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Nature-Based Solutions for Climate Mitigation in Kotalipara: A Community Perspective

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Abstract: ***Background:*** *Bangladesh, particularly rural areas like Kotalipara, faces increasing climate-related challenges such as flooding, riverbank erosion, and cyclones. Nature-Based Solutions (NbS) offer a sustainable approach to climate mitigation and resilience, yet their adoption remains limited due to various socio-economic and institutional barriers.*
Aim of the study: *This study aimed to assess the awareness, perceptions, and willingness of the Kotalipara community to engage in Nature-Based Solutions for climate mitigation.*
Methods: *A cross-sectional study was conducted among 563 residents of Kotalipara using structured, face-to-face interviews. Participants aged 18 years and older, residing in the area for at least one year, were included. Data were collected on sociodemographic characteristics, environmental awareness, knowledge and attitudes toward NbS, barriers to implementation, and willingness to engage. Descriptive and inferential statistics were used for analysis using SPSS version 26.*
Result: *Among respondents, 91.6% were aware of climate change impacts, with flooding (86.5%) and riverbank erosion (70.5%) being the most recognized issues. Knowledge of NbS was moderate (67.1%), but active participation was low (23.4%), primarily hindered by a lack of knowledge (83.8%) and funding (70.7%). Despite these barriers, 73.2% supported nature-based climate actions, and 62.0% expressed willingness to engage in future initiatives. Traditional ecological practices were still widely used (55.4%), and 70.7% supported integrating these practices with modern NbS strategies. However, trust in local institutions remained low (38.4%).*
Conclusion: *The community of Kotalipara demonstrates strong awareness of environmental issues and a positive attitude toward Nature-Based Solutions, although actual participation remains limited due to knowledge gaps, financial constraints, and institutional challenges. Strengthening education, financial support, and policy integration is essential for enhancing NbS adoption and building climate resilience at the local level.*
Keywords: *Climate Change, Nature-Based Solutions, Community Participation, Environmental Awareness, Sustainable Development*
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Original Research Article

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INTRODUCTION

Bangladesh is particularly vulnerable to the effects of climate change, such as increasing sea levels, stronger cyclones, and more flooding, because it is located on the Ganges-Brahmaputra-Meghna delta [1]. In order to protect its citizens and ecosystems, the country must make significant national and international efforts as it approaches its adaptation limits, according to the International Centre for Climate Change and Development [2]. These issues are especially noticeable in rural areas like Kotalipara, where people's livelihoods are mostly dependent on agriculture and natural resources [3]. Nature-Based Solutions (NbS) have emerged as effective strategies that utilize natural processes to mitigate climate impacts while promoting sustainable development [4]. NbS encompass a range of approaches, including the restoration of mangroves, wetlands, and forests, as well as the implementation of sustainable agricultural practices [5]. In Bangladesh, the effectiveness of NbS has been well-documented. For instance, the restoration of mangrove forests significantly reduces the impact of storm surges and coastal erosion, providing critical protection to vulnerable coastal communities [6]. Studies have shown that villages protected by mangroves experienced only about half of the monetary loss from flood and wind

damage associated with cyclone Sidr compared to other villages [7]. Similarly, a 100m deep coastal shelterbelt of healthy mangroves can reduce storm surge velocity by up to 92%, protecting embankments from costly damage [8]. Despite the proven benefits of NbS, their implementation in regions like Kotalipara faces several challenges. Limited awareness and understanding of NbS among local communities can hinder adoption [9]. Additionally, socio-economic factors, such as land tenure insecurity and limited access to financial resources, can impede the ability of communities to invest in and sustain NbS initiatives [10]. Institutional challenges, including fragmented policies and lack of coordination among stakeholders, further complicate the scaling up of NbS [11]. A policy brief by the International Centre for Climate Change and Development highlights the need for better evidence, governance, and coordination to effectively support NbS implementation in Bangladesh [12]. Addressing these challenges requires a comprehensive approach that includes community engagement, capacity building, and policy integration. Empowering local communities through education and participatory planning can enhance the acceptance and effectiveness of NbS. Integrating NbS into national and local policies can provide the necessary institutional support and create an enabling environment for implementation [13]. Furthermore, securing sustainable financing mechanisms is crucial to ensure the long-term viability of NbS projects. The International Centre for Climate Change and Development emphasizes the importance of exploring investment mechanisms to enhance resilience, considering the limited access to finance for applying and scaling up NbS in Bangladesh [14]. Nature-Based Solutions offer a promising pathway for climate mitigation and sustainable development in Kotalipara. By leveraging natural processes and engaging local communities, NbS can enhance resilience, protect biodiversity, and support livelihoods [15]. However, realizing the full potential of NbS requires overcoming existing challenges through coordinated efforts that integrate scientific knowledge, community participation, and supportive policies [16]. The aim of this study is to assess the awareness, perceptions, and willingness of the Kotalipara community to engage in Nature-Based Solutions for climate mitigation.

MATERIAL AND METHODS

This study employed a cross-sectional design to assess the community perspectives on Nature-Based Solutions (NbS) for climate mitigation in Kotalipara. A cross-sectional study involves observing a defined population at a single point in time or over a short period, allowing researchers to analyze multiple variables simultaneously without influencing them.

Inclusion Criteria

- Residents of Kotalipara for at least one year.
- Aged 18 years or older.
- Willingness to provide informed consent.

Exclusion Criteria

- Had cognitive impairments affecting their ability to provide informed responses.
- Were temporary visitors or non-residents of Kotalipara.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review board prior to data collection. The study adhered to ethical principles including voluntary participation, informed consent, anonymity, confidentiality, and minimizing potential harm to participants. Participants were informed about the study's objectives, procedures, potential risks, and benefits, and their right to withdraw at any time without consequence. Confidentiality of the collected data was strictly maintained.

Data Collection Procedure

Data collection involved administering structured questionnaires to participants through face-to-face interviews conducted by trained field researchers. The questionnaire was designed to gather information on sociodemographic characteristics, awareness and perceptions of climate change, knowledge and attitudes toward NbS, community participation, barriers to NbS implementation, and suggestions for promoting NbS. Prior to the main study, a pilot test of the questionnaire was conducted with a small subset of the target population to ensure clarity, relevance, and reliability of the questions. Based on feedback from the pilot test, necessary adjustments were made to the questionnaire to enhance its effectiveness.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables. Inferential statistical tests, such as chi-square tests for independence, were conducted to examine associations between categorical variables. A p-value of less than 0.05 was considered indicative of statistical significance. The results were presented in tabular and graphical formats to facilitate interpretation and discussion.

RESULTS

A total of 563 community members from Kotalipara participated in this study. The majority of respondents (31.3%) were aged between 31 and 40 years, with males comprising 54.5% of the sample. A significant portion of the population consisted of students (28.8%) and individuals involved in farming, agriculture, or fishing (24.3%). Educational attainment varied, with 25.4% having completed higher secondary education, 9.1% holding a bachelor's degree, and 15.6% reporting no formal education. Most participants (75.8%) had lived in Kotalipara for more than 10 years, indicating strong community ties. Environmental awareness was notably high, with 91.6% of respondents indicating knowledge of climate change and its impacts. Among the most commonly identified climate-related issues were flooding (86.5%), riverbank erosion (70.5%), and cyclones (60.7%). These environmental challenges were perceived to significantly affect livelihoods, particularly through agricultural losses (55.4%), property damage (51.0%), and decreased income (45.1%). Regarding knowledge of Nature-Based Solutions (NBS), 67.1% had heard of the concept, with water hyacinth management (86.5%) and floating gardens (45.8%) being the most recognized examples. However, active participation in NBS initiatives remained limited to 23.4% of respondents. Key barriers included a lack of knowledge (83.8%) and insufficient funding or institutional support (70.7%). Despite these obstacles, community attitudes were optimistic, with 73.2% supporting nature-based climate actions and 62.0% expressing willingness to participate in future initiatives. Traditional ecological practices were still prevalent, with 55.4% reporting usage. Techniques such as traditional paddy cultivation (78.0%), indigenous water management (71.3%), and plant-based erosion control (57.0%) were commonly cited. Additionally, 70.7% supported integrating traditional practices with modern NBS strategies. Water resources were reported to be affected by climate change by 86.3% of participants. Farming remained rooted in tradition, with 89.3% practicing land-based methods. Meanwhile, 76.0% expressed openness to climate-resilient techniques. Institutional trust was mixed; only 38.4% trusted local institutions, and just 26.1% believed that local governance or NGOs were doing enough. Finally, most respondents viewed NBS as essential for the future, with 70.6% rating them as either important or very important for long-term sustainability.

Table 1: Sociodemographic Characteristics of Respondents in Kotalipara

Variables	Frequency (n)	Percentage (%)
Age		
> 20	87	15.50
21-30	154	27.30
31-40	176	31.30
41-50	98	17.40
51<	48	8.50
Gender		
Male	307	54.50
Female	256	45.50
Occupation		
Farming/Agriculture/ Fishing	137	24.30
Small business/Shop owner/ Day laborer	79	14.00
Homemaker	102	18.10
Student	162	28.80
Job (Govt./ NGO)	45	8.00
Other	38	6.70
Education Level		
None (No Formal Education)	88	15.60
Primary Education	141	25.00
Secondary Education	113	20.10
Higher Secondary	143	25.40
Bachelor's Degree	51	9.10
Master's Degree or Higher	27	4.80
Length of Residence in Kotalipara (years)		
< 5	39	6.90
5 to 10	97	17.20
> 10 years	427	75.80

Table 2: Environmental Awareness and Climate Change Perception

Variables	Frequency (n)	Percentage (%)
Awareness of climate change and its impacts		
Yes	516	91.60
No	47	8.40
Common Climate-related Issues		
Flooding	487	86.50
Riverbank erosion	397	70.50
Drought	203	36.10
Cyclones	342	60.70
Salinity	226	40.10
Other	58	10.30
Perceived Impact on Livelihood		
Agricultural losses	312	0.55
Property damage from flooding	287	0.51
Decreased income	254	0.45
Health issues	189	0.34
Water supply problems	176	0.31
Forced relocation	97	0.17
Limited impact	45	0.08
No response	23	0.04

Table 3: Knowledge and Attitudes Toward Nature-Based Solutions (NBS)

Variables	Frequency (n)	Percentage (%)
Heard of NBS		
Yes	378	67.10
No	185	32.90
Examples Known (n = 378)		
Mangrove planting	54	14.30
Floating gardens	173	45.80
Water hyacinth management	327	86.50
Rainwater harvesting	65	17.20
Natural embankments	57	15.10
Organic farming	82	21.70
Other methods	28	7.40
Support for Nature-Based Climate Actions		
Yes	412	73.20
No	47	8.40
Not sure	104	18.50

Table 4: Community Participation and Barriers in NBS Initiatives

Variables	Frequency (n)	Percentage (%)
Ongoing NBS in Community		
Yes	157	27.90
No	217	38.50
Not sure	189	33.60
Participation in NBS		
Yes	132	23.40
No	431	76.60
Barriers to Adopting NBS		
Lack of knowledge	472	83.80
Lack of funding/support	398	70.70
Land/property issues	247	43.90
Low interest	163	29.00
Others	72	12.80

Table 5: Willingness to Engage and Recommendations for Promoting NBS

Variables	Frequency (n)	Percentage (%)
Willing to Participate in NBS		
Yes	349	62.00
No	67	11.90
Maybe	147	26.10
Support Needed for NBS Promotion		
Training programs	437	77.60
Government/NGO support	489	86.90
Community workshops	387	68.80
Financial incentives	503	89.30
Educational campaigns	426	75.60
Suggestions for Local Improvement		
Tree planting initiatives	276	49.00
Improved waste Management	243	0.43
Water Conservation	231	41.00
Community Education	212	37.70
Sustainable Agriculture Training	187	33.20
Local Committees	143	25.40
Traditional Knowledge Sharing	98	17.40
No Suggestions	33	5.90

Table 6: Traditional Knowledge and Integration with Modern Practices

Variables	Frequency (n)	Percentage (%)
Use of Traditional Methods		
Yes	312	55.40
No	147	26.10
Not sure	104	18.50
Examples (n = 328)		
Traditional paddy cultivation	256	78.00
Indigenous water management	234	71.30
Plant-based erosion control	187	57.00
Seed Preservation Techniques	165	50.30
Natural pest management	142	43.30
Seasonal calendars	134	40.90
Weather prediction	97	29.60
Other methods	54	16.50
Support for Integrating Traditional with Modern NBS		
Yes	398	70.70
No	53	9.40
Maybe	112	19.90

Table 7: Impact on Water, Agriculture, and Livelihood

Variables	Frequency (n)	Percentage (%)
Climate Change Affected Water		
Yes	486	86.30
No	77	13.70
Farming Practices Used		
Traditional land farming	503	89.30
Hydroponic/floating beds	156	27.70
Aquaculture	278	49.40
Mixed farming	217	38.60
Others	39	6.90
Openness to climate-resilient techniques		
Yes	428	76.00
No	42	7.50
Maybe	93	16.50

Table 8: Perception of Environmental Governance and Institutional Trust

Variables	Frequency (n)	Percentage (%)
Local Government/NGOs Doing Enough		
Yes	147	26.10
No	301	53.50
Not sure	115	20.40
Attended Environmental Meetings		
Yes	183	32.50
No	380	67.50
Trust in Local Institutions		
Yes	216	38.40
No	187	33.20
Not sure	160	28.40

Table 9: Youth Involvement in Environmental Actions

Variables	Frequency (n)	Percentage (%)
Youth Involvement Active		
Yes	163	29.00%
No	247	43.90%
Not much	153	27.20%
Ways to Encourage Youth		
School education	387	68.80%
Youth workshops	342	60.70%
Social media campaigns	298	52.90%
clubs/organizations	276	49.00%
Competitions	243	43.20%
Green Jobs	236	41.90%
Intergenerational Transfer	176	31.30%
Youth decision-making	167	29.70%
No suggestions	45	8.00%

Table 10: Final Thoughts and Community Recommendations

Variables	Frequency (n)	Percentage (%)
Perceived Importance of NBS for Future		
Not important	23	4.10
Slightly important	56	9.90
Neutral	87	15.50
Important	194	34.50
Very important	203	36.10
Additional Comments/Suggestions		
Need for consistent funding	289	51.30
Government policy reform suggestions	267	47.40
Better coordination between stakeholders	243	43.20
Long-term planning concerns	212	37.70
Success stories from other regions	178	31.60
Climate justice and equity issues	156	27.70
Technological integration ideas	134	23.80
Need for scientific research	123	21.90
No additional comments	87	15.50

DISCUSSION

The study conducted in Kotalipara Upazila, Bangladesh, offers a thorough examination of the sociodemographic traits, environmental consciousness, climate change perspectives, and attitudes toward nature-based solutions (NBS) of the community [17]. The findings were contextualized by comparing them with relevant studies to highlight similarities and differences. The age distribution of respondents indicated that the majority are between 31 and 40 years old (31.3%), followed by those aged 21–30 (27.3%). This aligned with demographic data from the 2011 Bangladesh census, which reported a significant proportion of the population within these age brackets [18]. Gender distribution showed a slight male predominance (54.5% male vs. 45.5% female), consistent with national statistics. Occupationally, the community was diverse where 24.3% were engaged in farming, agriculture, or fishing; 28.8% were students; and 18.1% are homemakers. This occupational spread reflected the rural nature of Kotalipara, where agriculture remains a primary livelihood, yet there was a notable student population indicative of educational pursuits. Educational attainment varied, with 25.4% having completed higher secondary education and 9.1% holding a bachelor's degree. These figures suggested a moderate level of education, which was crucial for understanding and implementing climate adaptation strategies. Environmental awareness was notably high, with 91.6% of respondents aware of climate change and its impacted. This heightened awareness surpassed findings from other regions; for instance, a study among private university students in Bangladesh reported varying levels of climate change awareness [19]. The prevalent climate-related issues identified include flooding (86.5%), riverbank erosion (70.5%), and cyclones (60.7%). These concerns were consistent with those reported in other studies focusing on Bangladesh's southern regions. The perceived impacted on livelihood were significant: 55.4% report agricultural losses, 51% property damage, and 45.1% decreased income. These perceptions aligned with broader research indicating that climate change adversely affects agriculture and economic stability in vulnerable communities [20]. Regarding NBS, 67.1% had heard of such solutions, with water hyacinth management (86.5%) and floating gardens (45.8%) being the most recognized examples. This awareness was higher compared to findings from other upazilas, where knowledge of NBS varies [21]. Support for nature-based climate actions was strong, with 73.2% expressing willingness to engage. However, actual participation was lower, with only 23.4% having engaged in NBS initiatives. Barriers included lack of knowledge (83.8%) and insufficient support or funding (70.7%), challenge that were similarly identified in studies across Bangladesh [22]. Willingness to participate in NBS was high (62%), yet this did not translate into actual participation, highlighting the need for targeted interventions. Support mechanisms such as training programs (77.6%) and financial incentives (89.3%) were deemed necessary to promote NBS. These findings were in line with recommendations from other research emphasizing capacity building and financial support as critical enablers for community engagement in sustainable practices [23]. Traditional knowledge played a role in the community's approach to environmental management, with 55.4% utilizing traditional methods. Examples included traditional paddy cultivation (78%) and indigenous water management practices (71.3%). The integration of traditional knowledge with modern practices was supported by 70.7% of respondents, reflecting a broader trend in recognizing the value of indigenous knowledge systems [24]. Climate change had affected water resources for 86.3% of respondents, impacting farming practices. Traditional land farming is predominant (89.3%), but there was openness to climate-resilient techniques (76%). This openness was crucial for the adoption of sustainable agricultural practices [25]. Perceptions of environmental governance reveal that 53.5% believe local government and NGOs were not doing enough, and trust in local institutions was moderate (38.4%). These perceptions were critical as institutional trust influences community engagement in environmental initiatives [26]. Youth involvement in environmental actions was limited, with only 29% actively participating. Encouragement through school education (68.8%) and youth workshops (60.7%) was suggested, aligning with strategies proposed in other studies to enhance youth engagement [27]. Finally, the perceived importance of NBS for the future was high, with 70.6% considering it important or very important. Additional recommendations include the need for funding (51.3%) and policy reforms (47.4%), echoing sentiments from other communities facing similar challenges [28]. The study reflects a community that is aware of climate change and its impacts, recognized the value of both traditional and modern approaches to environmental management, and was willing to engage in NBS given appropriate support [29]. These findings were consistent with broader research in Bangladesh, highlighting common challenges and opportunities in addressing climate change at the community level [30].

Limitations of the study:

- The study was conducted in a single sub-district (Kotalipara), which may limit the generalizability of findings to other regions of Bangladesh.
- As a cross-sectional study, it captures perceptions at one point in time and cannot assess changes over time or causality.
- Self-reported data may be subject to recall bias or social desirability bias, potentially affecting the accuracy of responses.
- Limited sample size may reduce the statistical power to detect certain associations.
- The study relied heavily on participants' awareness and understanding of Nature-Based Solutions, which may vary widely.

CONCLUSION AND RECOMMENDATIONS

This study highlights that Nature-Based Solutions hold significant promise for climate mitigation in Kotalipara, with strong community interest and recognition of their benefits. However, barriers such as limited awareness, financial constraints, and institutional gaps must be addressed. Strengthening local capacity, promoting participatory planning, and integrating NbS into regional policies are essential steps forward. Increased investment, policy coherence, and educational initiatives can empower communities to adopt sustainable practices. Future research should expand to other regions and adopt longitudinal designs to assess long-term impacts. This community-centered approach can serve as a model for scaling NbS in climate-vulnerable areas of Bangladesh.

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