different villages of the coastal blocks- Sagar, Namkhana, and Gosaba conducted at several rounds of surveys carried out in 2004, 2006, 2015 and 2019.

Secondary documents include literature and newspaper reports, Census Data and policy documents. In-depth interviews were also conducted over phone with few migrants who have experienced the twin impacts of the cyclone and the lockdown.

Participants were recruited specifically from the Community Development (CD) blocks of Patharpratima, Namkhana, Sagar, Basanti and Gosaba blocks of South 24 Parganas with the help of a network of key informants from local community-based organisations. These blocks were badly affected by storm surge during cyclone *Amphan* in 2020 as well as during cyclone *Aila* in May 2009.

### **Results and Findings**

- **Observations on natural changes**

The Indian Sundarbans is bearing a very negative impact of climate change evident in the last three decades. The study performed by the author during her Ph.D research tenure from 2002 to 2007 in the island system has revealed several natural changes that the region is facing under climate change scenario which are listed below.

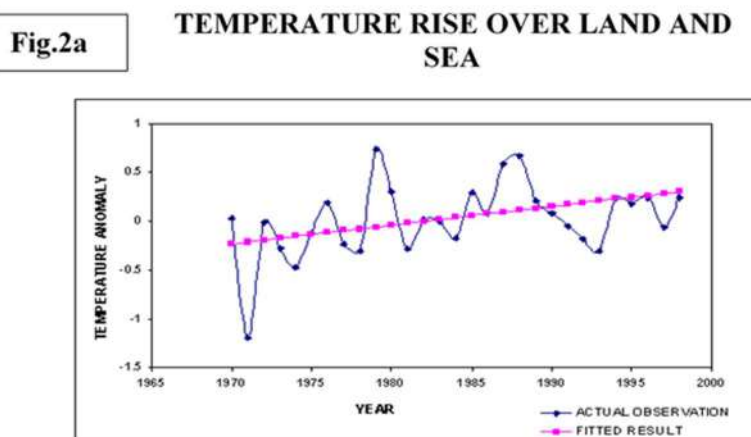
- Temperature rise over land and sea,
- Marginal increase in rainfall,
- A rise in the frequency of high intensity events (with wind speeds more than 64 knots)
- Salinization of estuarine water and soil
- Loss of forest cover and floral/faunal diversity

It is evident that temperature is rising over this part of Bay of Bengal in Sundarbans @ 0.019 deg.c/year (Fig.2a) . If this same trend continues, the region is expected to experience a rise of 1°C in temperature by 2050. From the analysis of tide gauge data of the Sagar island observatory, it has been found that the relative sea level around this part of the Bay of Bengal is rising @3.14mm/year - significantly higher than the global average of 2.0 mm/year (IPCC, 2019). The study from Satellite data IRS LISS I image of 1961 and IRS LISS III image of 2001 during the Ph.D research tenure has further revealed that from 1969 to 2001, the total land area loss by erosion is estimated to be 163 sq. kms. while the total amount of accretion is almost half i.e. 82.5 sq. kms.

Thus a net loss of 80.5 sq. kms land has occurred from 1969 to 2001 (Fig.3) .It is apprehended that with the present rate of rise, the sea level might reach to 20 cms. by 2050. The sea-facing part of the delta is becoming increasingly vulnerable due to coastal erosion, frequent embankment failures, submergence and flooding. Increased coastal erosion has **completely wiped out some islands like Lohachara, and Bedford** rendering thousands of people homeless. Other densely populated islands like Ghoramara, Sagar & Moushuni are suffering from bulk of erosion.

The trend of change in rainfall pattern over Sundarbans is somewhat ambiguous. A study of 74 years (1930-2004) rainfall pattern over the region (Station Alipore) indicates an increase in the monsoon and post monsoon rainfall which bears some serious consequences over the flood and food security of the region. Hazra et. al. (2003) has estimated that there is a strong probability of rise in relative mean sea level by 50 cm in 2050.

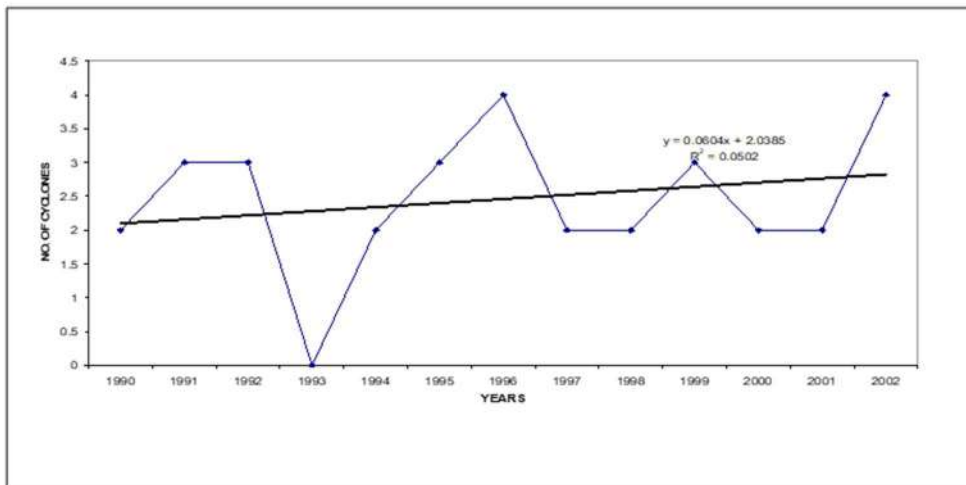
Furthermore, the study of pattern of cyclones over Bay of Bengal coast suggests that though the frequency of depressions and storms (wind velocity 31-50 knots) around Sundarbans have decreased over the years there has been a rise in their intensity (more than 62 knots) shown in Fig.2b . The increase in the number of cyclones/severe cyclones compared to storms and depressions certainly has a strong bearing on coastal flooding, erosion and salinization of the region as has been estimated by Hazra et. al. (2003).



Source Hazra et. al. (2003) .

**Fig.2b**

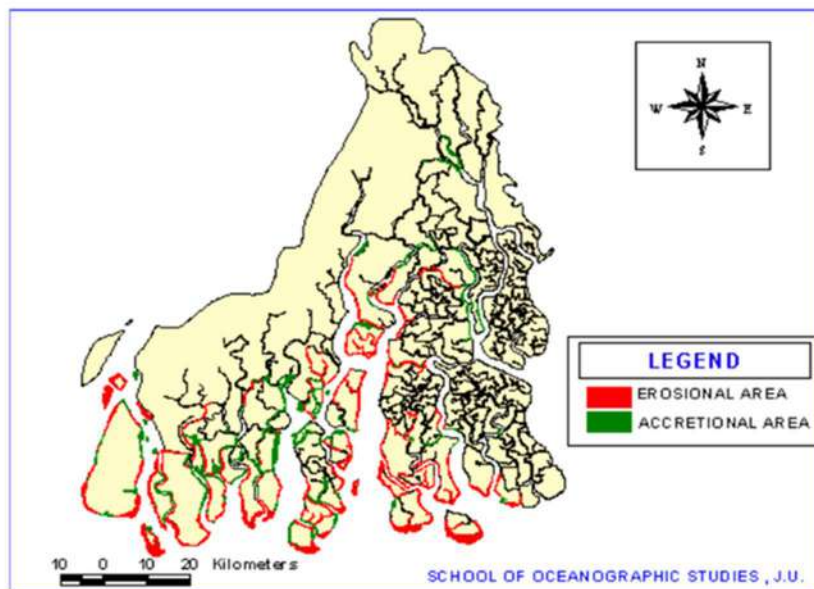
**RISE IN THE HIGH INTENSITY EVENTS – CYCLONES**



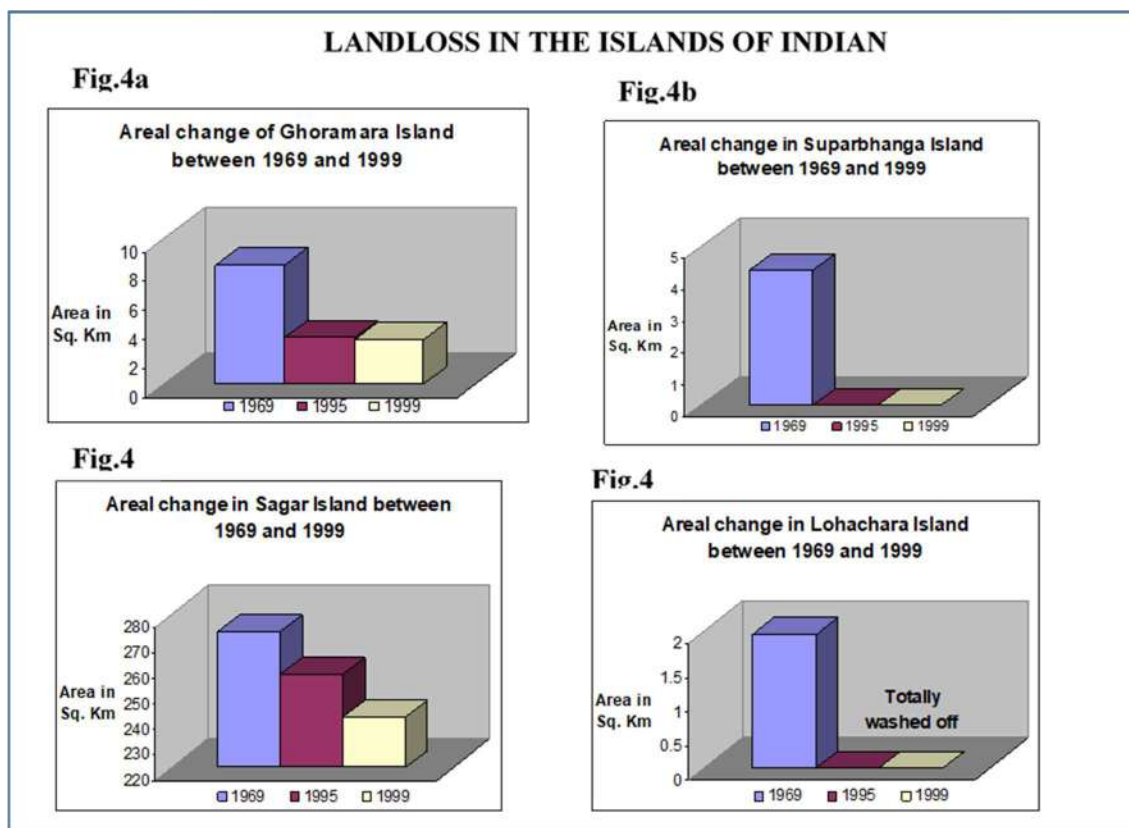
Source : Hazra et. al., 2003

**Fig.3**

**COASTAL EROSION AND ACCRETION IN INDIAN SUNDARBANS**



Dakshin Surendranagar (Patharpratima Block), Sagar , namkhana, Moushuni and Ghoramara all islands are suffering a bulk of erosion problems registering a landloss of 15.56%, 4.8%, 4.88%, 14.6% and 41% from 1969 to 2001 displacing a huge number of people compelling them to become *environmental refugees*. The landloss of few islands from 1969 to 1999 are provided below (Fig. 4a, 4b, 4c and 4d )



Source : Hazra et. al., 2003

Infact, the rise in the mean sea level by 50 cm, rise in wind velocity during high intensity cyclones and rise in the surge height which may be more than 3.5 meter during once in a 50 year storm pose a serious threat to flood and inundation in vast areas of Sundarbans. This may lead to colossal loss of life and property.

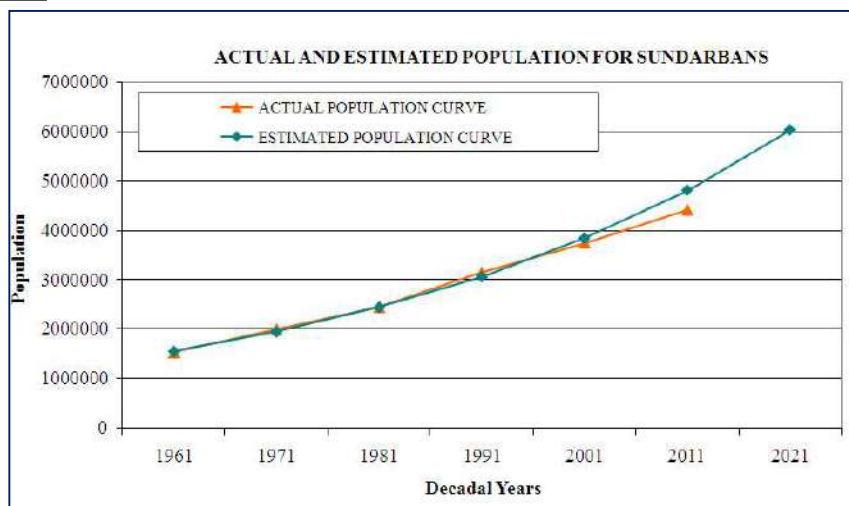
- **Population explosion in Indian Sundarbans and change in Occupational Pattern**

Census data reveal that Sundarbans has experienced a rise of 281.72% in population size since independence from (1,15,9559 in 1951 to 4,42,6259 in 2011). This spectacular rise in population has resulted to wide scale reclamation, deforestation together with unsustainable resource exploitation practices. In 2001, the population density in Indian Sundarbans was 897 persons per sq. km. and in 2011 the population density figure is 996 persons per sq. km. which indicates a sharp rise of 11.04%.

The population density for the coastal blocks (Sagar, Namkhana, Pathrapratima, Kultali and Gosaba combined) stands to be 645 persons per sq. km. in 2011 and this has also risen from the figure of 2001 which was 561 persons per sq. km (Data Source Census Data 1991, 2001 and 2011).

The population projection of Sundarbans for the year 2021 done in absence of published data indicates that the region might have experienced a population explosion with nearly more than 60 lakhs of inhabitants (Fig.5) . Based on previous Census data of 1981, 1991, 2001 and 2011 it is further anticipated that the coastal blocks (5 in number) might have experienced a growth of 105.68% in population size from 2001 to 2021 while for inland blocks the corresponding figure will be 96.80%.

**Fig.5** POPULATION PROJECTION IN INDIAN SUNDARBANS

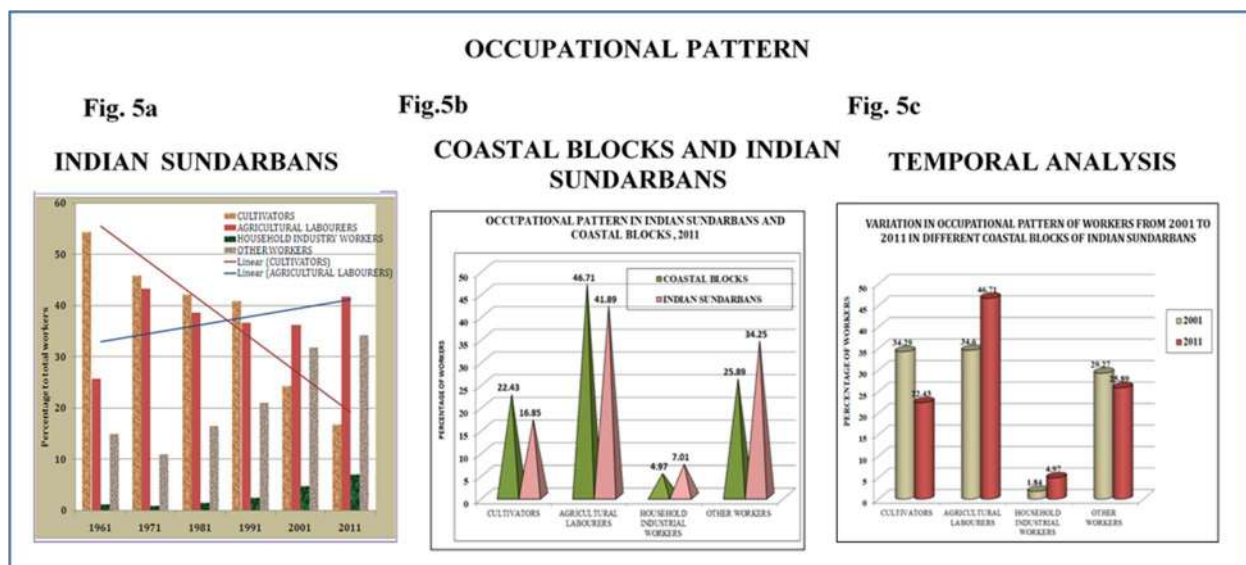


The analysis of workers for all community development blocks of Indian Sundarbans based on Census data further indicates that the percentage of cultivators over has declined significantly while the proportion of landless agricultural labourers has increased (Fig5a).

This may be due to loss in cultivable land by coastal erosion. The rise in the proportion of agricultural labourers further adds to the poverty level resulting in more social vulnerability.

For coastal blocks - Percentage of cultivators and agricultural labourers is relatively less compared to the average Sundarban figs (Fig.5b). On the other hand, the Proportion of household industry workers and other workers (engaged in business, transport or hotel ) are more in coastal blocks than the average Sundarban figs (Fig.5b) .

There has also been a marked decrease in the percentage of cultivators in the last decade in coastal blocks. While proportion of agricultural labourers have increased pushing the vulnerability level of these coastal locales to a higher side (Fig5c).



- **Impact of Climate Change on Different Production systems**

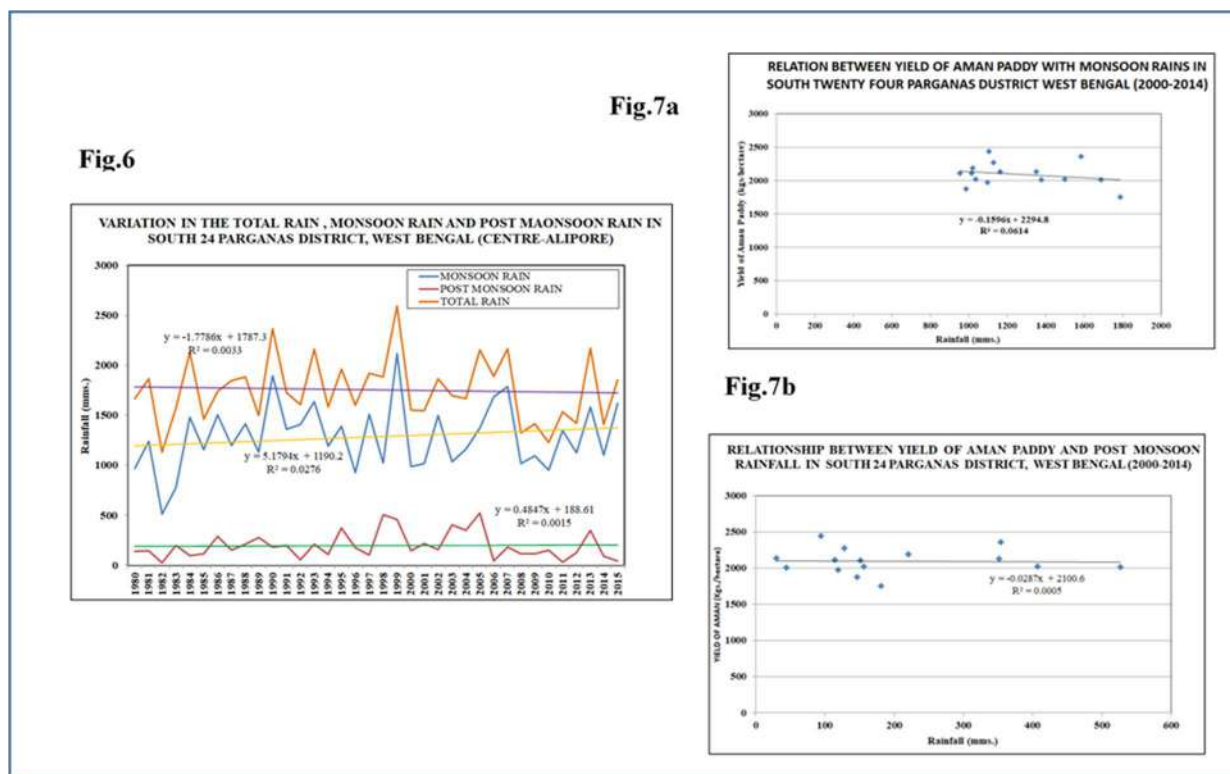
*Agriculture* : Since the British period (last 200 years) the Sundarbans ecoregion is considered as a very fertile detail part of the coastal West Bengal where paddy is the major crop grown in every season year after year. More than 45% of the total workers are still today engaged in the agricultural sector either as cultivators or agricultural labourers. The region is primarily dependent on rainfed aman paddy though Boro paddy is also cultivated in different locales of the island system. The agricultural diversification is very less in Indian Sundarbans. The crop combination maps prepared in the years 1992 -93 and 199-2000 further reveals that even in the early 90s the region used to produce wheat along with paddy. However with a decade the scenario changed and the region turned into a monocrop area producing chiefly the rain fed aman paddy.

Another interesting point to note regarding the relation between the aman paddy productivity with both monsoon and post monsoon rains is provided below :

- There is a rising trend in the both monsoon and post monsoon rains for the whole of South 24 Parganas district of West Bengal from 1980 to 2015 (Centre –Alipore, IMD data) shown in Fig. 6.

- However, the productivity of Aman paddy is showing a declining trend with rise in the monsoon and post monsoon rainfall when regressed (Fig. 7a and 7b).

This observation is really striking under climate change situation because if this trend continues ten surely it is going to increase the vulnerability of the farmers in the region.



The net sown area under both paddy and Boro has also fallen in the period from 2000-'01 to 2014-'15' in Indian Sundarbans though there has been a slight increase in the cropping intensity and productivity of both Aman and Boro paddy within the same time frame .

Different rounds of surveys conducted in different coastal villagers of Gosaba, Sagar and Namkhana in 2004, 2006, 2015 and 2019 have revealed that rise of salinity and uncertainty in the rainfall conditions have led to major problems for crop growth in the Indian Sundarbans. Fragmented small size of landholdings also pose major problems for agriculture development and expansion . The villagers have also opined the problem of very less crop diversification to be another reason for declining agricultural production in these locales.

*Fisheries:* In Indian Sundarbans, within the 15 years time span i.e. from 1984-'85 to 2002-'03, the catch per unit effort is found to be declining. This has occurred mainly due to over fishing. Under this situation, if warming continues in the region under climate change scenario, the plankton production may get adversely affected in future and may lead to further reduction in fish stock. This will endanger the livelihood and sustenance of the ecological community of Sundarbans.

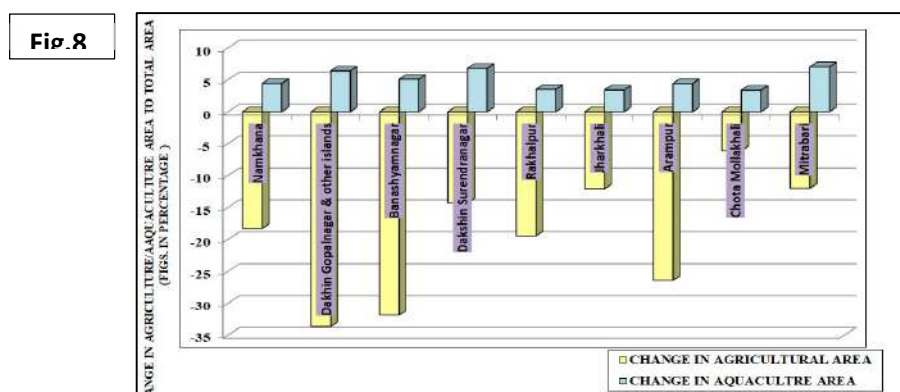
The Hilsa catch that constitutes a major share in the overall fish catch has declined from 1981-'82 to 1999-2000. This may be perhaps due to decline in hatcheries ground of Hilsa at the downstream part

*Forestry:* In addition to agriculture and fisheries the forestry sector is also bearing a negative impact due to climate change. Quite a large number of villagers in Gosaba and Kultali block still earn their family income by collection of forest products like honey, timber etc from the buffer zone of the Sundarban Reserve forest. However, the Indian Sundarbans region has experienced a substantial loss of 116.843 sq. kms. in the forest area cover as has been observed from 1969 to 2001 from satellite data (IRS LISS I image of 1969 and IRS LISS III image of 2001). This is due to coastal erosion as well as from natural degradation and anthropogenic intervention. A trend in the degradation of mangrove forest cover has also been observed along with changes in the existing species combination due to unavailability of sweet water. Some fresh water species like *Heritiera* (Sundari), *Nypa* (Golpata) or *Zylocurpus* (Dhundul & Passur) are already showing a trend of migrating northward, but might not get enough space due to the advancing human habitation front and may thus get extinct unless appropriate adaptation strategies are taken.

- **Change in Landuse Pattern in different islands of Indian Sundarbans**

Throughout the Indian Sundarbans a large scale change in the landuse pattern is taking place presently due to rise in salinity in the soil and estuarine waters. In coastal blocks there has occurred a marked increase (164.65% rise) in aquaculture area from 1986 to 2004 (**40.76 sq. kms. in 1986 to 107.87 sq. kms. in 2004**) compared to the inland blocks of where there has only been **42.87%** rise. This may be due to saline water ingression in the agricultural fields making the fields infertile especially after the cyclone events that have become very frequent in recent years under the climate change situation. The change in the landuse pattern at the expense of agricultural lands as found from satellite data in different islands of the coastal blocks of Indian Sundarbans is shown in Fig. 8 (below). It is apprehended that if this massive change of landuse continues in the region in future then the problem of food insecurity may get initiated at any time under climate change scenario

**CHANGE IN THE LANDUSE PATTERN OF DIFFERENT ISLANDS OF COASTAL BLOCKS IN INDIAN SUNDARBANS (1986-2004)**



### Economic Condition and Human Development Status of the Inhabitants

Indian Sundarbans is an economically depressed zone where more than 90% people live in rural areas. The people are mostly unskilled and under-educated to get absorbed in secondary or tertiary activities. So till date their livelihood is dependent on agriculture and fishing mostly in the coastal blocks. However the sustainability of these production systems are getting threatened day by day due to climate change issues. Hence the social vulnerability is rising in the region and the coping capacity of the people is reducing fast.

The Rural Households Survey conducted by Development and Planning Department, Govt. Of West Bengal in 2005 revealed that the percentage of households below poverty line in Indian Sundarbans was 44% . For blocks located in the inland parts near to Kolkata metropolis, the economic condition is relatively better since the job opportunities for the male workers are more compared to the coastal blocks lying far away from the metropolis. Infact for all the coastal blocks like Sagar, Namkhana, Patharpratma, Kultali and Goaba the percentage of households below poverty line is above the average figure of Sundarbans. In the inland blocks ,the landless agricultural labourers with average per capita per month income of Rs. 300 to 400/- are the most vulnerable groups in terms of their income while in the coastal blocks the meen seed collectors is the most vulnerable economic group with per capita per month income ranging from Rs. 300 to Rs. 500/- . This is less than the landless agricultural labourers in the coastal locations. The aqua-culturists group with average per capita per month income of Rs. 15000 to 16000/- owing to export earnings holds much better position than other occupational groups in Sundarbans.

The Human Development Index value for the whole Sundarbans region ( as obtained from individual block level data) is **0.549 i.e. 0.55**. This is much low compared to the State's average HDI figure of 0.61. (Source : Human Development Report, North and South 24 Parganas, West Bengal 2009). Interesting to find that the average HDI for coastal blocks stands to be **0.56** while for inland blocks, the figure is **0.52**. This HDI scenario indicates that the people's well being in Sundarbans is much lagging behind compared to other parts of the state. If proper developmental and adaptive measures are not taken the human development status may further worsen in future under climate change scenario

Sundarbans do not have any industrial development to offer jobs for the people. Hence in absence of suitable job opportunities many youths from the Indian Sundarbans are now migrating to other nearby states and to Kolkata metropolis for offering themselves as casual labourers in construction activities or as delivery boys mostly in the unorganized sector having no proper terms and conditions for their jobs . They are subjected to different kinds of exploitation by their employers. Again since they leave their elderly family members with children and females in their native villages the physical coping capacity of these masses during calamities gets further reduced.

### Feasible Management Strategies

At this backdrop therefore, some fruitful adaptation strategies and mitigation measures are suggested to increase the coping capacity of the vulnerable coastal community . These are listed below

- ❖ To boost up the agricultural production in the region under the scenario of rising salinity many researchers working in the similar fields have opined that it will be more viable to revert to salt-tolerant varieties of rice. Hamilton and Malta varieties of paddy may be introduced in the Sundarbans.
- ❖ The role of village administration is very crucial in facilitating, monitoring and accessing the schemes of National and State Governments that will enhance the coping capacity of the vulnerable communities. This will enable the households to build resilience to natural hazards events and other weather-related shocks.
- ❖ To ensure no poverty, good well-being and zero hunger the village administration has to play a fundamental role in the identification of the vulnerable sections of the community and their needs. These exercises would ensure that families are covered and included in the Public Distribution System.
- ❖ For imparting Quality Education and to ensure gender equity the village administration can plan for more residential schools for children, both boys and girls. It can also ease access to scholarships, textbooks, uniforms, and meals. The village council can also facilitate vocational evening courses for both school children and school dropouts.
- ❖ To ensure decent work and economic growth the local village administration may take major initiatives to provide assistance and training to youths both male and female, to start small and medium businesses.

### Concluding Remarks

High intensity events under climate change situation often result in irreparable losses and impede long-term development prospects in climate volatile hotspots like Sundarbans . The local village administration here can play a crucial role to facilitate awareness about climate change and climate variability on the lives and livelihoods of people in the community. Micro level vulnerability assessments are required to be conducted by the village administration.. Community-based management of forest areas through the Joint Forest management scheme is operational in the region which may prove to be fruitful for restoring the degraded mangrove forests. These should be further linked with Mahatma Gandhi National Rural Employment Guarantee Scheme where local species of mangroves and other tree and plant species should be promoted. Further awareness on conservation of forests should be developed, especially given the uncertainties of weather and extreme weather events. Community participation is the key word for ensuring developmental activities in Indian Sundarbans in a sustainable way to manage climate change and climate volatility effectively by empowering local people to become active agents in creating resilience. Finally, decentralization and coordination in the planning process together with the assurance of

huge technical assistance and hence huge fund from both within and outside the nation is very much needed to save our beloved Sundarbans from getting extinct in the near future.

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