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Impact of Climate Change on Livelihood of Sundarbans People & Their Participation in Sustainable Development

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Abstract:
The Sundarbans is a coastal delta and major climate hotspot located at the southern finish of Bangladesh and in the state of west Bengal in India.

*The delta faces vital environmental condition and different ecological challenges (*e.g., *disappearing mangrove forest, islands full of rising sea levels, erratic precipitation and cyclones). This working paper seeks to look at global (climate change temperature* change) and *uncertainty within the context of however various actors, particularly men and girls within the Sundarbans, live with, understand and cope with climate change and uncertainty and also their participation in sustainable Development. The surround approximately 4.37 million people. As per the analysis conducted it's believed that the Sundarbans have soaked in 4.15 crore tons of CO2. Due of global climate change the Sundarbans faces many challenges. With rising sea levels, islands are disappearing and therefore the increasing salinity within the water and soil has severely vulnerable the health of mangrove forests and therefore the quality of soil and crops. Frequent cyclones and erratic monsoon raining pattern are damaging ecology and humanity. With risk of the Sundarbans submerging, there's an urgent need for global reduction of emissions and replacement of fossil fuels with renewable energy. Governments also need to promote plantation of native saline resistant seeds.*

Keywords: *component; Sundarbans, climate change, sea level, salinity, biodiversity, threat, conservation, mitigation, Awareness, poverty, mangrove, poverty, habitat.*

1. Introduction:

The Indian Sundarbans contains of 54 islands and is home to 5 million people (Government of India 2011). In the north-eastern shores of India lies the Sundarbans, the world's largest contiguous mangrove forest that is unfold across approximately 9,630 sq. kilometers, of which 5,363 sq. kilometers is saved across and the 4,267 sq. kilometers are protected mangrove forests. A further 6,000 sq. kilometers of contiguous mangrove forests are unfolded across neighboring Bangladesh.[1] The delta faces vital environmental condition and different ecological challenges (e.g., disappearing mangrove forest, islands full of rising sea levels, erratic precipitation and cyclones). Financial condition and deprivation are each high, with migration rising as a significant development issue in recent years. Within the past decades, climate change stressors like a rising sea level, land erosion, erratic patterns of rainfall and temperature are

[1]Government of West Bengal, Government of India, "West Bengal State Action Plan on Climate Change"; Wild Bengal. Directorate of Forests, Government of West Bengal, Government of India. June 10, 2012. Retrieved on 13.03.2021 from http://www.wildbengal.com/urls/con_ar_tr_sunderban.htm

profoundly changing the ecology, lives and livelihoods in the Sundarbans.[2] Sundarbans isn't only a land of mangroves, rivers and tigers. It also homes to 6 million people in India. Though' agriculture and fishery is he major livelihood here, a large portion of the people depends heavily on forest product to earn their bread. Consequences are male migration leaving behind women headed households with kids and old, the foremost vulnerable population of society. The famous phrase 'a tiger on the land, a crocodile in the water' has supposedly originated from this region.[3] The Sundarbans delta faces tremendous pressure by a bourgeoning human population that's economically, educationally and socially. The Sundarbans is an innocent victim of accelerating global warming and climate change and faces a direct threat to its terribly existence.

2. Objectives of the Study:

i) To find out the present status & livelihood of Sundarbans people.
ii) To find out the major environmental hazards that frequently occurring in Sundarbans Island.
iii) To find out reasons behind the Climate change of Sundarbans region.
iv) To find out the various challenges & threats are facing of Sundarbans people.
v) To suggest some guideline & strategies for participation of Sundarbans people in Sustainable Development.

3. Methodology :

The present paper is a micro level and descriptive study in nature. For the purpose of writing this paper, I have reviewed and analyzed secondary data, information and literature that is available in the public domain, including information available on official websites of several Governmental agencies, published records, books, journal, organization, individuals, scientific data and reports. The researcher considered the methodology of the study as 'Mixed' research method. Here the researcher tried to find out the answers by applying qualitative and quantitative approaches. This is basically qualitative research. Discussions with experts from part of the research work. As these secondary sources have obvious limitations of sampling and dimensional studies.

4. Area of the Study:

The purpose of writing this paper to find out the impact of climate change on livelihood of Sundarbans people & their participation in sustainable development. This paper also finds out the various challenges & threats are facing of Sundarbans people and also providing some guidelines and strategies to overcome such kind of challenges. For writing this article paper I have selecting the area of Indian Sundarbans which

[2] Ghosh, U., Bose, S. & Bramhachari, R. (2018). Living on the Edge: Climate Change and Uncertainty in the Indian Sundarbans, STEPS Working Paper 101, Brighton: STEPS Centre
[3] Nature Environment and Wildlife Society (NEWS). Retrieved on 13.03.2021 from http://naturewildlife.org/sundarbans

contains of 54 islands and is home to 5 million people. In the north-eastern shores of India lies the Sundarbans, the world's largest contiguous mangrove forest that is unfold across approximately 9,630 sq. kilometers. Basically, this study is covered the whole region of Indian Sundarbans.

5. Data Collection & Analyzed:

The present study is purely theoretical and descriptive in nature. The individual experiences have been analyzed thoroughly to get every aspect related to the given issue. This is such an issue about which we get a lot of experiences in our surrounding society as well as local people's. The researcher has used data collected from the primary and secondary sources of data and also used for empirical analysis materials have been collected from newspaper, websites, journals, research paper, book, census report and government reports.

6. Findings of the Study:

The findings of the study will enlighten the impact of climate change on livelihood of Sundarbans people & their participation in sustainable development. This paper also find out the various challenges & threats are facing of Sundarbans people and also giving some suggestions and strategies to overcome such kind of problems. The finding of the study shows that the Sundarbans delta faces various vital environmental condition and different ecological challenges (e.g., disappearing mangrove forest, pollution, spread diseases, man-animal conflict, islands full of rising sea levels, erratic precipitation and cyclones). The result of this paper also shows the natural areas of the Sundarbans are influenced by human use and, in recent years, increasingly by climate change. The study recommends for special attention of Government and policy makers to design programmes for disseminating environmental awareness among Sundarbans people to reinforce their Participation in sustainable Development. The finding of study will act as important source of various stoke holders and local people of Sundarbans who are dealing with these issues in day-to-day life. Future researcher will get a new platform for designing their studies which is a very concerned field in recent issue.

7. About the Sundarbans :

7.1 Beauty of the Mangrove Forest in Sundarbans:

The Sundarbans, literally 'beautiful forest' (Jalais 2010)[4] in Bengali, the world's largest mangrove delta, is spread the southern end of both state (India) and Bangladesh. Recently, the area has gained prominence not only as a United Nations Educational, Scientific and Cultural Organization (UNESCO) heritage site or the largest remaining natural habitat of the Bengal tiger, but also through being one of the victims of worldwide climate change and related uncertainties. The

[4] Jalais, A. (2010) Forest of Tigers: People, Politics and Environment in the Sundarbans. Retrieved from https://www.routledge.com/Forest-of-Tigers-People-Politics-and-Environment-in-the-Sundarbans/Jalais/p/book/9780415690461

Sundarbans comprise an area of 40,000sq km that includes water, forested islands reserved for the Bengal tiger, inhabited islands, and cultivatable land.

7.2 Demography status : People of Sundarbans:

The inhabited area of Sundarbans contains 54 islands with a dense population of concerning 5 million people (Government of Asian nation 2011) spread over 19 administrative blocks. They face challenges of poverty, marginalization and acute struggle against geo-climatic events. The complicated topography of rivers, creeks and estuaries, as well as poor road infrastructure, is a constraint on access to the area. According to the 2011 Census[5], the sex ratio was 955 females per 1000 males, above that of both West Bengal state (950) and India (933).

7.3 Folklore- *Bonbibi,* the God of Syncretism:

Bonbibi, the goddess of the jungle is worshiped by all islanders irrespective of their caste, creed religion and faith in the Sundarbans. Legislation passed in 1970s permits the islanders who depend upon the forest products are allowed to go to the jungle double a year. *Bonbibi* is worshiped by chanting from the *Bonbibi-joburanamah*. According to *Bonbibijoburanamah Bonbibi* has Islamic roots. She was asked by Allah to safeguard the islanders from tiger attack.

8. Impact of Climate changes and threats to Sundarbans:

Sundarbans space is cyclone-prone, monsoonal and low-lying, as a result of that changes in climate have significantly impact the area, flora, fauna and also the population living inside it. Report (Government of West Bengal, Government of India, "West Bengal State Action Plan on Climate Change").

8.1 Effect of Global Worming - Increasing of Temperature:

Between 1980 and 2007, it has been determined that the temperature of the waters in the Sundarbans has raised at an accelerated rate of 0.5℃per decade compared to the determined global sea surface temperature warming at the rate of 0.6℃ per decade.[6] This change greatly impacts the Sundarbans area because it is an estuarine delta.

8.2 Cyclonic Activities:

[5] Government of India (2011) Census 2011, Retrieved on 13.03.2021 from- http://www.censusindia.gov.in/2011-common/census

[6] Center for Science and Environment, "Living with changing climate: Impact, vulnerability and adaptation challenges in Indian Sundarbans" .Retrieved on 13.03.2021 from- http://www.indiaenvironmentportal.org.in/content

Among the natural hazards that occur in the subcontinent, cyclones are the foremost severe and most frequent in the Sundarbans region. Out of 14 global tropical cyclones related to the highest fatalities in recorded history, 9 have occurred in the Bay of Bengal.[7] During the incidence of Cyclone Aila in 2009, a 400 km stretch of embankment was broken and also the waves crossed over the peak of the embankment and entered the flood plains. The sea water got logged and over 2 million people were marooned for many days affecting not only agriculture but also drinking water supply. Additionally, the farmland became unproductive due to salt water incursion in the soil.[8]

8.3 Deforestation:

Between 1777 and 1971, continuous deforestation and land reclamation activities have been carried out in the Sundarbans region. It has been observed that 5% of forest cover was lost between 1989 and 2009. This deforestation has increased man animal conflict, native extirpation of several species and added to the biological loss of the region.[9]

8.4 Rising Sea-Levels:

For the Sundarbans coast, the maximum centennial-scale Relative Sea Level Rise (RSLR) is calculable to be 0.9 ± 3.3 cm/yr. based on subsidence rates obtained through the dating of buried salt kiln sand mangrove root horizons.[10] Due to continuous submersion in higher water, as an implication of rise of sea level, the plants are being noted to be shorter and narrower with fewer branches and leaves resulting in lower rates of photosynthesis and regeneration of the mangroves.

8.5 Change in agricultural patterns:

Agricultural production is under constant threat from natural hazards like storm surge, salinity incursion, water logging/drainage congestion, tidal flooding, and river erosion. based on the IPCC projections of sea level rise in Bangladesh, it's estimated that the acceptable area for transplanted Aman paddy will be reduced to 60 % by 2050 with a sea level rise of 32 cm, and by the year 2100 only 12 % appropriate area will be available with a sea level rise of 88cm.[11] with

[7] World Bank, 2014. Building Resilience for Sustainable Development of the Sundarbans: Strategy Report. Washington, DC: IBRD/The World Bank. Retrieved on 13.03.2021 from- https://documents.worldbank.org/en/publication

[8] Government of West Bengal, Government of India, "West Bengal State Action Plan on Climate Change".

[9] Government of West Bengal, Government of India, "West Bengal State Action Plan on Climate Change". Retrieved on 13.03.2021 from http://www.environmentwb.gov.in/pdf/WBSAPCC

[10] Hanebuth, Till J., Hermann, R Kudrass., Jörg, L., Badrul I., & Anja, M. Zander. (2013). "Rapid coastal subsidence in the central Ganges-Brahmaputra Delta (Bangladesh) since the 17th-century deduced from submerged salt-producing kilns." *Geology* 41, no. 9: 987-990. Retrieved on 13.03.2021 from http://dx.doi.org/10.1130/G34646.1

[11]Centre for Environmental Geographic Information Services (CEGIS). 2006. Impacts of Sea Level Rise on Land use Suitability and Adaptation Options. GoB; Ministry of Environment and Forest, Government of Bangladesh and United Nations Development Programme (UNDP).

continuous increase in population, agriculture production in the region is not able to meet demand.

8.6 Pollution:

Due to heavy siltation and disposal of solid waste from adjacent cities, the rivers in the Sundarbans don't receive fresh water from the upstream Ganges River and are primarily tidal fed. The Sundarbans receives an additional supply of fresh water during monsoon which lasts for a period of May to Oct.[12]

8.7 Erosion of Sea Face and Estuary Margins:

There is no dearth of evidence that mangroves play a vital role in protecting coasts against natural hazards like storms, tsunamis and coastal erosion. However, a combination of sea level rise and tidal hydraulics often results in erosion of the sea face and estuary margins. This in turn causes progressive reduction of land area in the islands and also the raising of channel floors, leading to prolonged inundation.[13] Consequently, the whole southern face of the region has people, regardless of whether or not the islands area unit wooded or occupied.

8.8 Cyclone *Amphan* as a Key Event:

Even as our planet is in the grip of the COVID Pandemic, a furious cyclone, Amphan, the worst in living memory, has hit the South Bengal coastline, bringing unprecedented misery and destruction to millions. With an eye that was 30 kms in diameter and a wind speed of 185 km/ hr. During landfall, the cyclone left a trail of devastation in the coastal areas, with the people grasping for survival. Earthen embankments have been breached in many areas, and surging, frothing saline water has flooded many hectares of land, fish ponds, and vegetable gardens.[14]

9. Major Challenges faced by peoples of Sundarbans:

India has passed several policies and laws at the Central and State levels in respect of protection of the Sundarbans and measures are taken to tackle the effects of climate change.

9.1 Encroachment & Poverty:

It is typically witnessed that any measure to remove encroachments from the forested areas is likely to be strongly opposed by local politicians as well as people. Sundarbans is one of the foremost densely populated parts of India with a population density of about 929

[12] Government of West Bengal, Government of India, "West Bengal State Action Plan on Climate Change". Retrieved from http://www.environmentwb.gov.in/pdf/WBSAPCC

[13] World Bank, 2014. Building Resilience for Sustainable Development of the Sundarbans: Strategy Report. Washington, DC: IBRD/The World Bank. Retrieved on 13.03.2021 from – https://documents.worldbank.org/en/publication

[14] Nature Environment and Wildlife Society (NEWS). Retrieved on 13.03.2021 from- http://naturewildlife.org/sundarbans

persons/square kilometers in 2001 that has increased to 1,082 persons per sq. kilometers in 2011. The economic profile of the local population dismally lags behind the national average. About 87 per cent people in the area live with some sort of food shortage and healthcare infrastructure is in shambles. Approximately 33 percent of the population doesn't even have access to a primary health care.[15]

9.2 Mangrove Exploitation:

The mangrove ecosystem plays an important role in limiting silt and nutrient outflows to the near shore marine environment, as well as run-off of sewage animal waste and top soil during the heavy tropical rains or from rivers. It can function as buffers to protect the shore line from wind generated storms while at the same time, they absorb silt, nutrients, virulent substances and support fisheries, offer construction materials, medicines and a large range of different product utilized by communities. The clearing of coastal forests will increase suspended sediments and nutrients in terrestrial run-off, causing direct and indirect effects on algal and coral growth and competition and coral reef resilience and recovery.[16]

9.3 Overpopulation:

The carrying capacity of the Indian Sundarbans has been exceeded, and the increased population is exerting pressure on the fragile and richest ecosystem of the planet, a World Bank report said this. “The population is growing and exerting even greater pressure on fragile and recovering natural systems. As a results of high birth rates and migration inflows, population density is high.[17]

9.4 Spread of Diseases:

As a result of long periods of stagnation of water, the population is at a larger risk from water borne diseases resulting in increase in incidences of morbidity and mortality. Similarly increase in intensity of cyclones is likely to cause more injuries and deaths.[18]

9.5 Increase in man-animal conflict:

Even as climate change adversely affects the production of biomass and fruits on which the wild animals thrive and forest land is lost because of submersion, there's increased threat of animals

[15] Center for Science and Environment, “Living with changing climate: Impact, vulnerability and adaptation challenges in Indian Sundarbans”.
[16] Das, A.K, & Sarkar, B. (2016). Environmental awareness among women of Sundarbans Islands and their participation in sustainable development. Retrieved on 13.03.2021 from- http://hdl.handle.net/10603/251067
[17] World Bank, 2014. Building Resilience for Sustainable Development of the Sundarbans: Strategy Report. Washington, DC: IBRD/The World Bank. Retrieved on 13.03.2021 from- https://documents.worldbank.org/en/publication
[18] Government of West Bengal, Government of India, “West Bengal State Action Plan on Climate Change”. Retrieved from- http://www.environmentwb.gov.in/pdf/WBSAPCC

coming into greater direct conflict with man outside the forests. A conflict situation has always been harmful for both man and animal and has resulted in the death of either of the two.

10. Remedies & Guidelines to overcome the challenges and participation in sustainable development among Sundarbans people:

The Sundarbans has always been a land of natural resources-based livelihoods without the option of industrial development, limiting the choices for the local population. The complex interplay of climate changes along with changing market forces and globalization has led to growing livelihood uncertainties in the Sundarbans in last twenty years. The islanders of the Sundarbans got to face each visible and not-so-visible uncertainties in their ancient livelihoods like agriculture and fishing. The Central Government of India and also the state Govt. of West Bengal are currently in the process of finalizing an action plan, titled 'West Bengal State Action plan on Climate Change' to deal with the problem of climate change and its impact on the Sundarbans as well as take steps for poverty alleviation.

10.1 Agriculture and Food Security:

In discussions in a participatory rural women respondent who have seasonal migrant husbands clearly showed the relationship between seasonal variation, livelihood strategy, food security and accessibility of available resources. According to the women their husbands generally migrated May to July and October to Dec. However, during June to August, the usual rainy season, households have few livelihood choices. The impact of frequent heavy showers, storms and areas of waterlogging makes access to agricultural land tough and casual work less accessible. Food that are hold on throughout the year becomes scarce due of the loss of garden vegetables as a result of storms. Household food security also diminishes during the monsoon season as links to markets and fishing opportunities become risky and expensive.[19]

10.2 Fishing:

Fishing has been maybe the most common and staple livelihood choices for the people of Sundarbans since their habitation of the area. It's not only provided livelihoods to the households but also provided protein in the diet of the islanders. The people of the Sundarbans have historically been fishers in terms of skill and culture. One reasons they see behind the declining fish catch may be a combination of environmental condition and other market related factors. A declining fish catch and increasing operational cost make conditions tough for the fishermen in the Sundarbans to stick to this once most viable livelihood option.

[19] Ghosh, U., Bose, S. & Bramhachari, R. (2018). Living on the Edge: Climate Change and Uncertainty in the Indian Sundarbans, STEPS Working Paper 101, Brighton: STEPS Centre

10.3 Alternative Livelihoods:

They are forced to take alternative livelihood options just to sustain their families because of the increasing frequency of the climatic adversities. This includes leaving the comfort of ancient livelihoods like agriculture and fishing to take up mostly unskilled option like wage labour, embroidery work, crab collection and migration out of the area. It was quite tough for them to cope with this livelihood transition. Some local NGO & Organization like Sagar Mangal also taken initiatives to aware the local people to create and maintained mangrove forest.[20] They also created some rules and regulations to control harmful human behavior's like-✓ Cutting trees were strictly prohibited-

✓No birds would be disturbed.

✓ Work side for mangrove forestation would be protected by local people.

✓ Cows and goats wouldn't be allowed to the mangrove forestation area etc.

10.4 Coping Strategies:

People of Sundarbans finds differing types of coping methods, particularly with regards to livelihoods. Due to degradation of grassland and low grass production after cyclone Aila, they need had to reduce the numbers of livestock. The majority of local people planting salinity resistant crops like cotton and a few vegetables, rather than cereal crops, with the assistance of the Panchayat.

10.5 Construction of Disaster Resistant Homes:

Following a tidal surge in 2007, GOAL piloted an intervention to build disaster resistant homes for the poor residents of the Sundarbans. Since most homes inbuilt the Sundarbans are manufactured of mud and wattle, the organization selected to use vernacular design with modern disaster resistant technology.

10.6 Awareness and information:

The Central and the State Governments should educate the people concerning climate change and ways of adaptation. It's been observed that over a period of time the people have lost their traditional knowledge but haven't been able to replace it with new or mainstream knowledge. The govt. should conduct training and mass awareness programs.

10.7 Tourism versus Eco-tourism:

Tourists are not practicing 'eco-tourism' and waste product such as plastic are found in the core areas of the national park. The authorities should take measures to confirm that tourists adhere

[20]Government of West Bengal, Government of India, "West Bengal State Action Plan on Climate Change". Retrieved from on 13.03.2021 from- http://www.environmentwb.gov.in/pdf/WBSAPCC

to eco-tourism. Thus, eco-tourism, differing from purely commercial tourism or mass commercial tourism, would need lesser infrastructure development and lower impact on the environment, whereas at the same time providing employment opportunities to the native people.[21]

10.8 Release of Extra Fresh Water:

A primary cause for rise in salinity and resultant change in the ecological patterns is because of increased consumption of upstream freshwater and release for little freshwater into the Sundarbans. The lack of freshwater has caused many creeks to turn fully saline, with only the monsoons providing freshwater supply. The Govt. are required to extend the supply of freshwater into the Sundarbans to confirm the existence of the area as an estuarine delta.

10.9 Afforestation programs:

Certain parts of the Sundarbans are selected as 'deforested mangrove swamps', mostly in the western and central regions of the delta. Since these are uninhabited, the Govt. must carry out afforestation programs at the earnest to confirm that the loss of mangrove cover is offset to the utmost extent possible.

10.10 Protection of Threatened Species:

The MoEF[22] and the Government of West Bengal should jointly take steps to identify both floral and faunal species, particularly the heartier fungus genus or *'Sundari'* mangrove species and identify strategies for their conservation and protection.

11. Conclusion:

The Sundarbans Eco region, straddling India and Bangladesh, is home to the largest contiguous mangrove forest in the world. Parts of the forest area designated as World Heritage Sites in both countries due to their rich biodiversity. The natural area areas of the Sundarbans are influenced by human use and, in recent years, increasingly by climate change. lastly, it need to accept for that there are literally 2 Sundarbans – the periphery Sundarbans, that is nearer to urban centers, a lot of accessible, and a lot of developed, whereas the opposite – the remote Sundarbans – is nearer to forest and sea, exhausting to access, and fewer developed. Undoubtedly places at intervals Sundarbans vary with their situation, issues, problems and desires. The study recommends for special attention of Government and policy makers to design programmes for disseminating Environmental Awareness among Sundarbans people to reinforce their

[21] West Bengal Forest Department. June 10, 2012. Retrieved on 13.03.2021 from - http://westbengalforest.gov.in/urls_all/activities_eco_tourism.html

[22] Mahadevia, K., & Vikas, M. (2019). Climate change – impact on the sundarbans. International Scientific Journal Environmental Science, Vol. 8, ISBN-10: 1672358841. Retrieved from - http://environment.scientific-journal.com

Participation in sustainable Development. The Central and the State Governments must give importance to educate the people concerning about climate change and methods of adaptation.

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