



RESEARCH ARTICLE

IMPACT OF CLIMATE CHANGE ON GHORAMARA ISLAND

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ABSTRACT

Ghoramara Island is a small island located in the Sundarbans Delta in the Bay of Bengal, off the coast of West Bengal, India. The island has a total area of approximately 2.88 square kilometers. However, due to the impact of climate change, the island is gradually shrinking in size as a result of erosion and rising sea levels. In fact, it is estimated that the island has lost approximately 75% of its landmass over the past few decades. This paper is an attempt to study how the impact of climate change effected livelihoods and areal changes of the Island. Some statistical tools have been utilised during the study like regression analysis and coefficient of variance (R^2). It has been shown that over the time the island is shrinking continuously and the result is shocking.

INTRODUCTION

Ghoramara Island, located in the Bay of Bengal off the coast of West Bengal, India, is one of the most vulnerable areas in the world to the impacts of climate change. The island is only 4.5 square kilometers in size and is home to approximately 5,000 people. The island has been facing the brunt of rising sea levels (Hazra et al, 2002), erosion, and cyclones. Here are some of the impacts of climate change on Ghoramara Island:

Sea-level rise: The sea level around Ghoramara Island has risen by more than 3 millimetres per year in recent decades. This has led to the island's coast eroding away at an alarming rate, causing the loss of land and homes

Erosion: The island is losing land at an average rate of 5 meters per year, and some areas have lost up to 150 meters of land since the 1960s. This has led to the displacement of people and destruction (Jana et al, 2012) of homes, infrastructure, and livelihoods.

Cyclones: Ghoramara Island is located in a cyclone-prone area, and climate change is expected to increase the frequency and intensity of these events. Cyclones can cause significant damage (Bandyopadhyay, 2000) to homes, infrastructure, and crops, leading to food and water shortages.

Saltwater intrusion: The rising sea levels and erosion have led to saltwater intrusion, which is when saltwater enters freshwater sources and contaminates them. This makes it difficult for people on the island to access clean drinking water.

Rising temperature: rising temperatures have a significant impact on Ghoramara Island's ecosystems (Bandyopadhyay, 1997) economy, and human health. High temperatures lead to heat waves, which is dangerous to human health, particularly for vulnerable populations such as the elderly and young children.

Agriculture: Temperature can affect the growth and yield of crops. Changes in temperature can also impact the timing and success of planting and harvesting seasons. Rising temperatures can lead to melting glaciers and ice sheets, causing sea levels to rise. This is a significant issue for Ghoramara Island, as it is already experiencing the impact of rising sea levels. The island is already facing the consequences of climate change, and continued warming could exacerbate the challenges it faces. The impacts of climate change (Hazra et al, 2010) on Ghoramara Island are severe and are affecting the livelihoods and well-being of the people living there. Without intervention, the island may become uninhabitable in the near future.

OBJECTIVES

Objectives of the study is to observe and analysis the impact of climate change on Ghoramara island.

Major objectives are

- To observe the vulnerability and erosional threats of Ghoramara Island.
- To investigate the issues and fight for survival.
- To determine the cause of the residents of Ghoramara Island's job dilemma.
- To highlight the issues that makes the islanders 'climate refugee'.

STUDY AREA: Ghoramara (21°53 '56 "N-21°55 '33 "N, 88°7 '10 "-88°8 '47" E) was joined to Sagar until 1903-'04 and then separated from the bigger island in 1904-'05 (Bandyopadhyay, 1997). Ghoramara's principal villages include Baishnabpara, Baghpara, Raipara, Mandirtala, Chunpuri, and Khasimara. Only one local trawler connects Ghoramara to the mainland (Kakdwip). The service is called as vutvuti, and it is accessible four times a day. With roads that are either brick or earthen, communication within the island is quite limited. Most of the peoples are living here under below poverty level. There were four mouza namely Lohachara, Khasimara and Ghoramara in this Island and comprised a population of 25000 few years back. Presently, Lohachara and Khasimara is submerged (Hazra et al, 2010) completely under water. Only Ghoramara is left. Most of the residents are leaving the place and taking shelter outside. Some villagers migrated Chakma, 2014) to nearest city like Kakdwip, Kolkata etc. specially those who are economically sound. There is 5.7km cement made road with width 5/6 fits under the scheme of ISGP (Integrated Strengthening of Gram Panchayet), PBG (Performance Base Grant), 15th finance and 14th finance scheme. 2.3km long concrete river band made by Kolkata Port Trust to save the ship canal. Total five Totos and some paddle vans are available here for transport concern.

in Ghoramara village is 964, which is higher than the state average of 950 in West Bengal. According to the census, the Ghoramara's child sex ratio is 917, which is lower than the West Bengal average of 956. In comparison to West Bengal, the literacy rate in Ghoramara village is greater. Literacy rate in the village was 81.95% in 2011, compared to 76.26% in West Bengal. Male literacy in Ghoramara is 90.40%, while female literacy is 73.25%.

Table 1. Population distribution in Ghoramara Island

Details	Total	Male	Female
Population	5193	2644	2549
Child up to age of 6 years	694	362	332
SC	1235	628	607
ST	1	1	0
Literacy rate	81.9%	90.40%	73.25%
Workers	2038	1487	551

(Source: Census 2011.)

POPULATION GROWTH: Total population of Ghoramara Island has increased gradually from 1971 to 2001 census but from 2001 to 2011 the number began to decrease as per following table. Reclamation began here, like in other parts of the Sundarban, in the early nineteenth century (Table 2).

Table 2. Population growth in the Island

Year	1951	1971	1981	1991	2001	2011
Population	2164	4163	4336	4972	5236	5193

In the last 50 years, this intertidal island has lost more than 70% of its land area. Despite the fact that Ghoramara is said to be prone to erosion, the population is organically rising here as the number of households increases. In 1951, the population was 2,164 people, with 433 families. Despite the fact that the island is undergoing erosion, population growth has been consistent with the exception of 1981. According to the 2001 census, the population is 5,236 people, with 899 households. The decadal growth rate is likewise increasing (Fig.1). The island is part of the Sagar CD. Block and has 2.82% of the total population. Agriculture is the most important economic activity here.

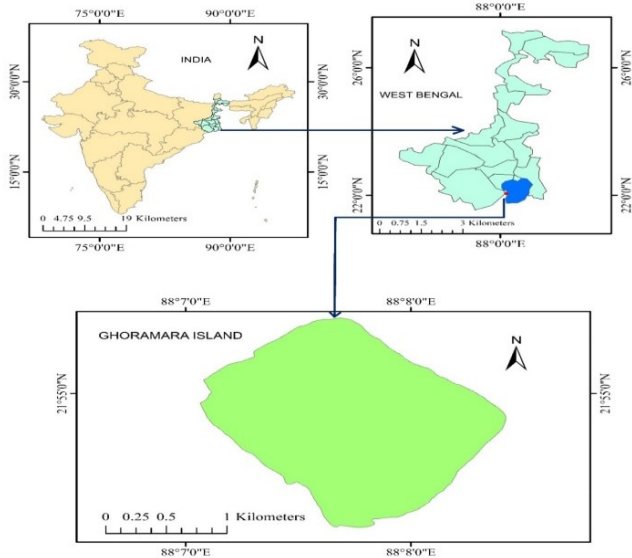


Fig. 1. Location map of Ghoramara Island

Location map of Ghoramara Island is in the following Fig. 1.

MATERIALS AND METHODS

For this investigation, both primary and secondary data are employed. The information is gathered from several databases and sources, such as.

Primary source: Primary data was acquired by a field survey on Ghoramara Island in 2021 using a questionnaire schedule.

Secondary Source: Secondary data was gathered primarily from the Ghoramara Gram Panchayet, and also from books, journals, and newspapers. Collected data were analysed by utilizing different statistical tools like regression analysis, coefficient of determination (R^2) etc.

POPULATION DISTRIBUTION AND EDUCATION: Ghoramara is a big hamlet in the Sagar Block of the South Twenty-Four Parganas district of West Bengal, with a population of 1095 people. According to the 2011 Population Census, the Ghoramara village has a population of 5193 people, with 2644 men and 2549 women. The number of children aged 0 to 6 in Ghoramara village is 694, accounting for 13.36% of the total population. The average Sex Ratio

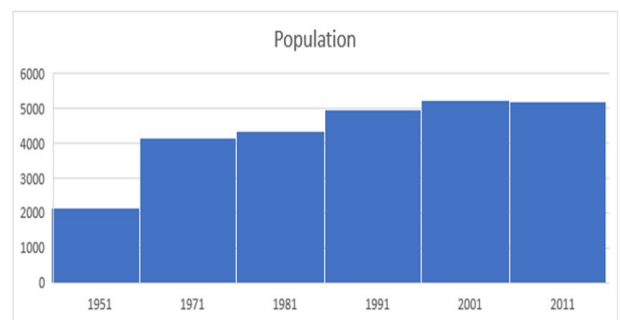


Fig. 2. Bargraph of population growth

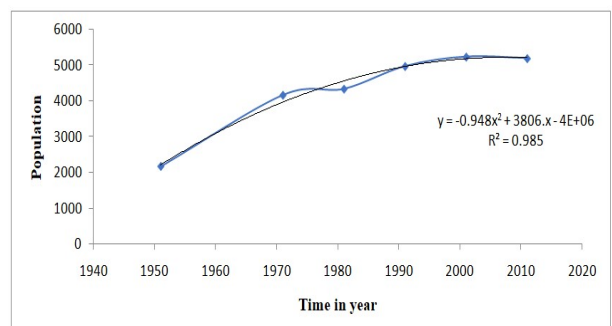


Fig. 3. Regression line of the population growth

Table 3. Cyclones affected Ghoramara Island

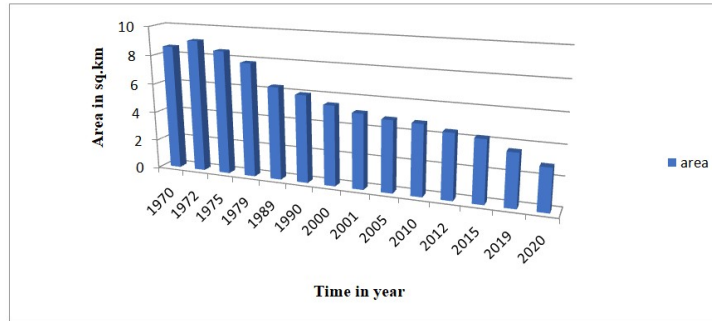
Cyclone	Date	Time	Location of landfall	Wind speed (km/hour)	Time of High Tide (IST)	HTL at Sagar (M)	Nature
Aila	25 th May, 2009	13:30 to 14:30	Close to Sagar.	110-120km. gusting to 130km/hr at landfall	12.50	4.20	Severe Cyclone
Bulbul	9 th November, 2019	20:30 to 21:30	Dhanchi Island	110-120km. gusting to 135km/hr at landfall	20.29	4.77	Severe Cyclone
Amphan	20 th May, 2020	15:30 to 17:30	Lothian Island	155-165km. gusting to 185km/hr at landfall	20.44	4.67	Very Severe Cyclone
Yaas	26 th May, 2021	10:30 to 11:30	Dhamra(Balasore)	130-140km. gusting to 155km/hr at landfall	9.15	7.50	Very Severe Cyclone

(Source: Report of the expert committee- July, 2021, Environment Department, Govt. of West Bengal)

Table 4. Land use and land cover of Ghoramara Island.

Class name	1972	1979	1989	2000	2010
Land vegetation	157.68	99.35	102.96	108.50	116.37
Wetland	151.56	145.86	155.52	98.75	87.21
Uncultivated land	272.52	170.05	201.33	208.76	129.33
Fisheries	4.68	3.72	1.89	1.22	1.71

(Source: Jana et al, 2012)



(Source: Report of the expert committee- July, 2021, Environment Department, Govt. of west Bengal and Jana et al, 2012)

Fig. 4. Areal changes of the Ghoramara Island over time

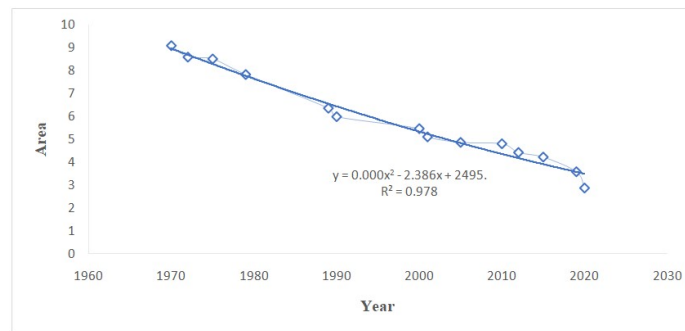


Fig. 3. Regression line of the areal changes of Ghoramara Island

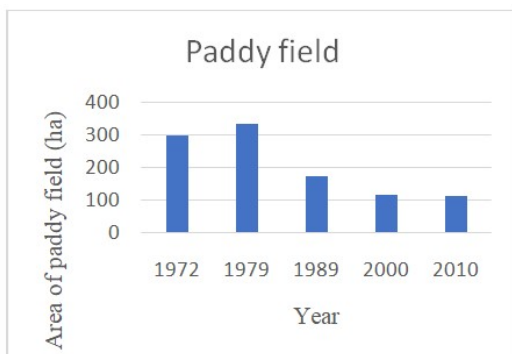


Fig. 5. Areal change of paddy field (1972-2010)

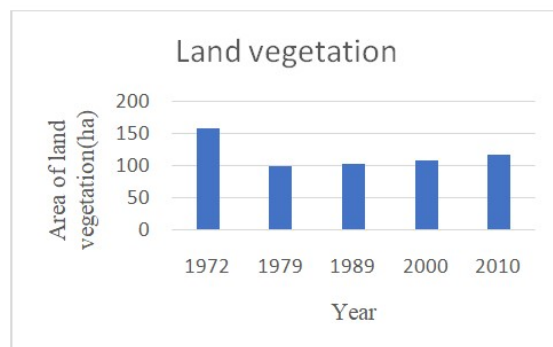


Fig. 6. Areal change of land vegetation (1972-2010)

Continue

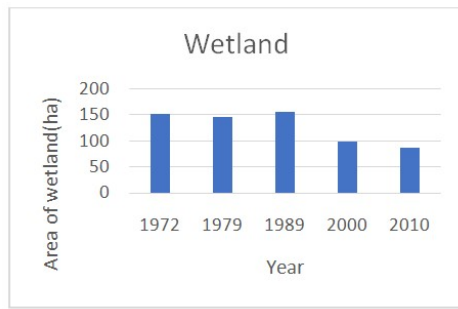


Fig. 7. Areal change of wetland (1972-2010)

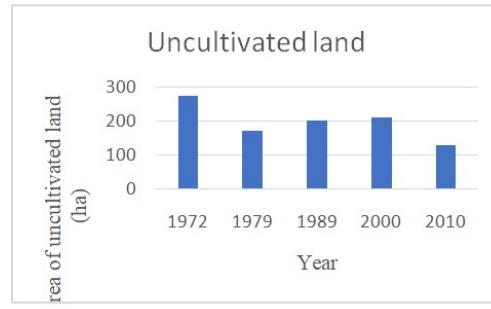


Fig. 8. Areal change of uncultivated land (1972-2010)

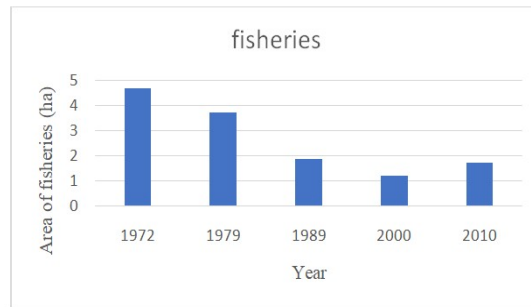


Fig. 9. Areal change of fisheries (1972-2010)

CLIMATIC IMPACTS

AREAL CHANGES OF GHORAMARA ISLAND: M Ghoramara Island, located in the Sundarbans delta region of West Bengal, India, has been severely affected by coastal erosion and rising sea levels. The island has experienced significant land loss over the years, and several parts of the island have been submerged, displacing many residents. Coastal erosion and sea level rise are natural phenomena, but they have been accelerated by factors such as climate change and human activities, including the construction of dams and water diversion projects upstream.

CLIMATE REFUGEES: Ghoramara Island has been significantly affected by coastal erosion and rising sea levels, leading to the displacement of many residents. The inhabitants of the Island have faced the harsh reality of losing their homes, agricultural lands, and livelihoods due to the encroaching sea. As the island shrinks in size and becomes more vulnerable to tidal inundation, the residents have been forced to abandon their homes and seek refuge elsewhere. The displacement of people from Island is a complex issue with social, economic, and environmental implications. The loss of land and livelihoods disrupts the social fabric of communities and often leads to economic hardships. The displaced individuals face challenges in finding new homes, livelihood opportunities, and access to basic services such as healthcare and education. The islanders' lives are intertwined with vulnerability. The Government authority has provided shelter to evacuees from Ghoramara on Sagar Island. Bankimnagar, Gangasagar, and Jibantala-Kamalpur colony areas have the highest concentrations. Low-lying areas are reclaimed in the same manner as in other sections of the island area. The Indian government, in collaboration with various organizations and agencies, has initiated efforts to address the situation of environmental refugees from Ghoramara Island. These initiatives include the implementation of relocation programs to safer areas and the provision of support for livelihood rehabilitation. However, the scale of the problem and the long-term sustainability of such interventions remain significant challenges.

CYCLONIC STORMS: Cyclonic storms frequently wreak havoc on Bengal's littoral region. Cyclones are slamming the Bengal coast more regularly, causing massive damage to the ecosystem and culture. Four cyclones have destroyed the Bengal coast since 2009.

These Aila (2009), Bulbul (2019), Amphan (2020), and Yaas (2021) are among them. Widespread inundation of coastal villages due to embankment breaking/overtopping/collapsing, large scale damage of human habitation, casualties, and saline water submergence of agriculture land, rendering it unsuitable for cultivation were all common in all of these incidents. Furthermore, whenever the Cyclones' landfall timing coincided with high tide, the resulting damages were more severe. Such an unlucky coincidence occurred in the situations of Aila, Bulbul, and Yaas. However, Amphan's landing at Lothian Island coincided with the low tide and As a result, even though it was classified as "Very Severe," the damages were less severe. Cyclone', with winds of 110-120 km/h gusting to 130 km/h at landfall (Table 3). It is vital to remember that the Cyclones that pass over the coast of Bengal always travel in an anti-clockwise direction. When a cyclone advances north or north-east over the ocean, The wind blows from east to west in Sundarban's littoral tract.

LOSS OF SOIL PRODUCTIVITY IN GHORAMARA ISLAND:

The region faces a basket of environmental hazards round the year. It experiences sudden-onset extreme weather events in the form of about nine cyclonic storms a decade, a third of which are severe. In the recent past, Sidr (2007), Aila (2009), Phailin (2013), Hudhud (2014), Bulbul (2019), Fani (2019), Amphan(2020) and Yaas (2021) have struck the Sundarbans with cycles of immense destruction. In the background of recurring cyclonic storms, are slow-onset environmental hazards that people have lived with for centuries. Some of these, such as a rising sea level, salinization of soil and water, loss of ecosystem services and failure of the ring of embankments built to protect the region from erosion have led to decreased access to safe drinking water, lack of food security and inadequate WASH (water, sanitation, and hygiene) facilities. Salinity in soil has reduced land productivity in a region primarily dependent on agriculture as its chief livelihood strategy. Salinity in water sources and lack of piped water supply have resulted in poor health outcomes and high diarrhoea-related mortality, especially among children. The year 2020, however, the people of the Indian Sundarbans faced a triple crisis. In the fourth week of May, the deadliest tropical cyclone to have ever impacted the Bay of Bengal, Amphans coincided with the ongoing COVID-19 pandemic in the background of deep-seated impacts of slow-onset hazards.

LAND USE AND LAND COVER OF THE ISLAND: The island's land usage and land cover were also impacted by the area reduction. Between 1972 and 2010, the area of farmed paddy fields decreased significantly, from 292.72 hectares to 113.49 hectares. Similarly, the area of uncultivated land falls from 272.52 hectares in 1972 to 129.33 hectares. Additionally, fishing has shrunk from 4.68 hectares in 1972 to 1.71 hectares in 2010. Increasing the island's vegetation cover is the sole effective remedy for balancing the erosion. As a result, there are now more plants growing on the land, including mangroves, caesars, and bamboos. Land vegetation covers about 29% of the area (Jana et al, 2012). The following tables represents the evolution of the island of Ghoramara's land use and land cover from 1972 to 2010.

RESULTS AND DISCUSSION

The analytical techniques that are used here are regression analysis method and R^2 (regression coefficient). Figure 3 depicts the morphological alterations seen on Ghoramara Island. During 1972, mud flats appeared all over the island, covering an area of approximately 9 km². A creek formation in the southeastern mud flat causes considerable erosion of this section. During the period 1972-1979, erosion in the southern part and deposition in the northern part are seen, although erosion is more intense than deposition, so the total area is reduced to 7.83Km². During the 1979-89 period, the overall area was further reduced, with erosion on the NW and NE sides and deposition on the SE and SW sides. Marginal deposition occurred on the SE side during the 1989-2000 timeframe (figure 6), but only on the southern side during the 2000-2010 interval. The bar graph of area changes over time shows a declining trend, indicating that area is shrinking every year. Climate change will be felt in sectors that rely on natural resources and are the foundation of people's livelihoods in the Environment and Sustainable Development. Extreme occurrences, rapid changes, and the nonlinear behaviour of climate system processes will drive repercussions on people and ecosystems, with an increasing risk of breaching dangerous thresholds. As a result, the purpose of this paper is to raise awareness among readers about the importance of limiting their climate-change-related actions in order to safeguard this one-of-a-kind "World Heritage Site."

CONCLUSION

The island is undergoing serious erosion, and it has been estimated that the island has lost over 75% of its area during the last five decades due to severe erosion on all sides. The decline in fresh water influx in the Hooghly River owing to natural and anthropogenic sources is a primary cause of the island system's instability. Transect wise studies reveal degradation in practically all directions. The northwestern side experiences the most erosion, whereas the south experiences marginal accretion due to its location in the shadow Zone of Sagar Island.

The pace of erosion is substantially faster than the rate of accretion, which causes the island to decrease over time. The land use land cover map also shows a significant drop in agricultural land area and fisheries. Calculations of land use and land cover revealed that the island's total area had been reduced dramatically from 9.09 square kilometres to 2.88 square kilometres.

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