

## A socio-ecological resilience approach for coastal community: A case of Southkhali, Bagerhat

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### Abstract

Social-ecological resilience derives from systems ecology and is predicated on the notion that complicated, interconnected social-ecological systems exhibit non-linear dynamics of change. This research aims to understand better the connections between ecosystems and human communities, which can help reduce the vulnerability and increase the resilience of these connected systems in coastal areas like Southkhali, Bagerhat. The approach represents a significant paradigm shift from a traditional perspective that focuses on preserving the ability of socio-ecological systems to adjust to uncertainty and improvement, as well as from a perspective that seeks to control change in sustainable systems. After the site visit, we sought to identify and analyse the socio-cultural, economic, and environmental vernacularly as a socio-ecological resilient perspective. The synthesis focused on (1) the design of resilient homes on both environmental and social levels (2) climate responsive layout of community settlement (3) defensive landscape planning (4) a productive homestead system (5) adaptive strategies to anticipate, withstand, and recover from the lasting impacts of coastal disasters. The concluding suggestion gives more latitude for selecting homesteads based on local materials, affordability, and occupation and developing an integrative strategy that includes community participation and ecological awareness.

**Keywords:** *social-ecological resilience; defensive landscape design; southern coastal communities' development; resilient homes; climate responsive layout of the community.*

### 1 Introduction

Bangladesh is one of the seven most vulnerable countries in the world to climate change and weather events like cyclones, floods, and heat waves (Eckstein et al., 2021). This is because of its hydrogeographic location and social and economic conditions. The coastal region of Bangladesh, which stretches 710 km to the Bay of Bengal, is more vulnerable to various calamities because of climate change. The coastal zone of Bangladesh represents around 25% of the country's entire land area (47,201 sq. km) and about 28% of the population (35 million people). It is known as a zone of vulnerabilities as well as opportunities. The coastal area is full of diverse natural resources with a high range of productivity. Notably, six consecutive cyclones in southwest coastal Bangladesh, Sidr (2007), Aila (2009), Fani (2019), Bulbul (2019), Amphan (2020), and Yass (2021), as well as storm surge and coastal flooding, have exacerbated long-term issues for households in this area, such as saline water intrusion, waterlogging, and soil erosion (Shamsuddoha et al., 2013). The livelihood of coastal people primarily depends on agriculture, fishery, livestock, forestry, near-shore transportation, salt farming, etc. Agriculture and fishing are the two familiar drivers of earnings in the coastal zone (Tasnuva et al., 2021). Tropical cyclones, storm surges, high waves, floods, saltwater intrusion, and riverbank erosion all impact Bangladesh's southwest coast. Six consecutive cyclones on Bangladesh's southwest coast, SIDR (2007), AILA (2009), Fani (2019), Bulbul (2019), Amphan (2020), and Yass (2021), as well as storms and coastal flooding, have in particular caused long-term issues for the region's water resilience. Agriculture, fishing, animal husbandry, forestry, coastal transportation, and salt farming are the main sources of income for coastal dwellers. The coastal region's two most well-known economic drivers are agriculture and fishing (Tasnuva et al., 2021).

## 1.1 Literature review

Research into the interaction of nature and society has a long history and a profound legacy. This research group ranges from regional studies to global issues and is open to different interpretations within, between and across the humanities, social sciences and natural sciences. The concept of a socio-ecological system is an interpretation that emerges from this story. Berkes and Folke began using socio-ecological systems as an integrative perspective on humans and nature, associating them with the then-emerging concept of resilience (Holling, 1973). Berkes and Folke point out that "the boundaries between social and natural systems are artificial and arbitrary" from the perspective of socio-ecological systems (Berkes and Folke, 1998). In this concept, social refers to aspects of humans in multiple dimensions, including economic, political, technological, and cultural aspects, while ecological refers to the biosphere, the thin layer of the earth where life resides. Beginning with Baz Holling, he grounded the concept of resilience in studying the dynamics of boreal forest ecosystems with uncertainty, abrupt changes, and renewal cycles (Baz Holling, 1973). Recognizing that ecosystems often have many stable states, Holling sought ways to explain the ability of systems to renew and maintain themselves in the face of disturbance. He explained how a changing system stays stable within critical limits or changes into a new system (Folke et al., 2010). System dynamics is covered in resilience theory, which assumes that ecosystems are always subject to sometimes sudden and unpredictable change. It focuses on ecosystem renewal cycles and destructive events such as fires necessary for ecosystem regeneration before a new cycle of growth and development begins. In a broader sense, resilience refers to the relationship between ecosystems and people as an integrated socio-ecological system, where social systems and ecosystems are seen as connected, interdependent, and co-evolving (Berkes and Folke, 1998). Studies critically examining socio-ecological systems show that they are more than the sum of social and ecological systems. The term 'socio-ecological system' has been used frequently in the resilience literature since around 2000. Explicit consideration of social dimensions is consistent with efforts to address global challenges. Indeed, social and economic factors often contribute to rapid and unexpected change. The basic tenet is that there is no balance in nature, only imbalances or multiple equilibrium states, unpredictable systems, and constant cycles of change and renewal. Maintaining diversity and redundancy, managing connectivity, managing slow variables and feedback, encouraging thinking in complex adaptive systems, encouraging learning, enhancing participation, and encouraging polycentric governance are all critical social aspects facing society. It is part of a recently proposed principle for enhancing the resilience of ecosystem systems. of change. There are no quick fixes to building resilience. Before implementing such ideas, it is essential to carefully assess who may win and who may lose to prevent the perpetuation or widening of existing inequalities (Biggs et al., 2015).

## 1.2 Research objectives

In the face of increasing environmental challenges and social complexities, understanding the resilience of socio-ecological systems becomes crucial for sustainable development and effective policy-making. The primary objective of this study is to analyse the socio-ecological resilience of the coastal communities in southern Bangladesh:

1. Evaluate the ecological resilience of natural ecosystems within the region.
2. What conceptual framework describes the dynamics and interactions between social systems and ecosystems?
3. Assessing the social resilience of communities and their adaptive capacity involves identifying interconnections and feedback mechanisms between ecological and social components of the system.

## 2 Materials and methods

The research was structured into two main phases to achieve its research objectives.

Phase I: Vulnerability assessment and settlement analysis

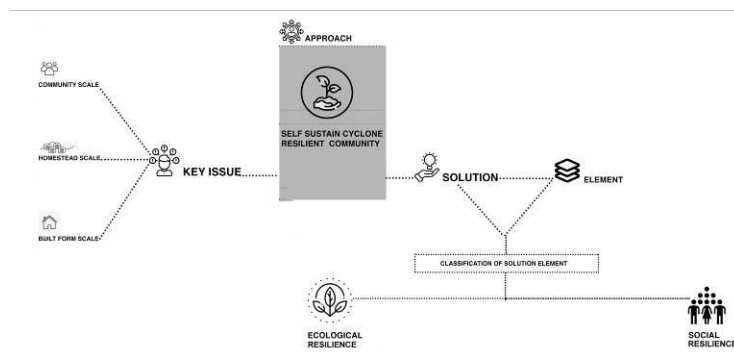
In this phase, assessed the vulnerabilities of the target community or region to various socio-ecological challenges. A physical survey was conducted 2023 in a highly remote coastal village named Southkhali, Bagerhat. The settlement zone, its surroundings, landscape, and agricultural and salt fields were meticulously studied during the survey. This could include identifying environmental threats, climate change impacts, social disparities, economic issues, and other factors that affect the community's overall resilience. The settlement analysis would involve studying the community's infrastructure and urban planning. This could include evaluating the layout of buildings, access to essential services like water, sanitation, healthcare, education, transportation, and the overall quality of life within the community.

Phase II: Architectural synthesis and propositions for achieving socio-ecological resilience

In this phase, likely used the vulnerability assessment and settlement analysis findings to propose architectural and urban planning interventions. The aim would be to create a resilient community that can withstand and adapt to various socio-ecological stressors while promoting self-sustainability.

### 3 Theoretical frameworks for architectural synthesis

Participatory and integrative strategies for architectural integration were selected based on interviews with concerned residents and on theoretical frameworks proposed by Fien, Charlesworth, Lee, Morris, Baker and Grice (Fien et al., 2008). The authors developed a circular approach with his six dimensions of interconnected sustainability as a basic framework for indigenous housing construction (Fien et al., 2008). Then conceptualisation of the interaction between the social and ecological systems and their dynamics to characterise



how frameworks conceptualise the interaction between the social system (S), and the ecological system (E). We followed the classification used by Scholz and Binder (Scholz et al., 2011). The framework adopted incorporates healthy lifestyle, environment, culture, engineering, community and economic sustainability in the community zone, followed by cluster design and individual building form design (Sohaana and Rahma, 2011).

Figure 1. The theoretical framework of the research.

### 4 Geographical and community profile of the study area

Southkhali is a historic Union located in Sarankhola Upazila, within the Bagerhat district of Bangladesh. Its establishment predates 1948 when Bangladesh was under British rule. "Southkhali" originates from the "khali," meaning vacant, as the southern part of the Union is mainly uninhabited. Situated in the southernmost part of the country, Southkhali is approximately 25 km from the Upazila headquarter of Sarankhola and 100 km from the district HQ.

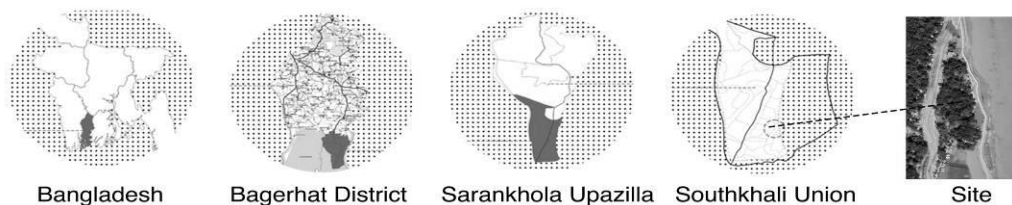


Figure 2. Geographic profile and location of the community.



Most families (58%) have 4-5 members, while the least common group is families with more than 5 members (14%). The most common monthly income range is 4000-6000 taka (42%), followed closely by 6000-10000 taka (35%). Regarding monthly expenditure, the largest group of families (43%) spends 5000-6000 taka. Most of the population (75%) is engaged in fishing, while the remaining 25% work as day

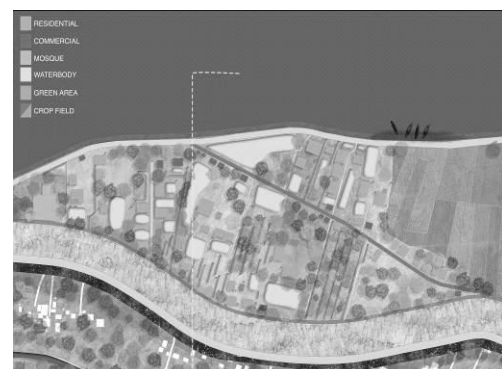
labourers.

Figure 3. Demographic profile of the community.

#### 4.1 Settlement analysis and vulnerability

Existing settlements in the coastal village studied are scattered throughout the area. Professions have identified two specific types of communities. The two leading establishments are the fishing community and the daily labour community. Their organisations' is assessed at two scales – macro (collective) and micro (individual).

macro assessment: Unplanned drainage system makes the drainage system inefficient. In the community, there is no economic stability. Due to bad conditions, evacuation routes are unsafe and have less

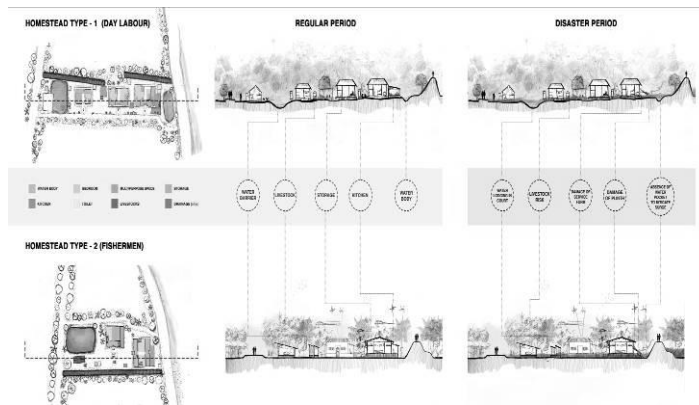


routes are unsafe and have less

Figure 4. Macro-scale mapping of the existing settlements

buffer space. The neighbourhood is facing a severe shortage of drinking water. Although there is only one tornado shelter in the evacuation zone of the settlement, there are no facilities for people with disabilities. Overall, there is no collective or collective effort to protect against natural disasters.  
micro (individual) assessment:

Table 1. Vulnerability assessment



	Homestead Type 1	Homestead Type 2
<b>Settlement type and location</b>	Linear	Scattered
<b>Occupation</b>	day labour	Fishermen
<b>Economic vulnerability</b>	Very poor	Poor
<b>Disaster vulnerability</b>	Extremely vulnerable	Vulnerable
<b>Structural vulnerability</b>	Exposed walls, fragile materials	core house relatively safe

Figure 5. Vulnerability assessment of two types homestead.

## 4.2 Identification of key challenges

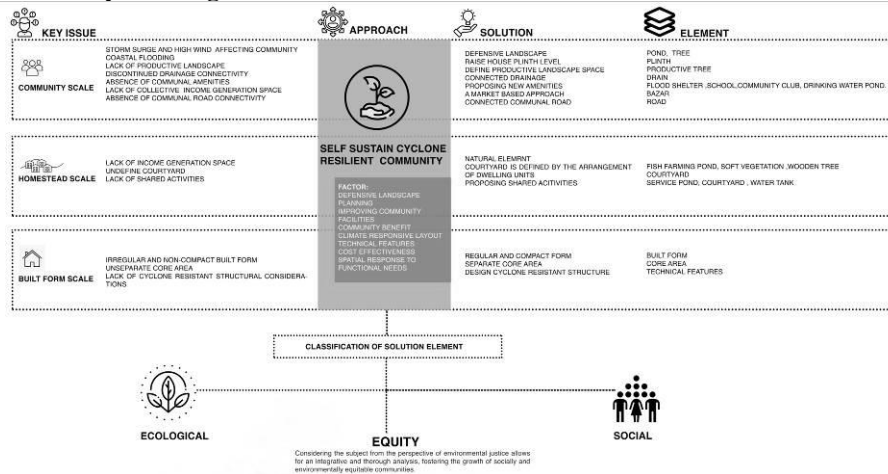


Figure 6. Key challenges and their architectural interventions.

## 5 Architectural Synthesis

The landscape master plan, cluster development, and resilient homestead constituted the architectural synthesis of social, environmental, and economic interventions. The lifestyle, adaptability, and post-disaster recovery of coastal inhabitants were considered to increase resilience.

### 5.1 Resilient Homestead

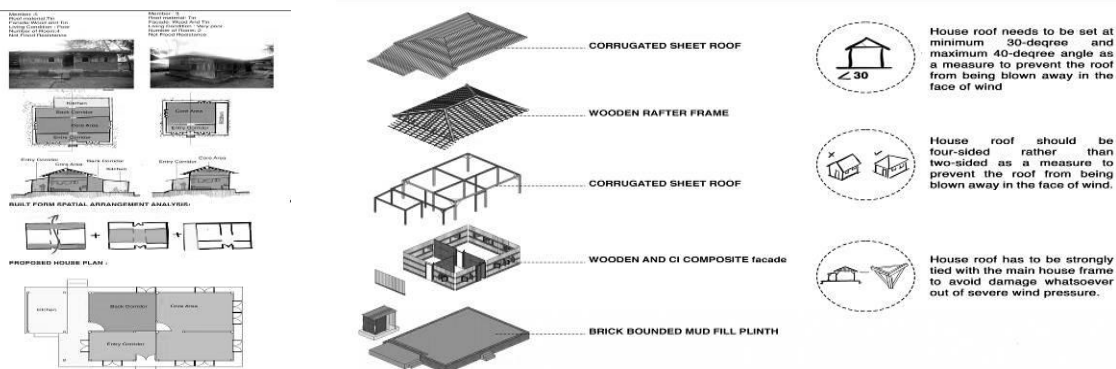


Figure 7. Proposed homestead modules, Construction phases and structural materials

### 5.2 Defensive landscape planning

The objective of defensive landscape planning is to develop strategies that protect communities, infrastructure, and natural ecosystems from the impacts of these coastal hazards while promoting sustainable development.

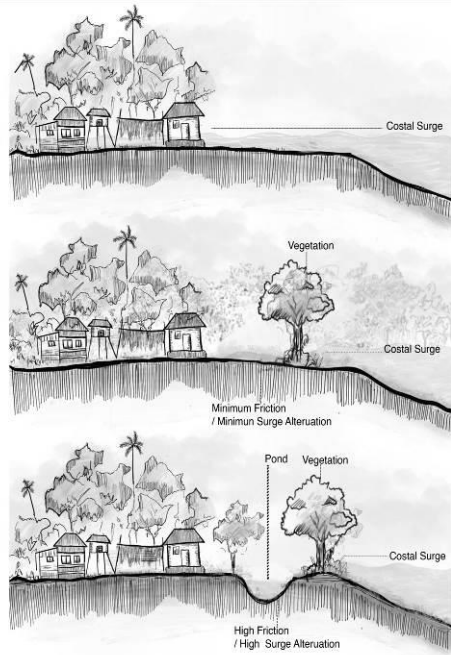


Figure 8. Defensive Landscape Step by Step

### 5.3 Sharing Configuration

In this configuration, multiple houses share a typical pond in a homestead setting. There is also a Shared Service zone and Backyard Activities area, which likely refers to a designated common area where residents from all houses can come together for social gatherings, events, or community activities. The shared drainage system within different homesteads suggests that the houses are interconnected through a shared drainage network. Overall, this configuration promotes a sense of community and cooperation among the residents. It allows them to share resources, engage in communal activities, and maintain a functional drainage system for the homestead, creating a harmonious living environment.



Figure 9. Sharing Configuration activity

### 5.4 Proposed Community Plan

A thorough landscape plan for the community was created, including a road system, emergency evacuation strategy, vegetation, drainage, and drainage. To offer the greatest level of protection against cyclonic wind, three-layered landscapes were created by the coastal plantation rules. Planting large windbreaker trees on either side of the embankment was suggested to spread the wind pressure in the outer layer. Between the housing complexes, outlying highways, and agricultural land, there would be a middle-layer plantation that would offer additional security. Low-growing inner-layer vegetation would be planted around the homesteads for economic and privacy reasons. Around houses and agricultural fields, a drainage system was created. In order to keep the community from flooding, it was situated next to the existing canal and further connected to the river with a sluice gate.



Figure 10. Proposed Community Plan

## 6 Conclusion

According to two sections of the report, coastal communities in southern Bangladesh will reduce vulnerability, build resilience and promote self-sufficiency through socio-environmentally resilient housing design, defensive landscape planning and community development. It is possible. One addresses ecological resilience, and the other social resilience. This integrative design approach could potentially be used by other vulnerable communities in similar situations to adapt to their environment and achieve self-reliance.

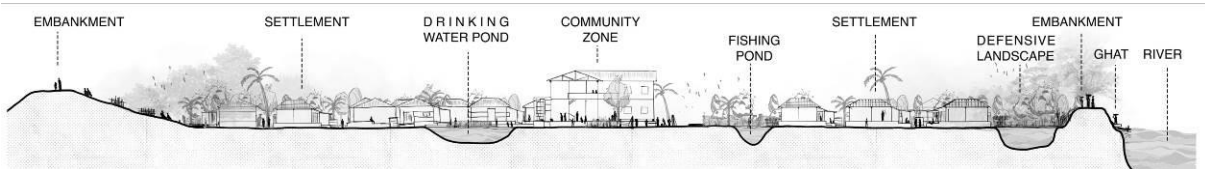


Figure 11. ecological resilience section



Figure 12. social resilience section

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