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Climate Change and Climate Adaptive Interventions in Sunderban: A Case Study of Initiatives undertaken by South Asian Forum for Environment (SAFE)

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ABSTRACT

Sunderban is one of the world's largest mangrove forests found in the Bay of Bengal. The delta formed by the Ganges, Brahmaputra, and Meghna rivers has been recently enlisted as a World heritage because of its huge variety of wildlife, such as the Indian python, estuarine crocodile, Royal Bengal Tiger, and 260 bird species. The Sunderbans are seeing significant effects from climate change. Sea level rise, land loss and increase in salt salinity is just a few to mention.The Sunderban has witnessed loss of land at 5.5 sqkm/year, increase in frequency of severe cyclone and erratic monsoon raining patterns by 26 percent very recently. These changes in the climate are damaging the ecology and indirectly impacting humanity severely. In order to prevent further damage there has been several initiatives undertaken at both governmental and non-governmental organizations to decrease global emissions and switch to renewable energy sources from fossil fuels in order to lessen the effects of climate change and poverty. My research paper will aim towards exploring various such initiatives being undertaken to mitigate the challenges of climate change. The research methodology would be qualitative in nature and would primarily be a case study on environmental sustainability initiatives being undertaken by South Asian Forum for Environment (SAFE) in Sundarbans.

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Introduction:

United Nations Framework Convention on Climate Change defines 'climate change' as a change in the climate that is directly or indirectly related to human activity that modifies the composition of the global atmosphere.Unfortunately, today it has emerged as a global threat and is no more restricted to a country or locality.

India is no exception. Climate change is posing a big threat to the subcontinent. Being an agro based country, Indian citizens are directly or indirectly being impacted with climate change. With climate change there is observable increase in sea water level every year leading to erosion of agricultural land, turning the sweet water into salty which is unsuitable for drinking and irrigation, acidification of ocean, degradation of biodiversity affecting availability of fresh water. Climate change is resulting in increased frequencies of floods, cyclones, hurricanes and droughts.

A 2019 study by the Times of India titled "Changing Climate Wreaks Havoc on West Bengal Crops, Hits Kharif Yield" (Bandyopadhyay, 2019) shows that climate change seriously affects productivity of crops in West Bengal.Out of all districts in West Bengal, Sunderban is the worst hit when it comes to impact of climate change.

The Sunderbans are seeing significant effects from climate change. Sea level rise, land loss and increase in salt salinity is just a few to mention.The Sunderban has witnessed loss of land land at 5.5 sqkm/year, increase in frequency of severe cyclone and erratic monsoon raining patterns by 26 percent very recently . These changes in the climate are damaging the ecology and indirectly impacting humanity severely.

The Sunderbans are seeing considerable impacts from climate change.

Over the past 10 years , Sunderbans has been losing land at 5.5 sqkm/year, sea surface temperature increasing at the rate of 0.5 degree centigrade leading to several implications like sea level rise ,land loss and increase in salt salinity. The frequency of severe cyclone and erratic monsoon raining patterns has increased by 26 percent over the century. These climatic changes are damaging the ecology and severely hitting humanity.

In order to prevent further damage there has been several initiatives undertaken at both governmental and non-governmental organizations in Sunderban to reduce global reduction of emissions, replacement of fossil fuels with renewable energy to mitigate and reduce problems of climate change and poverty alleviation. The research paper will aim towards exploring various such initiatives being undertaken by South Asian Forum for Environment (SAFE) to mitigate the challenges of climate change.

Aim of the study:

To explore various environmental sustainability and climate change adaptive interventions at community Level in Sunderban undertaken by South Asian Forum for Environment (SAFE)

Objective of the study:

1. To examine the impact of climate change

2. To study the various climate adaptive interventions being introduced by South Asian Forum for Environment (SAFE) at community level in Sunderban

Literature Review:

Balasubramanian, M., & Birundha, V. D. (2012) 'Climate Change and its Impact on India' explains the various challenges being faced in India due to climate change .The emission of the greenhouse gases, rise in sea level, increased frequencies of floods, cyclones, lack of availability of freshwater, negative agricultural impact, malnutrition, asthma, malaria and so on.

Bandyopadhyay, K. (2019). 'Changing climate wreaks havoc on West Bengal crops, hits kharif yield.'TNN reports how global warming is affecting the rainfall pattern and crop season of West Bengal.The report also highlights the observations of atmospheric scientist Krishna Achuta Rao on how rainfall in eastern India particularly in and around Kolkata could increase by 40% by 2050 and also how monsoons in Bengal could be delayed affecting the yield of Kharif.

Singh, S. S. (2018) 'Sundarbans mangroves struggle to find new ground' published in The Hindu emphasizes how habitat deterioration brought on by industrial pollution, fuel wood collecting, and a lack of high elevation areas threatens mangroves in addition to climate change.

Mukhopadhya. B (2014)'Global warming –a threat to the planet'.American Journal of Biology emphasises how global warming and emission of green house gases are slowly becoming a threat to the world and if not checked immediately can create havoc.

Research Methodology :

The objective of the research paper is to explore Climate Adaptive Interventions at community level undertaken in Sunderban to combat climate change impact . Hence, the research paper is purely a qualitative study conducted using case study approach to explore the various initiatives undertaken by South Asian Forum for Environment (SAFE), a regional civil society organization focused on Sustainable Development Goals in the South Asian ecoregion.The case study and triangulation approach method will not only help establish the background of the problem but will also give detailed description of how initiatives undertaken by South Asian Forum for Environment (SAFE) can give better eco-friendly alternatives that if adopted in larger scale can help mitigate climate change challenges in Sunderban. Methodological triangulation approach in case study can be obtained from observations from secondary data that has been obtained and analysed from various governmental websites and state government reports.

Major Findings from Climate Change Adaptive Interventions of South Asian Forum for Environment (SAFE) in Sunderban :

The Sundarbans, a World Heritage site, is one of the largest mangrove forests globally, located in North and South 24 Parganas. It is home to six million people, 87% of whom live below the poverty line and face frequent climate change-related disasters.Over the past 10 years, the deltaic island of Sunderban witnessed sea surface temperature increase at a rate of 0.5degree and land loss at 5.5 sqkm/year leading to land loss, rising sea levels, and rising salinity. Severe cyclones and unpredictable monsoon rain patterns have become more often by 26%.

Over the past years the Sunderban continues to be ever neglected.While on one hand this deltaic region witnesses influx and growth of population,at the same time it is witnessing instances of soil erosion and

loss of its fragile and limited land resources. This indirectly has resulted in poor agricultural productivity and growing disenchantment of the rural poor.

According to Chandra Bhushan, deputy director, Centre for Science and Environment, the mangrove forests of the Sunderbans has been neglected since ages and thereby it is is slowly heading to be a development deficit region .This is primarily because sustainable development of this region has always been disaster-based hazard mitigation excluding climatic change or the effects it has on its domain. Community-based climate adaptive intervention must replace disaster-based hazard mitigation as the paradigm for sustainable development in the Sunderbans. In one of the reports written by Dipayan Dey, chairperson of South Asian Forum for Environment (SAFE) 'What Sunderbans needs is a development plan that will not only bridge the development deficit of the region but will tackle the impacts of the changing climate. In this context, a new land embankment policy is a must'. On the one hand, it stated that the population of the area is growing quickly. Large areas of land have been left in ruins due to high salinity caused by sea water intrusion and land erosion and erosion caused by the increasing sea level.

Given the region's exposure to rising sea levels, saltwater intrusion, cyclones, and changing rainfall patterns, SAFE's efforts focus on fostering resilience, promoting sustainable livelihoods, and enhancing community-based climate adaptation. This paper explores the various initiatives undertaken by SAFE to holistic, community-driven climate resilience, initiatives aligning environmental conservation with social empowerment and economic sustainability for the vulnerable communities of the Sunderbans.

1. Float Farming (Haor) – Regenerative Agriculture on Floodplains

In one such step towards community based climate change adaptive interventions, South Asian Forum for Environment (SAFE) introduced float farming (haor) in flooded areas of Sunderbans where buoyant bamboo rafts were employed to support organic grow bags for regenerative agriculture on flooded floodplains.

This approach transforms waterlogged challenges into productive farming opportunities, aligning with regenerative agricultural principles. Key features include:

- **Low-Carbon Cultivation:** Utilizes solar-powered micro-irrigation systems, significantly reducing greenhouse gas emissions compared to diesel pumps.
- **Circular Nutrient Use:** Employs organic fertilizers and pesticide-free methods, enhancing soil health and water quality.

- **Carbon Sequestration:** Promotes carbon-neutral farming by minimizing methane emissions typical of conventional paddy cultivation.

This initiative has been documented as one of the best practices of nature-based solution in South Asia by the UN Office for South –South Cooperation.

2. Waste-to-Energy Project – Clean Energy from Municipal Waste

SAFE's **Integrated Municipal Waste Management System** aims to address both waste disposal and energy poverty by converting segregated municipal waste into clean, affordable electricity. This initiative focuses on:

- **Waste Diversion:** Reduces landfill pressure and methane emissions by converting organic and inorganic waste streams into energy.
- **Circular Economy:** Creates employment opportunities in waste collection, segregation, and processing, promoting resource efficiency.
- **Energy Equity:** Provides low-cost electricity to economically disadvantaged communities, enhancing their resilience to energy shortages.
- **Climate Mitigation:** Contributes to reduced fossil fuel dependence, aligning with broader carbon neutrality goals.

3. Algaculture – Carbon Sequestration and Livelihood Support

SAFE's algaculture project, supported by APN funding, empowers over 700 marginal farmers by promoting **commercial mass culture of algae**, known for its rapid growth and high carbon capture potential. Key elements include:

- **High Carbon Sequestration:** Algae absorb carbon up to 10 times faster than terrestrial plants, significantly offsetting local carbon emissions.
- **Diverse Product Portfolio:** Produces biofuels, animal feed, organic fertilizers, and nutraceuticals, diversifying farmer incomes.
- **Climate Resilience:** Reduces ocean acidification and captures marine pollutants, supporting broader coastal ecosystem health.

- **Economic Uplift:** Provides an alternative livelihood for coastal communities vulnerable to climate impacts.

4. Floating Solar Energy Plants – Sustainable Transportation Solutions

SAFE has implemented **floating captive solar energy plants** (10KVA) on local rivulets to power electric motor vans and boats, addressing both energy access and sustainable transport needs. Key impacts include:

- **Zero-Emission Mobility:** Enables clean, renewable energy-powered transportation, reducing fossil fuel dependence.
- **Economic Resilience:** Supports local transport businesses, reducing operational costs and increasing income stability.
- **Disaster Resilience:** Provides reliable power even during extreme weather events, enhancing disaster preparedness.

5. Organic Rice Cultivation – Resilient Agriculture in Saline Soils

SAFE's efforts to promote **organic rice cultivation** focus on transitioning farmers away from chemically intensive methods towards climate-resilient, organic practices. Specific strategies include:

- **Local Varietal Focus:** Cultivates salinity-resistant strains like **Jaminadu** and **Gobindobhog**, known for their higher resilience to saltwater intrusion.
- **Biological Soil Enhancement:** Uses vermicompost and bio-fertilizers like nitrogen-fixing and phosphate-solubilizing microbes to improve soil health.
- **Collaborative Research:** Partners with institutions like the Chinsurah State Rice Research Institute for access to high-quality foundation seeds and scientific guidance.
- **Yield Optimization:** Demonstrates superior biomass and grain yield under organic systems, enhancing food security and farmer incomes.

6. Seaweed Farming – Women's Empowerment and Marine Conservation

Seaweed farming, championed by SAFE, provides coastal women with alternative livelihoods while contributing to marine conservation. Key benefits include:

- **Economic Empowerment:** Creates stable income opportunities for women, promoting gender equity in coastal economies.
- **Ecosystem Services:** Seaweed acts as a potent carbon sink, reduces ocean acidification, and improves marine biodiversity.
- **Industrial Versatility:** Supports multiple industries, including biofuel, cosmetics, pharmaceuticals, and food production, driving local economic diversification.

Limitation of the work :

One of the primary limitations of this study has been the constrained timeframe, which restricted the scope for a detailed impact assessment. Without sufficient time for longitudinal observation, it was challenging to capture the long-term effects and sustained outcomes of the interventions studied. Additionally, the study relied solely on a case study approach, which, while valuable for providing in-depth insights into specific contexts, may limit the generalizability of the findings. Case studies often capture the nuanced realities of a particular situation but can lack the broader statistical power required for wider inference. Future research could benefit from a more mixed-method approach, integrating quantitative assessments to validate and expand upon these preliminary findings.

Conclusion:

Climate change is a reality today and is creating havoc in Sunderbans. The main cause of the effects of climate change is human-induced greenhouse gas emissions.Rather than being a passive recipient and prey to this potential threat to mankind, it is important that serious action and developmental, transformational changes should be initiated without further delay to to lessen the effects of climate change. the threat of submersion, global emissions must be drastically reduced, and fossil fuels must be replaced with renewable energy.

With increase of sea level and the risk of submerging, there is an urgent need for global reduction of emissions and replacement of fossil fuels with renewable energy. At the same time there is also need to promote plantation of local saline resistant seeds. Parallel to prevent the deltaic region to further economical degradation, poverty alleviation initiatives should be immediately put into action. Working in PPP model, governmental and non-governmental organizations should immediately finalise action plans to tackle the problems of climate change. Standing at such crossroads, initiatives undertaken by

SAFE as discussed above should be a role model to encourage other organizations to come forward to make India's commitment to attain net zero by 2070 in COP-26 turn into reality.

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