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Indigenous Adaptation in Household Spatial Pattern to Climate Change: A Case of Narendrapur Village at Kachua, Bagerhat

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ABSTRACT

Climate change has serious impacts on households in the low-elevation rural coastal zone of southwestern Bangladesh. Sea level rise due to changing climate is increasing the rate of saline intrusion as well as enhancing the risk and hazards like flash floods, water logging, water surges, and so on. To find out the existing settlements local adaptation to environmental risk in selected coastal areas in the present and future context in order to identify the key aspects of vulnerability coastal settlement. Formulating local responses in hazard-prone areas to develop adaptation strategies for settlement and household spatial level in the coastal context of Bangladesh. Spatial data prepared by an extensive survey (observation, interview, FGD) based on Mouza Map, is used for analyzing impacts of persistent water logging in homestead by ArcGIS. The outcomes resemble local experiences. Respondent's strategies to drain stagnant water vary with their household types. According to experts, adaptation is the key strategy to alleviate the adverse impacts of changing climate but it is unlikely to be effective without understanding the indigenous knowledge of local inhabitants. Adaptations like installing ponds, canals as dikes, water channelization, or leveling up the plinth are acting as some explications for the vulnerability, which can be further catalyzed by integrating the local indigenous knowledge with proper delicacy.

1. Introduction

The world experiences several calamities on an unprecedented scale. Between 1995 and 2015, there were a series of natural disasters (90 percent), including floods, storms, droughts, and other weather-related disasters (UNISDR, 2015). EM-DAT, the world's foremost international database of such occurrences, recorded 6,457 weather-related disasters (EM-DAT, 2015). During this time period (1995-2015), weather-related disasters killed 606,000 people, an average of 30,000 each year, with an additional 4.1 billion injured, homeless, or in need of emergency help (CRED, 1995–2015). Cyclones and storm surges have had a substantial impact on communities in South and Southeast Asia, the Western Pacific, and the Americas over the last 50 years. These were the worst disasters, accounting for 242,000(40%) of worldwide weather-related deaths, with 89 percent happening in low-income nations (CRED, 2015). The annual economic cost of such disasters has been claimed 14-fold since the 1950s, reaching USD 67 billion (UNISDR, 1995–2015).

Bangladesh has historically been the most vulnerable to natural disasters because to its low-lying deltaic geographical location, which has caused suffering among its people (IPCC, 2014, 2007; WB, 2013; GoB, 2010). The following disasters happened here: flood, cyclone, storm surge, flash flood, drought, and riverbank erosion. According to the United Nations Development Programme (UNDP), Bangladesh is the most vulnerable country to tropical cyclones and the sixth most vulnerable to (BCCSAP, 2009). As a result, making communities more resilient to disasters is critical for reducing vulnerability and threat.

Bangladesh is extremely vulnerable to cyclones, due to its fairly peculiar position and geography, which causes an inverted funnel effect, as well as the low flat terrain, large

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population density, and poorly built dwellings (Agrawala et al., 2003). Strom surges, or abrupt surges of water, are connected with cyclones, as are wind waves. Storm surges, which may wipe away entire islands and coastal communities, cause the majority of damage during a cyclone.

The southern sections of Bangladesh are classified as coastal zones, accounting for 21% of the country's geographical area and being more sensitive to natural disaster impacts than the rest (CZPo, 2005). Coastal and riverine homes in Bangladesh are the effects of climate-related natural disasters such as climatic variability, riverbank erosion, flood, water surge, salinity, and sea level rise (GoB, 2010).

Adaptation in physical infrastructure is an alternate strategy to disaster risk reduction that focuses on vulnerable communities. "It has been argued that designing and constructing a resilient community demands an in-depth understanding of the expertise and knowledge of avoiding and adapting the effects of natural disaster" (Little, 2004). To have a thorough understanding of the scenario, local ecological knowledge should be valued in environmental and climate change management. This study aims to assess the possible repercussions, how individuals are adjusting, and the external assistance required to increase their adaptation skills as a result of climate change.

2. Literature Review

The significant link between perceptions of climatic fluctuation and the adaptation processes has been studied in several countries, including Canada (Bryant et al., 2000), Australia (Wheeler & Von Braun, 2013), Vietnam (Le Dang et al., 2014), and India. In Bangladesh, there has been a study on displacement and the economic consequences of riverbank erosion (Alam et al., 2017).

However, there has been little in-depth empirical research on how resource-poor, hazard-prone households perceive climate change and unpredictability, and how their perspectives are linked to their local adaptive responses. Bangladesh's coastal and riverfront dwellings are the most exposed to natural calamities. According to researchers, local adaptation knowledge is crucial for enhancing the resilience of vulnerable groups (Hiwasaki et al., 2015).

2.1. Spatial pattern of typical rural coastal Households

Bangladesh's traditional rural home shape has evolved as a result of elements such as available land and its qualities, socioeconomic position of the resident, culture, religion, climate, and accessible resources. The basic layout of rural homesteads is introverted, with areas for household usage (Figure 1).

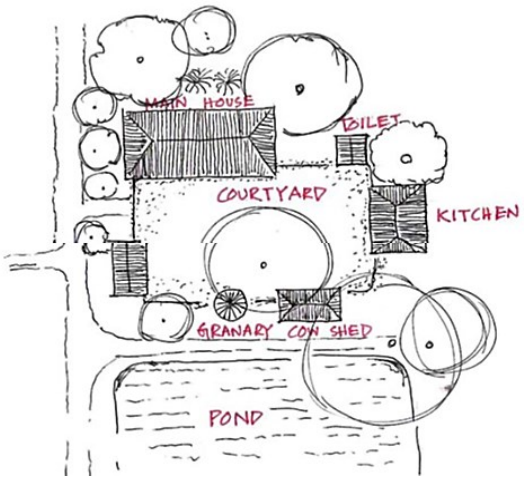

Figure 1: Layout of a typical rural household spatial pattern (Source: Author)

The design has a central courtyard surrounded by tree planting and functional areas. This structure protects the ladies from passers-by while allowing them to complete their home activities. "However, the distinct quality of homesteads is still significant in rural Bangladesh" (Rahman, 2008).

2.2. Indigenous adaptation against disaster vulnerability of household spatial pattern

Resilience and adaptation should be viewed as inherent aspects of disaster risk reduction measures. Physical infrastructure adaptation is an alternate strategy to reduce disaster risk, focusing on the most vulnerable communities is physical infrastructure adaptation. "It has been argued that designing and constructing a resilient community demands an in-depth understanding of the expertise and knowledge of avoiding and adapting the effects of natural disaster" (Little, 2004).

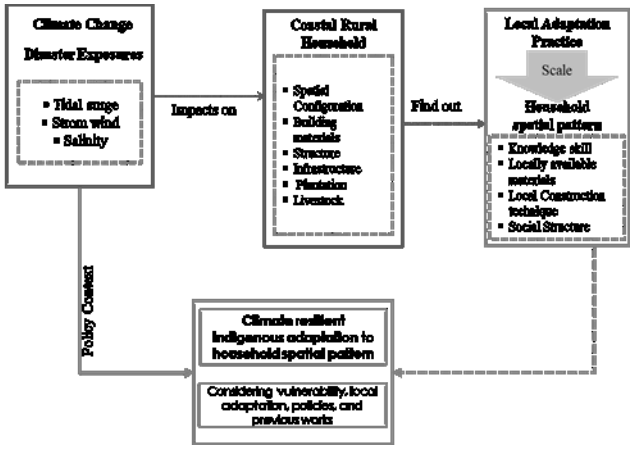

Figure 2 : Theoretical Framework (Source: Author)

3. Aim and Objectives

The primary goal of this study is to investigate the impact of rural coastal homesteads on spatial patterns in southwestern Bangladesh and to propose a local ecological knowledge-based spatial framework in which various homestead adaptation measures are arranged in ways that help homesteads maximize their resilience against climate change. The precise aims in addressing the overall goal of this research are as follows,

- To investigate the effects of climate change on rural coastal homesteading trends.
- Determine local ecological adaptation techniques for making rural coastal homesteads climate change resilient.

4. Study area selection

The study aims to examine climate change's impact on rural families and their adaptation process in Southwest coastal regions. The field research was conducted in Narendropur village, Raripara Union, Kachua Upazilla, Bagerhat District. Climate change-induced changes in land use and livelihood diversification are severe in this region. The effects on household assets, crop agriculture, and fishing are extensive and will last for a long time.

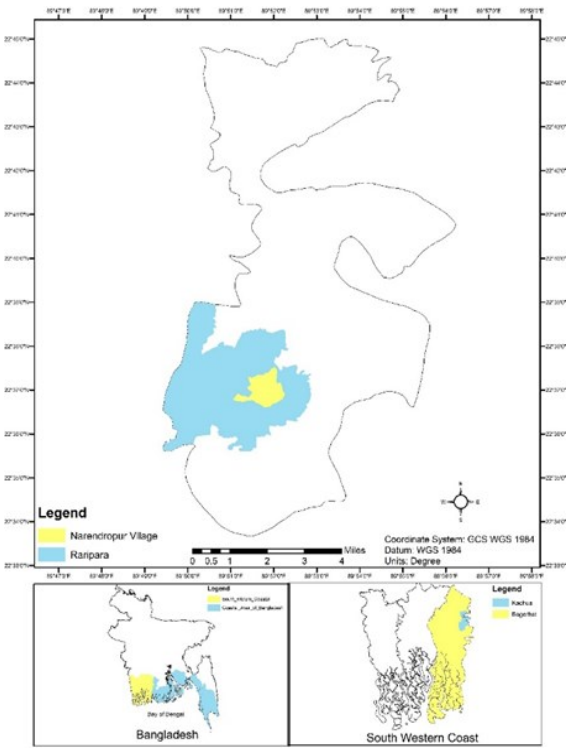

Figure 3: Study area: Narendrapur village southwest coastal zone (Source: Author)

5. Materials and Methods

This study was based on various primary and secondary data collected on the adaption process on Bangladesh's southwest coast. A comprehensive investigation was undertaken in a specific village named 'Narendropur'. For the study, both quantitative and qualitative data were gathered and processed for effect evaluation. Scientific literature, as well as trips to the research region and associated institutions, were used to acquire information.

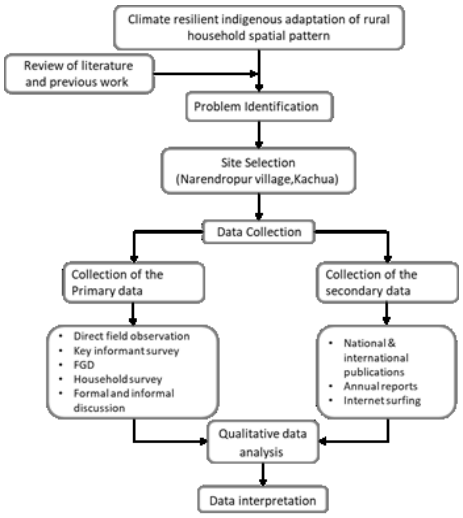

Figure 1: Methodological Framework (Source: Author)

6. Result

6.1. Climate change scenario

Bangladesh's coastline zone is the most sensitive to climate change. The southwest coastal zone has an average elevation of 4 to 5 meters. Its susceptibility to sea level change is exacerbated by its low elevation, active delta, and dynamic topology (Church et al., 2013).

A preliminary digitized map of households was created with the assistance of villagers, indicating the loss of features such as cow houses due to agricultural output losses and diminishing domestic gardens due to saltwater intrusion (Figure 5).

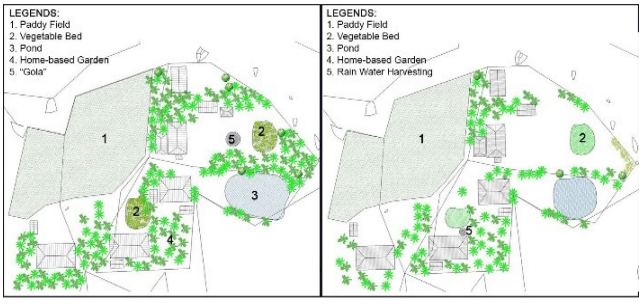

Figure 5: Past and Present Condition of Household Spatial Pattern (Source: Author)

Disconnecting ponds from canals to safeguard pond water from salinity eventually results in a water supply shortfall. The influences of climate change are modifying the household Spatial patterns of village 'Narendropur'.

6.1.1. Saline intrusion

According to the research, the kachua upazilla of Baegrhat district is one of the most severely damaged areas. Although SRDI does not have precise data from Kachua upazila, salinity measured in the Baleshwar river at the Pirojpur Bridge along the Bagerhat-Pirojpur road in June 2019 was 7.1 dS/m, up from 1.34 in 2018. It dropped to 3.2 dS/m in July and 0.42 dS/m in August (Chakrobartty, 2019). According to the research, soil salinity in Bagerhat rose from 2001 to 2009 by 21.42% during a 36-year period on 23000.14 acres of land (SRDI, 2010).

According to the household poll, the majority (79.2%) agreed that salt in land and water was impeding rice crop output. The majority of the peasants and their predecessors (82.4%) were skilled in rice agriculture and cow rearing. Farmers are unable to supply feed for cattle as rice output declines, and around (58%) families lost animals.

Figure 6: Saline Intrusion (Source: Author)

This town was once famed for growing coconut and betel nuts, but production from domestic gardening is gradually declining. Irrigation from salty polluted water and a rise in soil salinity are the primary causes of this issue, according to 10.9% of households who water homestead gardens from ponds. It was discovered that around 76% of settlement areas and homes were in the water shortage zone.

6.1.2. Waterlogging

Narendropur covers around 427 acres and has 355 homes. In July, when rainfall reaches a maximum of 600mm+ in 6m., the elevation of stagnant water increases to 2 ft across 155 acres of land, inundating around 34% of dwellings and a huge quantity of agricultural area. The waterlogging scenario's durability is eroding owing to riverbed siltation and the backwater effect caused by sea-level rise and high tide. Even toward the end of the rainy season (September), when rainfall is lesser (364.4mm in 6m), 43 acres of land are inundated. This problem continues to harm this town by submerging 13 acres of land in the winter (November).

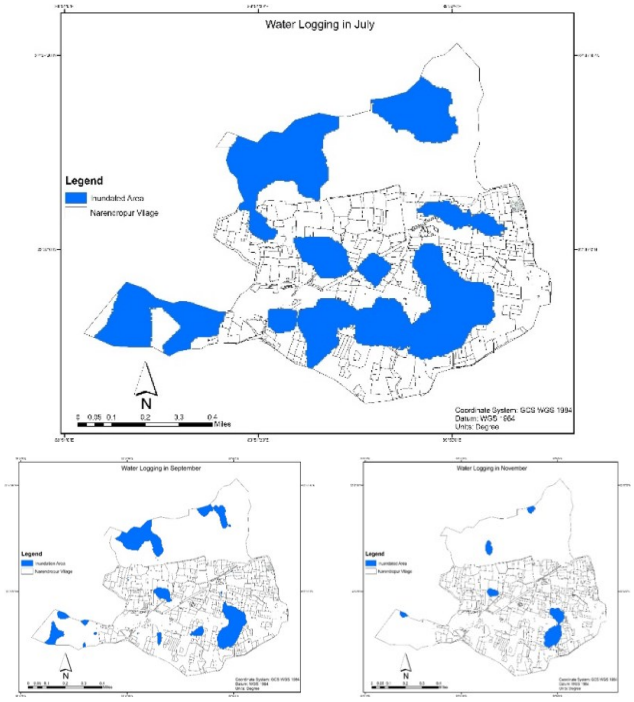

Figure 7: Waterlogging scenario in Narendrapur Village in different seasons (Source: Author)

6.2. Climate change Adaptation in household spatial pattern using indigenous knowledge

The ecological knowledge of adaptation in the community of 'Narendropur' in response to perceived climate change impacts and dangers was examined through a survey of 355 families. Households have become more aware of the effects on their livelihoods and resources, resulting in a greater sense of responsibilities. Families have used a variety of ways to increase resilience, which vary greatly amongst families. Planting new trees, alternate water sources and enhanced water drainage systems are all significant adaptation techniques.

6.2.1. Saline Tolerant Plants Layout

While the possibility of losing a standing crop is acknowledged by the majority, around 2% of families made necessary actions to adjust the circumstances by modifying planting in farmhouse gardens. Currently, salinity-resistant trees such as Ceylon Spinach, Nipa Palm, Sofeda, and others are being planted in household gardens depending on the crop species, growing techniques, soil type, climate, and location.

6.2.2. Alternative water source

During the monsoon, 87% of people utilize rainwater for

drinking, while the rest of the year, they use pond sand filters and protected pond water, and before Aila, Sidr, 51% used protected pond water. Women gather drinking water in 90% of families, and 65% of households directly use water from sources. Approximately 80% of homes have developed infrastructure to use rainwater for cooking during the monsoon, while 60% use pond water throughout the other seasons of the year (Figure 7).

Figure 8: Rainwater harvesting (Source: Author)

6.2.3. Creating a water channel and raising the plinth height

Some homes excavate one or two ponds into which a canal is extended to alleviate waterlogging after heavy rains (Figure 8). Water is poured into it for storage or irrigation of highland household gardens. This method is particularly useful for channeling water during the monsoon season. However, because the volume of water that must be evacuated is significant, this is just a temporary remedy.

Figure 9: Water Channel (Source: Author)

7. Conclusion and Recommendation

A harmonic solution between synthetic and natural settlement components is needed to guarantee the proper operation of coastal settlements in a resilient future setting. It's possible that a typical set of building and planning policies won't provide sufficient instructions for this particular scenario. Additionally, given the unique characteristics of the indigenous settlements established along the coastal belt, more research ought to focus on an in-depth assessment of the sustainability and morphology of manmade habitats. Thorough research must be done to determine the efficacy of any proposed architectural form alterations in terms of socio-cultural, economic, and environmental factors.

Understanding climate change through observation and mass media coverage could help a villager plan for the future and help policymakers implement and support mitigation efforts. Using survey data, the study illustrated local adaptation strategies in connection to rural households' views of climatic dangers and climate change. The outcomes of the poll show that most households believe that severe events and climate changes—most notably salinity and erratic waterlogging in terms of timing and distribution—have a significant impact on families. The negative effects of saline intrusion and waterlogging on their capital of subsistence, which include loss of infrastructure, trees, pond areas, homesteads, land, and poor yields and crops, all of which enhance household vulnerability.

In adaption techniques, there are significant disparities amongst families. Because the domestic garden production environment is rather adverse in saline-prone locations, and locals have ancestral competence in cow farming, livestock husbandry should be supported with adequate governmental assistance. For example, if impoverished households lack capital, government institutions and non-governmental organizations (NGOs) might give people livestock support or financing for owning cattle. They may also provide communities with information like case studies of successful adaptation to motivate them to adopt strategies with the right support, such as technical know-how and credit.

Similarly, targeted governmental interventions are required to support the growth of agro-based industries to create employment opportunities for unskilled agricultural laborers and consequently, lower migration. Developing high-tech solutions tailored to local conditions, particularly in the event of water shortage, is critical for expediting adaptive processes. To expedite the sensible and efficient implementation of adaptation measures across the town, the drainage infrastructure must be strengthened.

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