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CYCLONE DISASTER AND ITS IMPACTS ON RURAL (SUNDARBAN) LIVELIHOOD: A CASE STUDY ON RURAL COMMUNITY OF PAKHIRALAYA VILLAGE AT GOSABA BLOCK, SOUTH 24 PARGANAS, WEST BENGAL

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Abstract

The Indian Sundarban is the World Heritage Mangrove Forest, as well as the land of great Royal Bengal Tiger. The Gosaba C.D Block is an island, which situated at the eastern side of river Bidyadhari. The cyclonic phenomenon in the Indian Sundarban is a common incident. The occurrence resistivity period of cyclone is in every 2.61 years. The cyclonic storm and storm and its associated saline water flood and river bank erosion also the common phenomenon at Gosaba.. The cyclonic disaster brings lot of sorrow for the villagers, like- damage of dwelling house, agricultural crops, transport and communication system, and mostly the salinization of the agricultural land which stopped the agricultural farming minimum 2-3 years and lot of villager's loss their job and they have bounded to live below poverty level life. Due to bank erosion some villagers have bounded to shift their habitat to another part of Gosaba Block as well as the other part of the state. Due to damage of agricultural crops and salinization of farming land so many stakeholders shifted their job from cultivator to a migrated labour in the other part of the state as well as the other part of the country also. We can't prevent the cyclone but we can mitigate the impacts of the cyclonic impacts through taking some measures, like- hazard mapping, land use planning, engineered structured, retrofitting non-engineered structured, establishment of cyclone shelter, flood management, improve of green pitch, mangrove plantation, and public awareness generation.

Keywords: Cyclone, Flood, Livelihood, Mitigation, Pakhiralaya, Stakeholder.

1. Introduction

Cyclone is one of the powerful as well as distracting natural calamities of the world. The difference between the earth quake and cyclone is that the earth quake can't predict or forecast and the cyclone may predict and forecast. But the destruction capacity is more or less same. Sometime the destruction power of cyclone is more than the earth quake. The cyclone has happening all over the globe. The cyclones have frequently occurred at the tropical region. According to INSOLATION distribution the equatorial and polar zones are quite free from the cyclone. The Indian Ocean is one of the cyclone origin prone regions of the world. About 24% of the total cyclone has occur in the Indian Ocean in every eyer. The Bay of Bengal is the most important region for cyclone origin due to its latitudinal location and ocean current. The May-June and October-November are the two different periodical time for the cyclone origin in Bay of Bengal. Naturally in May and June the cyclones have occur at the Orissa, Bengal and Bangladesh coast, but in October and November the cyclone has occur at the Andhra and Tamil Nadu coast. The path of a cyclone has determined by the local wind and the local wind has controlled by the surface temperature and atmospheric pressure.

The name Sundarban has comes as follows "The forest (ban) of the Sundari (Heritiera fomes) trees (Blasco, 1975). Sundarban is the unique mangrove forest of the world. It is the richest mangrove forest of the world, with 64 flora and 1536 fauna species are found in Sundarban. The Sundarban had declared as Tiger reserved in 1973, as Wildlife Sanctuary in 1977, Sundarban National Park in 1984, World Heritage in 1987 and Sundarban Biosphere Reserve in 1989. In 17th Century Raja Pratapaditya one of the famous and powerful Jaminnder in Bengal constructed the naval port at Sundarban. Still now enough amount of broken concrete structure has found in so many places in Sundarban. In British rule the Sagar Island in Sundarban region was first selected for large scale human habitation for agricultural purpose in 1773 and the first tube well was first installed in 1950 (das, 2006). Sundarban is scattered in 102 Islands by 31 (thirty-one) rivers. The total area under Sundarban region is 9630 sq km, the mangrove forest area is 4263 sq km and the Tiger Project area is 2585 sq km in Indian Sundarban. Out of the 102 Islands 54 Islands are human habitat Islands and 48 Islands are mangrove forest Islands.

Gosaba Block is the most important area of Sundarban region. The total area of Gosaba Block is 296.78 sq km. The total population in Gosaba Block is 246598, male population 125901 (51.06%) and female population 120680 (48.94%) (Census, 2011). The Gosaba Block is consisted with 14 Panchayats, 51 Mouzas and 50 Villages. The total length of the embankment is 372.5 km, which is the height in length respect to the others Blocks in Sundarban. Pakhiralaya is one of the important villages of Rangabelia Panchayat of Gosaba Block. The Famous Sajnakhali Wild Life Sanctuary is situated in Gosaba Block. The total population at Pakhiralaya is 3946, male population 53.24% and female population 46.76%. In each and every year one or more cyclone has stricken at the Pakhiralaya and quite all the embankment has broken due to the high tidal bore during the cyclone. About all the dwelling houses have either completely or



partially destroyed. So, cyclone is the main natural panic for the Pakhiralaya villagers in every summer (May-June). The natural cyclone protector means the only mangrove forest has the capability to save the residents of Sundarban form the destructive cyclones and Riverbank erosion as well as floods.

2. Objectives

- A) Identify the frequency of cyclone since 2015.
- B) To dig out the adverse impacts of cyclone on rural livelihoods.
- C) Identify the relation between cyclone, bank erosion and flood at Pakhiralaya.
- D) Identify the relation between cyclone and agricultural practices.
- E) Identify the Economic effects of high intensity cyclone on villager's life (Phakhiralaya village).
- F) Identify the relation between cyclone and stakeholder migration.
- G) Identify and analysis of Environmental effects of high intensity cyclone on villager's life (Phakhiralaya village).

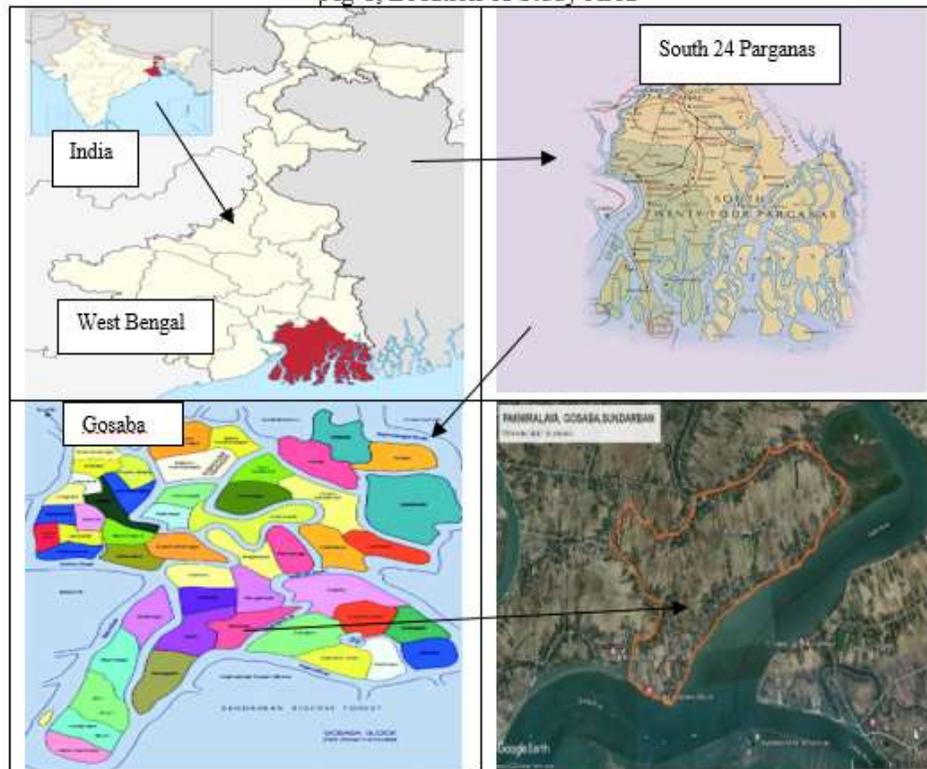
3. Methodology

The primary data has collected from randomly selected 81 households, through structured questionnaires and interview methods by door-to-door data collection. After collection of primary data by household level survey, prepared the tabulation sheet to assemble and summaries the data. After preparation of tabulation sheet, group discussion has conducted to make the oral analysis about the impacts of cyclone on Pakhiralaya. The primary data is not sufficient to understand the impacts of cyclone at any region. To completion the report the secondary data also collected from the several sources, such as Census of India Handbook of South 24 Parganas, The published and unpublished official data from BDO and Panchayat Office of Gosaba and Rangabelia Panchayat.

4. Study area

Sundarban is very much known as the land of Royal Bengal Tiger and also known as the 'World Heritage Mangrove Forest' which consisted by 7% of the total mangrove of the total world. Sundarban is scattered in 102 islands by 31 rivers. The Sundarban is originated by the alluvial deposition by the Ganga-Brahmaputra River at the mouth of Ganga. Gosaba C.D. Block is located in the Canning Sub-Division of South 24 Parganas, West Bengal, India. The C.D Block Gosaba also situated inbetween the River Bidya in west and Raimongal in east. The latitudinal and longitudinal location of the Gosaba C.D Block is 21°53' N to 22°9'54" N and 88°29' E to 88°48'28" E. And the Pakhiralaya village is located under Rangabelia Panchayat of C.D Block Gosaba. The arial latitudinal and longitudinal extension of Pakhiralaya is 22°7'37" N to 22°8'58" N and 88°48'47" E to 88°50'50" E.

Fig-1, Location of Study Area





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Result and discussion

5. General concept of cyclone & types

When any tropical unseal wind speed being reach 62 km/hr (39 mi/hr) around the central low pressure then the disturbance is considered as a **Tropical Storm** and then it is given a name. When the wind velocity reaches 119 km/hr (74 mi/hr), then the disturbance is considered as **Tropical Cyclone** (Nelson, 2012).

The tropical cyclone does not occur within 500 km from the equator, it's always origin minimum 500 km away from the equator and in a tropical oceanic part. To form a tropical cyclone the minimum temperature has reach 26.5°C throughout the upper 50 m of the tropical ocean. For the formation of tropical cyclone, Bay of Bengal is the suitable location for full-fill the favorable conditions. Each and every eyer a greater number of cyclones have originated in the Bay of Bengal. According to World Meteorological Organization 24% has originated in the Indian Ocean and 12% of the tropical cyclone has formed in Northern Indian Ocean. Bay of Bengal is the hot-spot of tropical cyclone.

Table-1, Cyclone Category and Impacts

Saffir-Simpson Hurricane (Cyclone) Damage-Potential Scale				
Cyclone Category	Central Pressure Mb or inches	Wind Speed mi/hr or km/hr	Storm Surge Feet or meters	Observed Damage
1	>980 (>28.94)	74-95 (119-153)	4-5 (1.2-1.5)	Some damage to trees, shrubbery & unanchored mobile homes.
2	965-979 (28.50-28.91)	96-110 (154-177)	6-8 (1.8-2.4)	Major damage to mobile homes; damage buildings' roofs & blow trees down.
3	945-964 (27.91-28.47)	111-130 (178-209)	9-12 (2.5-3.6)	Destroy mobile homes; blow down large trees; damage small buildings.
4	920-944 (27.17-27.88)	131-155 (210-249)	13-18 (3.9-5.5)	Completely destroy mobile homes; lower floors of structures near shore are susceptible to flooding.
5	<920 (<27.17)	>155 (>250)	>18 (>5.5)	Extensive damage to homes & industrial buildings; blow away small buildings; lower floors of structures within 500 meters of shore & less than 4.5 m (15 ft) above sea level are damage.

6. Hazards associated with cyclones

6.1 Storm surge

Storm surge is the abnormal rise in seawater level during storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by a storm's wind pushing water onshore. The amplitude of the storm surge at any given location depends upon the orientation of the coast line with the storm track; the intensity, size, and the speed of the storm (NOOA).

6.2 High intensity winds

The most destructive force of a cyclone comes from very intense winds. These winds have the enough force to damage as well as blow out the trees, sheds, power poles, communication systems, small houses, buildings, industrial structures etc. Many people were killed and homeless during the cyclones. Huge number of properties; like- forest, embankment, roadways, railways, fisheries etc. has destroyed due to cyclone.

6.3 Flood

Heavy and prolonged rain due to cyclones may cause flood in low lying regions. Not only the heavy rain, but also the storm surge is the main cause of embankment erosion riverain region near coast line as like Sundarban. The maximum floods have occurred at Sundarban due to the embankment erosion and the very intense storm surge and tidal bore are the main erosional force of embankment in Sundarban region. Due to flood situation in Sundarban almost every location has inundated and as result so many people become homeless, the drinking water has contaminated with pollutants, the agricultural lands have converted into saline land and agricultural practices have been stop for long time. Sometime the residents were drowned.



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7. Present livelihood status at phakhiralaya

The C.D Block Gosaba is well known for Sundarban and its unique presence of great Royal Bengal Tiger. The Gosaba Block is a very interior in view point of transport facilities, communication facilities, educational system, health facilities, job opportunities etc. The Phakhiralaya village of Rangabelia Panchayet is very important for its high frequency cyclone, bank erosion and saline water flooded condition about every year in summer and monsoon seasons. The Phakhiralaya village has 910 human settlements with 3946 population; 2002 are male and 1944 are female population (Census data, 2011). The life of villagers of Phakhiralaya entirely depends upon the riparian environment.

7. Livelihood capitals

7.1 Human capitals

Human capital represents skills, knowledge, ability to do labor and good health which together enable people to pursue different livelihood strategies and achieve their objectives (DFID, 2000). The household size, age group, age-sex ratio, marital status, and health facilities are the main components of human capitals.

According to household level collected socio-economic data from 81 families, the households are divided into three different categories according to their family members. The small size families which have containing <4 persons, medium families which have containing with 4-6 persons and the large families have containing >6 persons. According to collected primary data 32.10% families are small size, 62.20% families are medium size and only 3.70% families are large size. In present time in urban area maximum are nuclear family but in rural area human being lives in joint family. At Phakhiralaya we can found maximum medium size families of this village. The total population is divided into three different age groups according to their age workability. I) The child group between 0-14 years age, II) the working group 15-60 years age and III) non-working and senior citizen group above 60 years age. The first group (0-14 years) indicates that this group is child or depended group. The second group (14-55 years) indicates that this group is working group and last group (above 55 years) indicates that this group is non-working and senior citizen group. The child group containing with only 16.18% out of the total population, which indicate that the depended or child group is less in amount which is very good indicator for society from the view point of population control and development. The working group is containing with 74.12% of total populations which is also very good for society in séance of GDP. The old group has containing only 9.70% of total population.

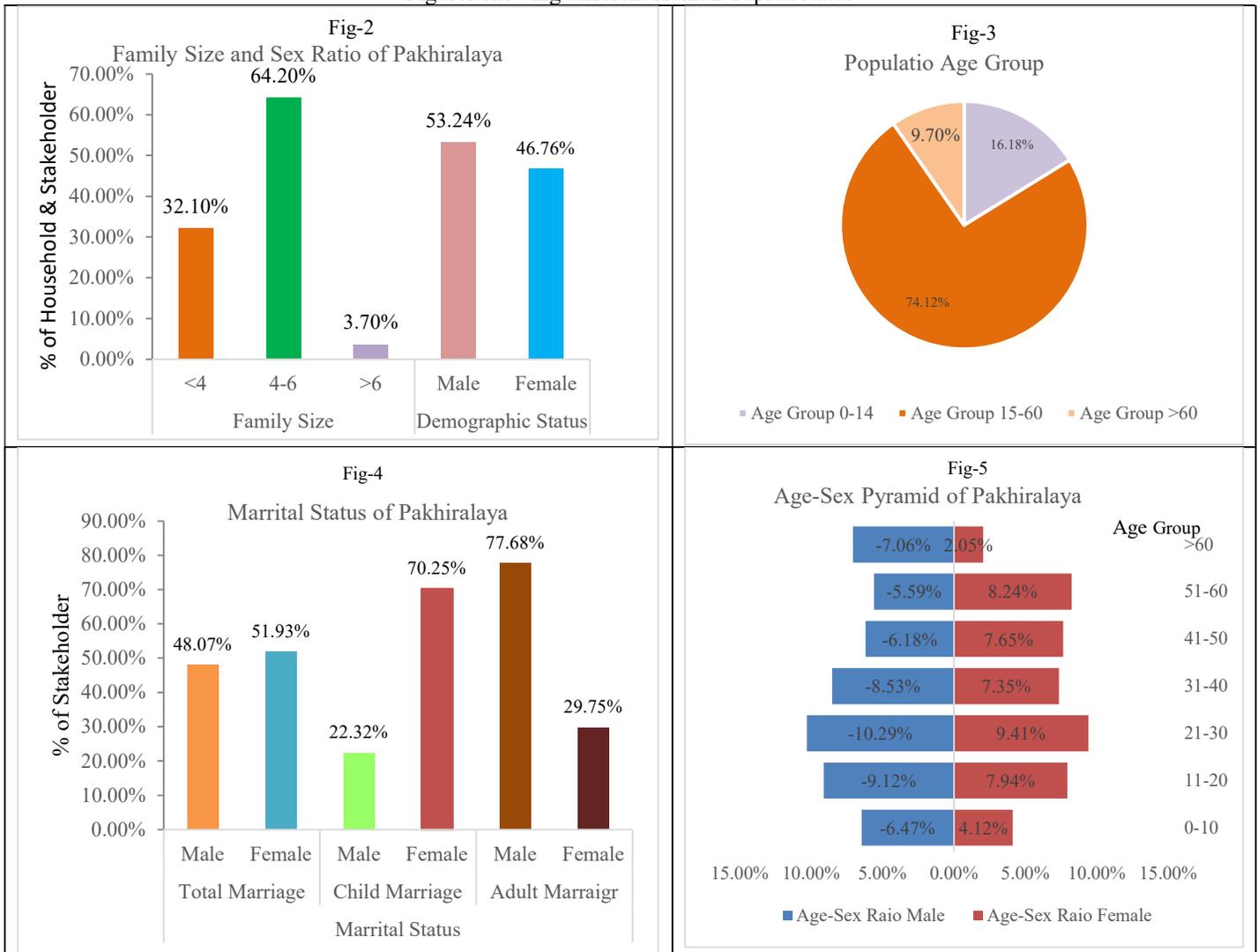
According to household level collected socio-economic data from 81 households and 370 population, 181 (53.24%) are male populations and 159 (46.76%) are female population. According to the primary sex ratio of this village is 878, but according to 2011 Census data the sex ratio is 971, which showing another picture. The household level surveyed sex ratio is much less than the national level (940) as well as C.D Block level (959). The sex ratio of this village is not indicating that the social as well as demographic condition is not in so good condition, which indicator the poor demographic condition.

Demographically Phakhiralaya is significantly different from the other villages Gasaba. The sex ratio of this village is 971. According to household level collected socio-economic data total population has divided into seven (07) age –sex groups. (i) 0-10 years, (ii) 11-20 years, (iii) 21-30 years, (iv) 31-40 years, (v) 41-50 years, (vi) 51-60 years and (vii) above 60 years. Only 6.47% of male and 4.12% female populations are under 10 years, which indicate low population growth, 9.12% male and 7.94% female populations are in age group 11-20 years, 10.29% male and 9.41% female populations are in age group 21-30 years, 8.53% male and 7.35% female populations are in age group 31-40 years, 6.18% male and 7.65% female populations are in age group 41-50 years, 5.59% male and 8.24% female populations are in age group of 51-60 years, and the last as well as senior citizen group is containing with 7.06% of male population and 2.05% female population. The 41-50- and 51-60-year age-sex group has showing the unusual picture than other part of rural Bengal. These groups are clearly reflecting the relation between occupations and age-sex composition in Sundarban. The honey and other non-timber forest products harvesting are two most important occupations, for which so many male population losses their life in several time.

At Phakhiralaya village 61.88% male populations and 76.10% female populations are married. Only 22.32% male among the married male population had got child married which very good for society compere to past few decade, in other hand 70.25% female populations had got child marriage category (marriage under 21 years for male and under 18 years for female population) which indicate that still now present day context the rural Bengal as well as rural India think girl Childs are burden for their family and it reflection we can find from this data, which is not good indicator for civic society.



Figures showing different Human Capital status



Source: Household Level Data Collection

Health facility is one of the most important demographics as well as social factors. Public health care facility level provides us clear information about poverty and vulnerability about the stakeholder of the society. Locationally the village Phakhiralaya situated at an Island of River Bidyadhari and Datta. The public Health facility is not sufficient at this village, according to collect data only some village Quack doctors are available but other health facilities are not available, even a primary health centre. To get health facility villagers goes to Rangabelia Panchayet health centre which is located at Rangabelia village. For better treatment villagers goes to Gosaba Block Hospital which is located 6 km away from this village.

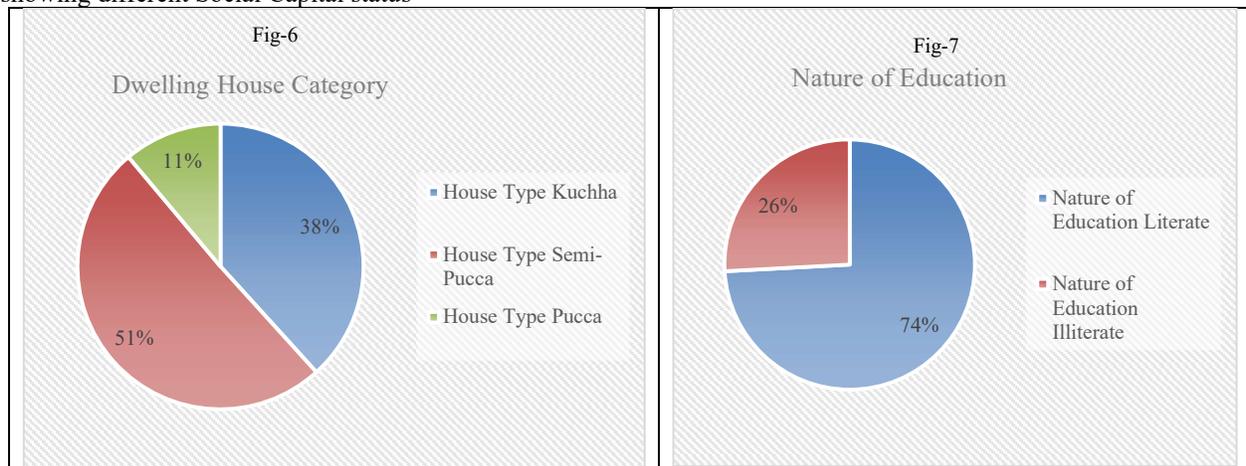
7.2 Social capitals

Social capitals are the most important factors of household from which society it belonging. House type, ownership of land, educational status and cast structure are the factors of social capitals. At the village Phakhiralaya has 910 households. We collected socio-economic data from 81 households. This village naturally located at the bank of river Bidyadhari and also very vulnerable zone from tropical cyclone and saline water flooding. The average MSL of this village is 2-3 meters and some where it is less than 2 meters. Condition and types of dwelling houses has found of this village are normal as like as other part of Gangatic plain of Rural Bengal. 38.27% houses are Kuccha as well as made by mud, bamboo, roof tiles etc. Most of houses like- 50.62% of this village are Semi-Pucca house or made by bricks wall and roof tiles or asbestos and only 11.11% houses of this village are Pucca house or bricks, cement, iron

rods, or concerted roof. According to household level collected data 92.59% household has only one house and 7.41% stakeholder has more than one house. About 12.34% households have 1 (one) room house, 48.15% households have 2 (two) rooms house and 39.51% households have more than 2 (two) rooms house. According to household level collected data about 62.96% stakeholders have the cultivated land and 37.04% stakeholders have no any land for agricultural practices.

At Phakhiralaya village, according to household level collected socio-economic data out of 340 (100%) surveyed populations only 9.73% populations are infant child, who actually have not started any level of education. Most of the stakeholders about 74.12% are literate and only 20.59% stakeholder are illiterate at Phakhiralaya village. According to collected primary data 24.94% children are continuing their education in primary level, 48.24% students are continuing their education in secondary level and 10.73% students are continuing their education in Higher Secondary level and 16.09% students are continuing their education in Higher Education from different institutions far away from the village, like- Sonarpur, Kolkata etc. About 59.13% formal literate stakeholders have drop-out from the educational system in several level (up to class-VIII). At Phakhiralaya village the literacy rate is average. The village has 74.12% literacy rate which is near to the national as well as state level.

Figures showing different Social Capital status



Source: Household Level Data Collection

Cast structure of Phakhiralaya village is significant. About 33.34% households are belonging from same cast group, which is belonging from general cast category. 35.80% households are belonging from S.C community and only 3.70% households from ST community and 27.16 have belonging from OBC community.

7.3 Natural capitals

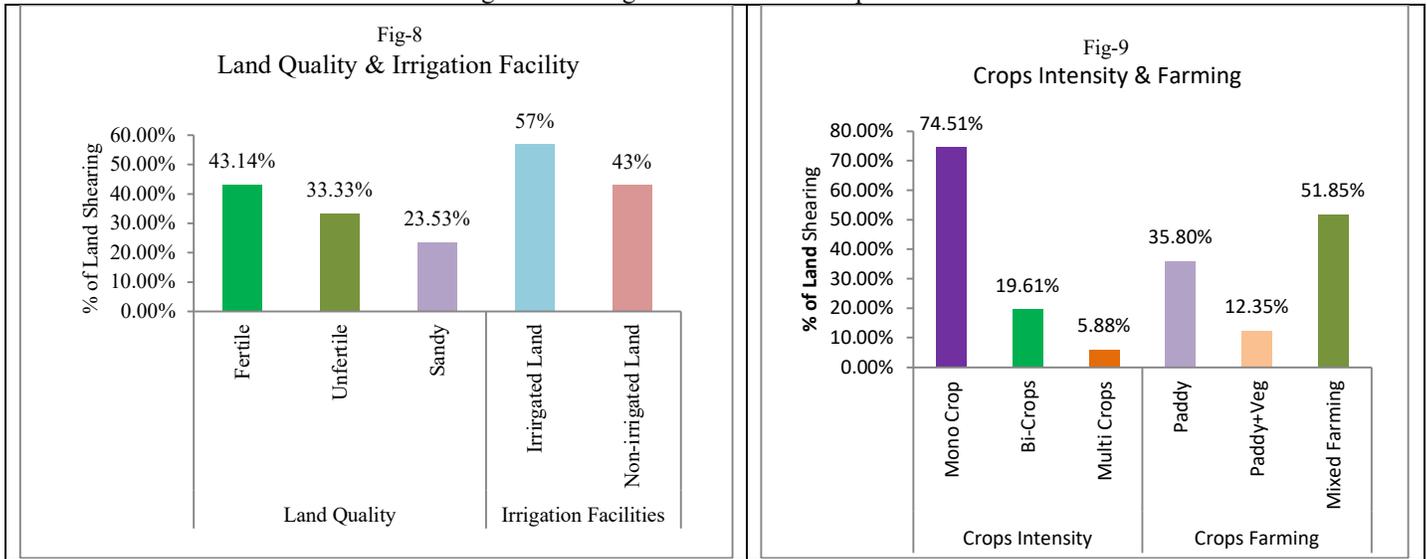
Availability of natural capitals is the key factors to develop any agricultural base rural area. The water sources & supply, agricultural land quality, irrigational facilities, crop intensity and types of crop farming are the major controlling factors of social capitals. At the village Phakhiralaya situated at the bank of River Bidyadhari. Normally every household has required water supply for two different purposes; a) For drinking purpose and b) For other domestic purposes. For drinking purpose 100% or all household has depended upon the Govt. pipe supply water for drinking purpose, except this system the villagers have no any alternative way or option. Some villagers use pipe supply water not only drinking purpose but also other domestic purposes also and 56.79% households have their own source of water supply for domestic purpose, like pond. Where ever this village situated at the bank of Bidyadhari River; villagers are unable to use river water for bath, sanitation, irrigation as well as so many other domestic purposes.

According to household level collected data at Phakhiralaya village 62.96% households has the cultivated land. Among the stakeholders at Phakhiralaya, who have processed the cultivated land, 43.14% stakeholders have said that their agricultural land quality is fertile in term of alluvial and loamy soil flood plain, as well as very good agricultural productive quality, 33.33% stakeholders have said that their agricultural land quality is unfertile in nature and 23.58% household land quality are sandy in nature. At this village the stakeholders, who have processed the cultivated land, among them 74.51% stakeholders have processed their land for mono-crop cultivation practice purpose, 19.61% stakeholders have processed their land for bi-crop cultivation purpose and only 5.88% stakeholders have processed their land for multi-crop cultivation production. Paddy cultivation is the dominating agricultural practice for food grain production for their family. About 35.80% lands are used for only paddy cultivation. About 12.35% lands are used for paddy and



vegetable production. Other cultivated crops are potato, onion etc. and about 51.85% agricultural land has used for mixed farming. The irrigational facilities are very poor at Pakhiralaya due to the nourished by tidal saline water river system in Sundarban region. About 57% agricultural lands have the irrigational facility, but the irrigational facility is occasional and very poor, and 43% agricultural lands have no irrigational facility. The entire agricultural practices totally depend upon the climatic condition, as well as the extreme weather condition. The average return period of cyclone in Sundarban coast is 2.61 years. So, the agricultural practices at Pakhiralaya have stopped for 2-3 years for the salinization of soil due to the storm surge and saline water flooding condition about in every cyclonic occasion.

Figures showing different Natural Capital status

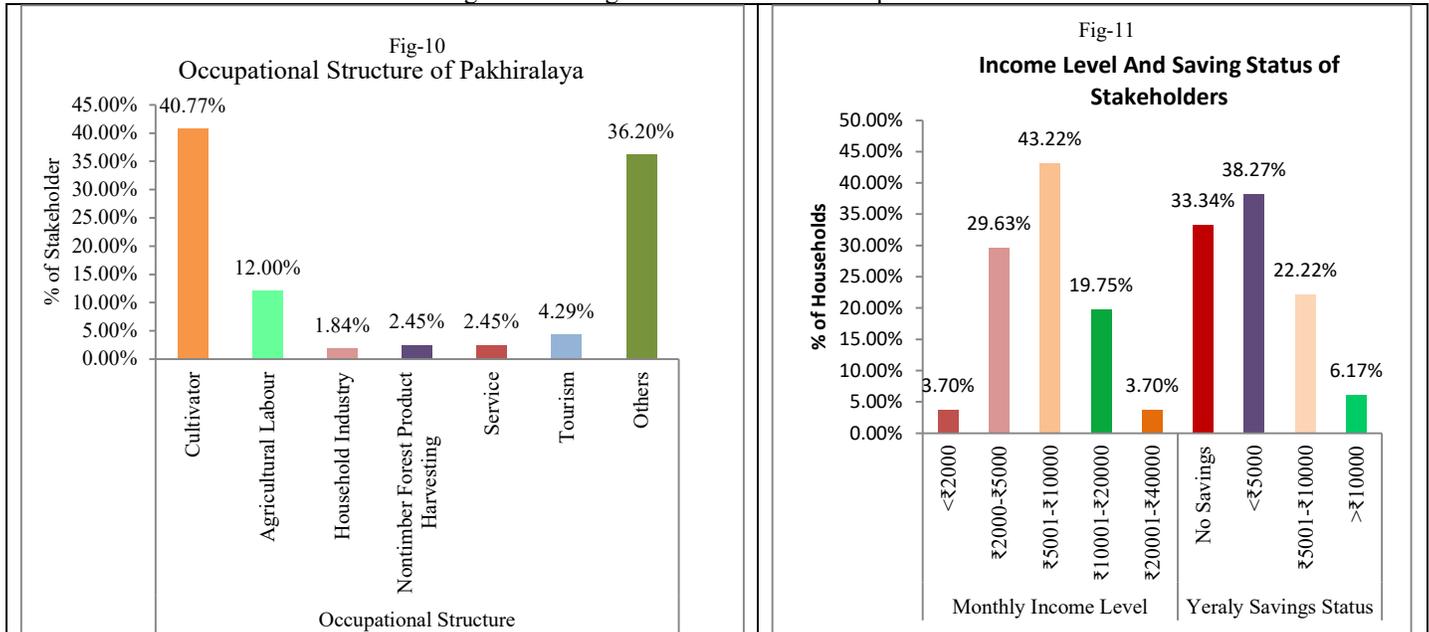


Source: Household Level Data Collection

7.4 Economic capitals

Financial status of any region gives us a general idea about the level of development of any region. Occupations, income level, per capita income and savings status are the major dominating feature of the economic capitals. Occupation is the most important socio-economic character of any region. According to household level collected data, the significant worker groups has identified at Phakhiralaya village. The different occupational groups are; a) Cultivator, b) Agricultural Labour, c) Household Industry Worker d) non-timber forest product harvesting from Mangrove Forest e) Govt. or Non-govt. Service, e) Tourism Industry and f) Other Workers. According to data sheet 40.77% households are mostly depend upon agricultural farming for their economic condition, 12% household involved as agricultural in job sectors, 1.84% households are mostly depending on Household Industry, 2.45% stakeholder involved in non-timber forest product harvesting such as honey, crabs fishing from creeks etc. 2.45% stakeholder involved in Govt. or Non-Govt. service for their economic condition, 4.29% households involved in Tourism Industries and their own business and rest 36.20% households involved in other types of economic activity, like- migrated labour and constructional worker for their economic condition.

Figures showing different Economics Capital status



Source: Household Level Data Collection

Income level is the most important indicator of development of any region. If income level of the stakeholders is high of any region, then it considers that is a developed region. According to household level collected socio-economic data at Phakhiralaya village the stakeholders are divided in five different income level groups; a) bellow ₹2000 per month, b) ₹2001-₹5000 per month c) ₹5001-₹10000 per month, d) ₹10001-₹20000 per month and e) ₹20001 or above per month. At this village 3.70% households per month family income is bellow ₹5000, 29.63% households per month income is in between ₹2001-₹5000, 43.22% households per month family income is in between ₹5001-₹10000, 19.75% households per month income is in between ₹10001-₹20000 and 3.70 households per month income is above ₹20000. So, most of the households are in good income level group and condition, which is the very good for social developmental indicator as well as economically developed village.

Savings is also one of the very important for future as well as economic development. According to household level collected socio-economic data at Phakhiralaya village the households are divided in four different savings groups; a) no savings households' group, b) savings bellow ₹5000 per year stakeholders' group, c) savings ₹5000-10000 per year stakeholders' group and d) savings above ₹10000 per year stakeholders' group. Most of the households about 38.27% save their money bellow ₹5000 per year, 22.22% households save their money between ₹5000-10000 per year, 6.17% households save their money above ₹10000 per year and 33.34% households have said that they have no savings through the year. Villagers save their money in banks or post office for coping with critical situation.

7.5 Physical capitals

Physical capitals also very important parameter of development level. Sanitation condition, road types, transport facilities, communication systems and electrification are the main dominating themes of physical capitals. According to household level collected socio-economic data at Phakhiralaya village the stakeholders has divided in two categories for assessment of sanitation condition. Sanitation facility is available or not at this village. If sanitation facility is available then it is open or close. At Phakhiralaya village 92.59% households has the sanitation facility. Among which families have obtaining the sanitation facility, 74.07% households have the close sanitation facility and 18.52% households have obtaining open sanitation facility. Only 7.41% families have no sanitation facility. They use open field for sanitation purpose.

Road type is the very important for rural socio-economic life. Now in modern time transport facility depend upon the road way network. Some roads in this village are concreted; about 43.22% and 56.78% roads are Raw Road. But all roads are in well condition. In cyclonic and monsoon somewhere road way condition becomes very bad due to the saline water flooding condition. Other than cyclonic and monsoon season roadways condition is almost in well condition. But in this riparian island road ways are not connected with the main land road ways, because there has no concrete bridge over the river Bidyadhari.



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The village Phakhiralaya situated at the east bank of Bidyadhari River. Villagers reach different types of transport facility to reach the Gosaba to Gadkhali ferry ghat. To reach the main stream transport system from Gadkhali, without ferry service there has no other system to cross the river Bidyadhari. During the cyclonic and monsoon season to cross the Bidyadhari River by ferry service is very risky and some time the boat sank incidents has happened and so many people has drowned in the river water. The village is almost flooded during every cyclonic time and transport system had been collapsed in every year at least one or two months. Inside village, stakeholders travel by walking or bi-cycle. During outside travel, the villagers are able different type vehicles from Gadkhali. Villagers mostly use by-cycle, motor cycle and small public transports to travel within the island.

One rural post office is situated at this village. Every villager has got the Indian Post Office service. Now a modern day almost all households or stakeholders have enjoying mobile telephone facility. So, from the communication point of view the village Phakhiralaya well connected with the other part of Bengal as well as India or World through Indian Post and Mobile Telephone.

Electrification is also one of the very important indicators of development. Electrification indicates stander of living. Most of the households of Phakhiralaya village about 95.06% access electric connection at different time phase and 4.94% households still now don't access the electricity connection.

8. Last four tropical cyclones & storms and its impacts

According to Indian Meteorological Department Sundarban is the most cyclone prone and vulnerable region of Bengal. West Bengal's South 24 Parganas district, within which the larger share of the Sundarbans is located, is impacted by cyclones the most frequently among Indian districts, found a recent study. The return period of cyclonic storms in the district was 1.67 years on a scale of 1.5 to 60 years, according to the analysis by India Meteorological Department (IMD), Pune. Shorter return periods indicate more frequent cyclones. For severe storms, the return period was 2.61 years, the report Climate hazards and vulnerability atlas of India showed. In back to back two years 2020 and 2021, the Sundarban has saw two cyclones (Amphan and Yaas cyclones) out of the 10 cyclonic disturbances that swept the country (IMD).

Table-2, Last Four Tropical Cyclones & Storms and Its Impacts

Table with 9 columns: Name, Date of Land Fall, Storm Velocity, Storm Surge, Flood Height, Damage (Human lives Loss, Livestock Loss, Fishery, Forest). Rows include FANI, BULBUL, AMPHAN, and YAAS with detailed impact data.

Source: BDO Office Gosaba

9. Impacts of cyclones

According to secondary data (source: BDO Office, Gosaba) the last 4 four tropical storms/cyclones which occur in Sundarban for last three years, two (Fani & Bulbul) are tropical storms and two (Amphan & Yaas) are category-I tropical cyclones. Due to these four tropical disturbances have occurred huge damages in the Sundarban.



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9.1 Life losses (human and livestock's)

According to secondary data in 2019, 2020 and 2021 no human life was loss due to tropical storms or cyclones. But huge number of livestock was killed due to storms or cyclones. Due to Fani and Bulbul in 2019, total 2 cows, 32 goats, 21618 chicks were died. In 2020, 15 Cows, 121 Goats, 16065 Chicks and 2292 Ducking were died due to cyclone Amphan. And in 2021, 14 Cows, 62 Goats, 4200 Chicks and 11051 Ducking were died due to cyclone Yaas.

9.2 Social in fractural losses

The gale force is the main destructive power of tropical storm or cyclone of any cyclone prone region. In Sundarban region not only gale force but also the storm surge is one of the destructive powers in costal or near coastal region. Physiographically Sundarban is a nourished by tidal water riverain low land (MSL 2-3 m) region. The Bay of Bengal is well connected with Sundarban by several big creeks and all the water of the creeks is the saline oceanic water. So, the gale wind and the storm surge frequently enter in the Sundarban region. As a result, more than 96% of the dwelling houses of the local residents have partially or completely destroyed due to cyclone. According to household level collected data 78 dwelling houses out of 81 were partially or completely destroyed by the cyclone Yaas. The storm surge of the cyclone Amphan was 5 meter and flood height were 3 meter in 2020 and in 2021 due to cyclone Yaas the storm surge was 6 meter and the flood height was 4 meter in different part of Gosaba Block. Pakhiralaya such a village which situated near to the core zone of Sundarban Tiger Reserved Forest and also near to the coast of Bay of Bengal. According to household level collected data in 20221, more than 74% cultivators' loss their agricultural productions due to Yaas. Not only for 2021 but also for 3 to 5 years all the saline water flooded farming lands have become barren land due to soil salinity, until the soil salinity neutralized naturally.

9.3 Economic losses

Due to gale force and storm surge of cyclone the embankment has eroded in several places and in several length and a result wide area has flooded by the saline water for a temporal scale 3 to 7 days in Sundarban. During the flood situation maximum stakeholder's loss their dwelling houses, cultivated crops, livestock, waterbodies, forest, cultivated fishes, fish seed, road, communication systems etc. According to provided secondary data from BDO Office of Gosaba, the total amount of economic losses in the Block for last three years; total number of Cows were loss 31, Goat 215, Chicks 41878, Ducking 13343, Mangrove Forest 257 sq km, Table fish 12103 Metric Tons and 299 million fish seed.

9.4 Environmental refugees

Embankment erosion and flood is the regular incident in Sundarban due to cyclone. At Pakhiralaya about a large number of stakeholders migrated or sifted their houses in any other part of the village as well as panchayat also. Some villagers have migrated to far away from the village to Sonarpur or Kolkata also. According to existing local residents bank erosion is the main cause for the migration. The River Dutta and Bidyadhari regularly shifting their bank through bank erosion. According to collected primary data from 81 households 10 villagers have permanently migrated with their family to other places at Pakhiralaya or somewhere away from the village.

10. Coping strategies and mitigation methods

Mitigation means measures taken to minimize the negative impacts of cyclone disaster. Mitigation measures for cyclone for both structural and non-structural issues. To implement the mitigation measures needs Governmental, Non-Governmental and stakeholders' participation. The mitigation measures cannot be implemented by the Government or Non-Governmental Organization or Community only. To reduce the negative impacts of cyclones, coping strategies formulation and implementation are the steps to mitigate the adverse impacts of cyclone.

10.1 Hazard mapping

Hazard mapping is the most important part of mitigation of hazard. Through hazard mapping easily we may make a general perception about the frequency of particular hazard and the average temporal duration of occurrence of cyclone. Cyclone such like a hazard which we can predict several days before its occurrence, but we can't make sure before 24 hours of its landfall about the particular location. But 24 hours is enough to evacuate the stakeholders from the vulnerable areas to any save place or save shelter. So, hazard mapping is very essential to prepared ourselves to fight against the cyclone ready us to reduce the potential damage of cyclone and also help us to mitigate the negative impacts of cyclone.

10.2 Land use planning

Proper land use planning may be reduced the negative impacts of cyclone. In Sundarban most of the area is lying between 1–3-meter altitudes from the MSL. The last cyclone YAAS in 2021, the height of the storm surge was 6 meter and flood height were 4 meters. So, almost every place in Sundarban was flooded by storm surge. To build the dwelling houses site selection is very important, comparatively



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high land (above the maximum flood height) is suitable for dwelling building. And also avoid the near places to embankment for settlement; if possible, build the dwelling houses minimum five hundred (500 m) meters away from the embankment. If possible, the dwellings may construct on man-made earthen hill, which will help to avoid the flooded situation. During the construction of the dwellings, orientation also very important to fight against the cyclone. If the dwellings are constructed long-winded towards the speed of the storm, then possibility of loss may reduce.

10.3 Engineered structures

Structures need to be built to withstand wind forces. Good site selection is also important. The unstable or Kuccha structures or dwellings are not safe from the cyclone in regular cyclone prone area. The public infrastructures including buildings for electricity services, communication facilities, hospitals, schools, rural healthcare centers and community centers should be engineered structures. The people should also be encouraged to construct engineered structures for their dwellings. These measures need government's intervention in providing building codes and other regulatory framework.

10.4 Retrofitting non-engineered structures

In Sundarban about 38.27% people lives in non-structured dwellings and 50.62% people live in semi-structured dwellings. All dwellings are self-designed non-engineered buildings and unstable houses. The knowledge on how to strengthen non-engineered buildings should be shared with the community. Local engineers and artisans can take part in the construction and retrofitting of the buildings in their locality and demonstrate disaster resistant construction methods to the people.

10.5 Cyclone shelters

Cyclone Shelters are necessary for areas vulnerable to recurrent cyclones. The construction of cyclone shelters requires substantial funding, therefore, generally linked to support from government or external donors. Besides, it also involves technical and engineering components which are usually beyond the capacity of community. For construction of cyclone shelters, the most appropriate sites should be selected, using the Geographical Information System (GIS) method, after a detailed consideration of the density of population, transportation and communication conditions, distance from areas where the cyclones took landfall in the past and the topography of the area. The location of the cyclone shelter should have road links to main routes and to surrounding rural communities so that people can reach the shelters during emergencies without delay. Consideration also needs to be given not only to shelter provision during disasters but to water supply, food storage, shelter for livestock and cattle and basic sanitation facilities. Special emphasis should be placed on the construction of cost-effective buildings. During normal time these buildings can be used as schools or as community centers. In case of cyclones or floods, community can take shelter in these designed buildings.

10.6 Flood management

Flooding will result from a cyclonic storm. Storm surges will flood the coastal areas. Heavy rains will bring in flash floods. Embankments along the rivers, sea walls along the coasts may keep water away from the flood plains. Water flow can be regulated through construction of reservoirs, check dams and alternate drainage channels/routes.

Community people should also take up the following flood mitigation activities:

- Improving drainage system in the area by clearing gutters, drains, creeks and streams of any debris so that they can carry rainwater away quickly and reduce the risk of flooding.
- Raising platforms for flood shelter for human beings and cattle and/or raising the public utility installations above flood levels.
- Elevate shelter on stilts. The shelter floor should be at least 3 feet above the ground.
- Create sufficient drainage under and around the shelter.
- Avoid storing materials under the shelter which may obstruct water drainage.
- Compact solid earth around the footings to avoid standing water.
- An attic should be constructed in the house so that it can act as a safe refuge when flood water rises above the house's floor level. An escape hatch should be included in the attic.

10.7 Improve green pitch

Improvement of the vegetation will increase water infiltration capacity of the soil. The roots of the plants and trees will keep the soil intact and prevent erosion and slow runoff to prevent or reduce flooding. The trees planted in rows will act as a wind breaker. Coastal shelterbelt plantations can be developed to break severe wind speeds as it minimizes devastating effects. There is need for urgent measures like mangrove shelterbelt plantations along cyclone-prone coastal areas. Species chosen for this purpose should not only be able to withstand the impact of strong cyclonic winds, but also keep in check soil erosion.



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10.8 Mangrove plantation

Mangroves protect the coastal area from storm surge and wind which accompanied with cyclones. The tangle of branches slows the flow of water. Community should also participate in the mangrove plantation which could be organized by the local authorities, NGOs or the community itself. Mangroves also help in erosion-control and coastal conservation.

10.9 Public awareness generation

Public awareness through education is the key to saving many lives. It has been proved that most of the damage to lives and livelihoods are due to lack of public education and awareness. These can be done through various public awareness generation strategies. Emphasis should be given on using the existing awareness generation mechanisms in order to make it more acceptable and easily understood. Public awareness can be generated through banners/posters, display boards, skill-based competition programmes in school/public gatherings/group discussions, documentary film/video show, mock drills and simulation exercises, pamphlets, brochures and handouts, song and drama in street plays, poster competition, photos exhibitions, street play and shows on cyclone and other related disasters. At the community level, public awareness programmes should also include interpretation of early warning and proper utilization of early warnings, identify safe shelters and identify safe routes for evacuation and signals to be used for every stage of early warning.

11. Problems

The villagers of Pakhiralaya have several problems, but the following major problems have identified: -

- i. The cyclonic storm is the main problem, which sweep-out the poor structural/non-engineered structural dwelling houses in every cyclonic occasion.
- ii. The storm surge and the associated saline water flooding at the Pakhiralaya village is the most important problem.
- iii. The storm surge and the associated bank erosion is one of the major problems of this area.
- iv. Salinization of agricultural land due to saline water flooding and all type of agricultural practices has stopped for 2-3 years until the neutralization of the soil salinity.
- v. Lack of employment facility at this village as well as the C.D Block Gosaba also a great problem for the citizen.
- vi. Drinking water quality is not adequate level, some time the salinity level of drinking water is more than the adequate level and all over the area the water supply amount is not equal, and somewhere more and somewhere is less.
- vii. There has no multi-specialty hospital in C.D Block Gosaba, the existing health/medical facility is not sufficient for the citizen.
- viii. There has higher educational institution at Gosaba Block. For higher education purpose the students to be compelled to go far away from the village as well as from the Block also.
- ix. Ferry transport service is always a risky way to cross the river Bidyadhari. Lack of alternation the villagers have compelled to accept the ferry service to cross the river.
- x. For lack of job opportunity so many villagers are compelled to accept the life risk job like- honey harvesting and crab fishing from the Sundarban core forest area.

12. Suggestion

- To cope with the cyclonic storm, engineered structural dwelling houses have made with proper orientation.
- To cope with the storm surge flood, the engineered structural building may be built on the manmade earthen hill to avoid the maximum flood height.
- After the saline water flooding, for neutralization of soil salinity level, farmer may practice salinity resistance crops; like- Root bit, Cotton, Burly etc.
- Honey bee cultivation practice and tourism may be most promising job sectors of Gosaba. The local residences may be involved in these two sectors with proper training to solved the job orientation issues.
- Proper mangrove plantation along with the embankment of the rivers and its proper maintenance is the major step to cope with the cyclonic storm and bank erosion.
- To solve the drinking water issues, Govt. may install more water purification station at Gosaba and frequently supply the drinking water over the island.
- To solve the health services issue Govt. may established a Super Specialty Hospital at Gosaba.
- Minimum one higher institution may be established at the island to solve the higher educational problems.
- A concrete bridge over the river Bidyadhari may solve so many problems of the islanders; like- health, education, transport, job etc. issues.



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13. Conclusion

Gosaba is an interior as well as backward rural C.D Block in term of human capitals, social capitals, natural capitals, economic capitals and physical capitals. Most of the islander depends upon the primate type of occupation to maintain their family. The income level of the villagers of the Pakhiralaya is very poor. The house type, health facility, educational status, the transport facilities also very poor at this village. But the village and villagers have the potentiality to improve themselves through using the existing facilities. The honey bee cultivation and tourism industry are the fields where the villagers engaged to improve themselves. If the Govt. take the initiation to build a concrete bridge over the river Bidyadhari then maximum problems will solved normally. So, we hope that the new good and promising time is waiting for them.

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