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IMPACT OF CLIMATE CHANGE ON COASTAL COMMUNITIES OF INDIA (EASTERN COAST)

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Abstract - *This study provides an in-depth exploration of the tangible impacts of climate change on the Eastern coastal communities of India, emphasizing environmental consequences without delving into mitigation strategies. The region, characterized by its vulnerability to rising sea levels, altered weather patterns, and heightened frequency of extreme climatic events, experiences multifaceted challenges that significantly affect the socio-economic fabric of its inhabitants.*

The research investigates the direct and indirect impacts of climate change on the Eastern coastal communities, with a particular focus on disruptions in agriculture, fisheries, and traditional livelihoods. Rising temperatures and unpredictable precipitation patterns contribute to immediate threats to food security and economic stability. The study uncovers the vulnerabilities of coastal populations, emphasizing the disparities in their ability to adapt and withstand these environmental changes.

Furthermore, the research delves into the environmental consequences of climate change, encompassing coastal erosion, loss of biodiversity, and alterations in ecosystems.

The geographical scope of the study encompasses selected coastal districts in West Bengal, Tamil Nadu, and Puducherry. These regions were chosen based on their vulnerability to climate change, considering factors such as sea-level rise, historical cyclone events, and population density.

In conclusion, this research contributes to a nuanced understanding of the impacts of climate change on the Eastern coastal communities of India, underscoring the urgency of addressing these challenges. By focusing solely on the environmental consequences, the study provides valuable insights for policymakers, researchers, and local stakeholders seeking to develop targeted strategies that enhance resilience in the face of an evolving climate landscape.

Key Words: Climate Change, Eastern Coastal Communities, Vulnerability, Rising Sea Levels, Altered Weather Patterns, Agriculture Disruptions, Fisheries Impact, Traditional Livelihoods, Food Security Adaptation, Coastal Populations, Precipitation Patterns, Coastal Erosion, Biodiversity Loss, Ecosystem Alterations, Resilience, Mitigation Exclusion.

1.INTRODUCTION

Indian coastline runs for about 7516km. and is inhabited by densely populated human agglomeration, climate change and climate variability induced impact posed alarming challenges to this ecosystem making them more vulnerable and risk prone. Intergovernmental Panel on Climate change (IPCC), defined climate change as a change in the long-term state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties. In another definition, the United Nations Framework Convention on Climate Change (UNFCCC, 2011), refers to climate change as, a climate change that is directly or indirectly attributed by human activity resulting in an alteration in global atmospheric composition and that is an addition in natural climate variability for a long period. In their 6th Assessment Report (AR6) 2021, IPCC clearly mentioned that Carbon dioxide (CO2) is the main driver of climate change, (AR6), since 2011 (measurement report AR5), concentrations have continued to increase and it reached 410 ppm for CO2, 1866 ppb for methane (CH4), and 332 ppb for nitrous oxide (N2O) annually in 2019 which resulted in serious global warming. In the same report (AR6) IPCC has mentioned that each of the last four decades has been successively warmer than any other decades since 1850, and global surface temperature of last two decades (2001-2020) of 21st century was 0.99 °C higher than 1850-1900. This incontrovertible change in climate is not only changing the land and sea surface.

The East Coast of India, renowned for its vibrant communities, rich biodiversity, and economic vitality, is presently at the forefront of formidable challenges stemming from the intricate interplay of climate change, human activities, and population growth. Rapid urbanization, particularly observed in megacities such as Kolkata and Chennai, has exacerbated the vulnerability of these coastal regions to an array of environmental threats, including rising sea levels, cyclonic surges, and unpredictable weather patterns.

This research embarks on a critical exploration of how climate change is reshaping the dynamics of life along the Eastern coast. The escalating impacts of these environmental changes extend beyond the immediate concerns of

infrastructure damage and erosion, permeating into the very fabric of communities, agriculture, and the delicate coastal ecosystems.

As we navigate the intricate conflict between large-scale anthropogenic activities and the diverse marine ecosystems, the need for innovative approaches to manage land, water, waste, and ecosystems becomes increasingly apparent. The application of advanced geospatial tools, including a digital elevation model incorporating critical factors such as extreme surge height, sea-level rise rate, historical cyclone events, and intensity, serves as the foundation for a detailed vulnerability assessment.

In the pages that follow, we delve into the specifics of this study, scrutinizing the nuanced vulnerabilities of different states along the East Coast – from West Bengal to Puducherry. Our exploration encompasses the profound impacts on agriculture, the escalating risks to coastal ecosystems like mangroves and coral reefs, and the intricate links between climate change, health risks, and the economic activities that sustain local livelihoods.

The urgency of our endeavor is underscored by the immediacy of action required. As we unfold the layers of vulnerability and resilience, we advocate for comprehensive strategies to mitigate the multifaceted challenges posed by climate change. From building resilient infrastructure and judicious land use planning to preserving coastal ecosystems and promoting sustainable agriculture, our recommendations encapsulate a holistic approach.

2. LITERATURE REVIEW

The impacts of climate change on coastal regions, particularly in India, manifest through various interconnected phenomena, each contributing to heightened vulnerabilities for coastal communities and ecosystems.

1. **Sea Level Rise (SLR):** Sea level rise poses a multifaceted threat to coastal regions, leading to risks such as retreat, submersion, erosion, and increased vulnerability to extreme marine events. Coastal communities face the loss of land, erosion, flooding, and saltwater intrusion in coastal aquifers, significantly impacting their livelihoods and well-being.

2. **Increased Sea Surface Temperature (SST):** The rise in sea surface temperature, driven by the absorption of solar energy due to greenhouse gas emissions, has widespread ecological consequences. The changes in SST have led to the disappearance or migration of several species, disrupting marine ecosystems. Moreover, the elevated SST contributes to the intensification of tropical disturbances, resulting in an increased frequency of cyclones with implications for coastal communities.

3. **Frequency of Cyclones and Floods:** The 21st century has witnessed a notable increase in the occurrence and severity of flood hazards in India, exacerbated by climate change. Cyclones and floods not only cause casualties and injuries but also lead to the widespread devastation of coastal infrastructure, road networks, schools, health centers, and other essential properties, posing significant challenges for disaster management and recovery.

4. **Saltwater Intrusion:** The problem of seawater intrusion in dug wells and bore wells during summer months directly affects households and enterprises close to the shore. Human activities, landscape alterations, and the absence of proper management practices exacerbate saltwater intrusion issues, degrading water resources and intensifying competition for freshwater resources.

5. **Drought:** Climate change parameters contribute to increased drought conditions in coastal areas, posing challenges to water supply for drinking, domestic use, and agricultural and industrial purposes. Prolonged water shortages in surface and groundwater sources significantly impact coastal villages, highlighting the need for adaptive strategies to manage water resources efficiently.

The intertwining impacts of sea level rise, increased sea surface temperature, frequency of cyclones and floods, saltwater intrusion, and drought underscore the complex challenges faced by coastal communities in India due to climate change. Addressing these challenges requires comprehensive and integrated strategies that consider both environmental and socio-economic dimensions.

2.1 Impact Assessment-

Impact on fisheries:

the impact of climate change on fisheries in coastal regions, with a specific focus on the challenges faced by Eastern India. In this region, the dependence on fisheries as a primary livelihood choice makes it particularly susceptible to the adverse effects of rising sea surface temperatures (SST) caused by greenhouse gas (GHGs) emissions.

The poikilothermic nature of aquaculture-reared species in Eastern India renders them highly sensitive to even minor changes in SST, posing a threat to their metabolism and growth. Zacharia et al.'s (2016) study specifically highlights the Bay of Bengal, where fishermen have had to adapt by increasing the depth at which they cast nets due to rising SST. Additionally, changes in wind direction and speed during certain months have led to a decline in tuna catch in the Indian Ocean, impacting the traditional fishing practices of Eastern India.

Moreover, considering the changing climatic regime, the projection for Eastern India's Indian East Coast suggests a substantial decrease in ecosystem services by 2050, resulting in an estimated overall loss of 17 billion US$ (Mohanty et al., 2017). This underscores the urgency for implementing proper mitigation strategies in Eastern India to address the specific challenges faced by coastal communities and sustain the fisheries sector.

In summary, the impacts of climate change on fisheries in Eastern India include shifts in fishing practices, decreased catch due to changing weather patterns, and projected economic losses. Addressing these challenges requires region-specific mitigation strategies to protect the livelihoods and ecosystem services crucial to Eastern India's coastal communities.

Impact on agriculture:

In Eastern India, the agriculture sector is uniquely affected by changing climatic parameters, presenting specific challenges that distinguish it from other regions. Coastal agriculture in Eastern India is particularly susceptible to the adverse impacts of climate change, with factors such as seawater intrusion, cyclones, and increasing soil salinity posing significant threats.

The phenology of plants in Eastern Indian coastal regions has been adversely affected by the sheer change in climatic parameters. Erratic rainfall patterns, coupled with an increased temperature regime, have disrupted the traditional cropping patterns. the excessive increase in temperature poses a severe threat to the yield of irrigated paddy and maize in the East Indian coastal areas. This indicates a direct and tangible impact on the staple crops of the region, affecting both food security and economic stability for the local farming communities.

The disruption of the traditional cropping calendar in Eastern India has broader implications for the livelihoods of smallholder farming communities. The majority of inhabitants in coastal areas in Eastern India engage in smallholder farming, lacking the resources to implement expensive climate-smart strategies. This lack of resources exacerbates their vulnerability to the changing climate, making it challenging for them to adapt effectively.

In summary, Eastern India's coastal agriculture faces unique challenges due to climate change, including seawater intrusion, cyclones, and soil salinity. The impacts are evident in disrupted cropping patterns, threats to staple crops, increased pest risks, and challenges for smallholder farming communities. Addressing these region-specific challenges requires tailored strategies and support systems to enhance the resilience of Eastern India's coastal agriculture.

3. A STUDY OF WEST BENGAL COAST, INDIA

Introduction

West Bengal, located along the Bay of Bengal coast, stands as one of India's most climatically vulnerable states, facing heightened risks from severe cyclones, flood events, and rising sea levels. A comprehensive Literature study delves into the specific impacts of climate change on West Bengal, drawing insights from India's official climate assessment report and local observations. The climatic vulnerability of West Bengal, particularly in the context of climate change, is evident from various observations outlined in India's first official climate assessment report. Here are the key points from the report.

Cyclonic Activity:

- West Bengal is identified as one of the most climatically vulnerable states in India, facing a high number of severe cyclones along the Bay of Bengal coast.
- The Bay of Bengal region witnessed the highest number of cyclones in May and November between 1891 and 2018, with 41 severe cyclonic storms and 21 cyclonic storms in May and 72 severe cyclonic storms and 55 cyclonic storms in November during this period.
- From 2000 to 2018, the Bay of Bengal region experienced 16 Category 4 and above level cyclones out of 22 cyclones, indicating an increased frequency of very severe and extremely severe cyclonic storms.

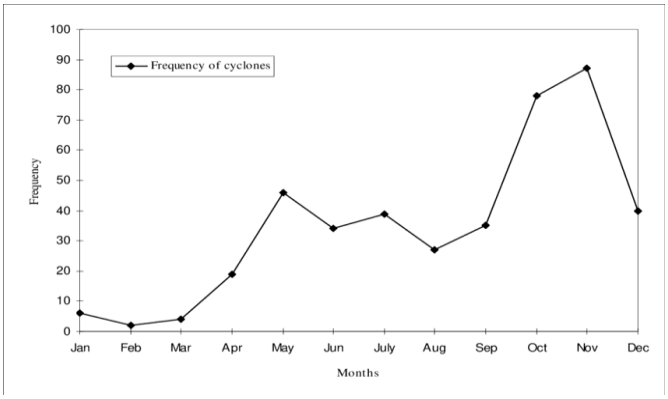

Fig -1: Monthly variation of the frequency of cyclones over the Bay of Bengal during 1891-1991

Shift in Cyclone Genesis Locations:

- The report highlights a significant eastward shift in tropical cyclone genesis locations in the Bay of Bengal region during post-monsoon seasons, potentially enhancing the risk for the coastal regions of West Bengal.

Landfall of Severe Cyclones:

- West Bengal witnessed landfalls of two extremely severe cyclones—Cyclone Bulbul in November 2019 and Cyclone Amphan in May 2020. Both made landfalls near the western part of Indian Sundarbans close to Sagar Island.
- Cyclone Bulbul had a maximum wind speed of 155 km per hour, while Cyclone Amphan had a maximum wind speed of 185 km per hour.

Flood Risk:

- The report indicates an increased flood risk over the east coast of India, including West Bengal, eastern Uttar Pradesh, Gujarat, Konkan region, and major urban areas like Mumbai, Kolkata, and Chennai.

Sea Surface Temperature and Thunderstorms:

- The sea surface temperature of the tropical Indian Ocean rose by an average of 1°C between 1951 and 2015, exceeding the global average warming of 0.7 degrees Celsius.
- The rise in ocean temperature is linked to the intensity of thunderstorms and cyclones. West Bengal experienced intense thunderstorm events and high casualties during the period 1978-2012.

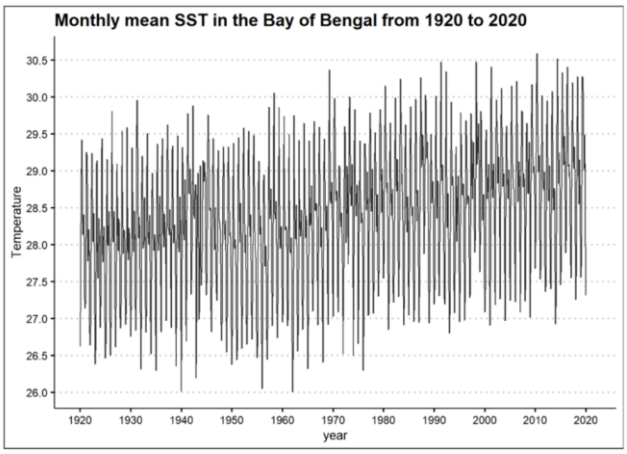

Fig -1: Sea surface temperature (Bay of Bengal during)

Sea Level Rise:

- The sea level off the Bengal coast is rising at a rate of five centimeters per decade, which is the highest in the country. This long-term impact of climate change poses a threat to coastal areas.

Government Response:

- The government acknowledged the sea level rise as the highest near Diamonharbour, near the mouth of the Sundarbans.

In summary, West Bengal faces multiple climate-related challenges, including increased cyclonic activity, flood risks, rising sea levels, and intense thunderstorms. These observations highlight the urgent need for adaptive measures and mitigation strategies in the region.

The expert, Dr. Anjal Prakash, research director at the Bharti Institute of Public Policy, Indian School of Business, highlights several potential impacts of climate change on West Bengal based on his analysis of the 6th assessment report of the Intergovernmental Panel on Climate Change (IPCC). Here are the key points he raised:

1. **Biodiversity Loss:**
   - West Bengal, known for its rich biodiversity, is expected to face biodiversity loss due to climate change.
   - The loss of many species could have significant implications for ecosystems and human livelihoods.

2. **Coastal Erosion:**
    - Climate change-induced rising sea levels could lead to coastal erosion along West Bengal's long coastline.
    - This poses significant threats to coastal communities, infrastructure, and the economy.
3. **Water Scarcity and Agriculture**:
    - Dependence on rainfall in West Bengal makes the region vulnerable to changes in precipitation patterns caused by climate change.
    - Altered precipitation patterns could lead to water scarcity, affecting agriculture—a major source of livelihood in the state.
4. **Heat Waves:**
    - The expert forecasts more frequent heat waves in West Bengal due to climate change.
    - Higher temperatures could pose health risks, particularly for vulnerable sections of the population.

In summary, the expert's analysis underscores the multifaceted challenges that climate change could pose for West Bengal, ranging from ecological disruptions and coastal erosion to impacts on water resources, agriculture, and public health. The implications extend to the national context, with vulnerable populations facing heightened risks.

3. DISCUSSION AND CONCLUSION

In the wake of escalating climate change impacts, particularly along the vulnerable Eastern coast of India, this research paper has undertaken a comprehensive exploration of the multifaceted challenges faced by coastal communities. The urgency of this study lies in its focused examination of tangible environmental consequences, specifically in West Bengal, Tamil Nadu, and Puducherry, shedding light on the intricacies of a region grappling with rising sea levels, altered weather patterns, and an increased frequency of extreme climatic events.

Key Findings: The research elucidates the direct and indirect repercussions of climate change on both the socio-economic fabric and the environment of the Eastern coastal communities. By narrowing the focus to disruptions in agriculture, fisheries, and traditional livelihoods, the study brings forth a nuanced understanding of the immediate threats to food security and economic stability. The vulnerability of coastal populations is underscored, emphasizing the disparities in their adaptive capacity.

Environmental Consequences: Delving into the environmental ramifications, the paper reveals the alarming toll on coastal ecosystems, including coastal erosion, loss of biodiversity, and alterations in ecosystems. The geographical scope encompassing selected districts facilitates a targeted examination of regions acutely susceptible to climate change, considering factors such as sea-level rise, historical cyclone events, and population density.

Unique Challenges and Impacts: The case study of West Bengal further amplifies the urgency, emphasizing the heightened risks of severe cyclones, flood events, and rising sea levels. The expert analysis by Dr. Anjal Prakash accentuates the region's vulnerability to biodiversity loss, coastal erosion, water scarcity, and the ominous threat of more frequent heatwaves. These findings underline the need for tailored strategies to address the unique challenges faced by Eastern India.

Impacts on Fisheries and Agriculture: The study zooms in on the critical sectors of fisheries and agriculture, elucidating the vulnerability of Eastern India's fisheries to rising sea surface temperatures and the unique challenges faced by coastal agriculture. The economic losses projected in the fisheries sector and the disruptions in cropping patterns paint a stark picture of the far-reaching consequences of climate change.

Conclusion and Advocacy for Action: In conclusion, this research contributes significantly to the understanding of climate change impacts on Eastern coastal communities. By focusing solely on the environmental consequences, the study provides a valuable foundation for policymakers, researchers, and local stakeholders to develop targeted strategies. The urgency of action is evident, and the recommendations encompass a holistic approach, advocating for resilient infrastructure, judicious land use planning, preservation of coastal ecosystems, and support for sustainable agriculture.

This research underscores the need for immediate and coordinated efforts to address the complex challenges posed by climate change. As the Eastern coastal communities navigate an evolving climate landscape, the research serves as a clarion call for strategic interventions, adaptation measures, and mitigation strategies that prioritize the resilience and sustainable development of these regions. In the face of an uncertain climate future, the insights provided by this research pave the way for informed decision-making and concerted action to safeguard the well-being of the communities and ecosystems along India's Eastern coast.

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