



Climate-security nexus in the Indian Sundarbans: Emerging environmental risks, livelihood vulnerability and resilience in South 24 Parganas, West Bengal

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Abstract

Climate change is increasingly transforming environmental degradation from an ecological concern into a multidimensional security challenge. This is particularly evident in the Indian Sundarbans, where rising climatic pressures intersect with fragile deltaic ecosystems, livelihood dependence, poverty, population vulnerability and strategic coastal considerations. South 24 Parganas, which contains a substantial part of the Indian Sundarbans, is exposed to cyclones, tidal flooding, coastal erosion, saline-water intrusion, sea-level rise and ecosystem degradation. Recent government assessments identify the coastal districts of West Bengal, including South 24 Parganas, as particularly vulnerable to cyclones and flooding. The district administration has also introduced a District Environment Plan 2025, demonstrating the increasing institutional emphasis on environmental management. This article examines the emerging climate-security nexus in South 24 Parganas through the interconnected dimensions of environmental security, human security, livelihood resilience and coastal governance. It analyses how climatic hazards affect agriculture, fisheries, freshwater availability, public infrastructure, migration and vulnerable households. The article further examines the role of mangrove ecosystems as natural protective infrastructure and evaluates the importance of integrated coastal-zone management, early-warning systems, ecosystem restoration and livelihood diversification. Recent initiatives concerning climate-resilient livelihoods and community-based adaptation are also considered. The article argues that environmental security in South 24 Parganas requires a shift from disaster-response-oriented governance towards anticipatory, ecosystem-based and community-centered resilience planning. Strengthening cooperation among government institutions, scientific organisations, local communities and civil society is essential for protecting both ecological integrity and human security in the Indian Sundarbans.

Keywords: Climate-security nexus, environmental security, South 24 Parganas, Indian Sundarbans, coastal vulnerability, human security, disaster risk reduction

Introduction

Climate change has become one of the most significant environmental and security challenges confronting India in the twenty-first century. Its consequences are no longer confined to changes in temperature or rainfall; they increasingly influence food security, water availability, public health, livelihoods, migration, infrastructure and disaster vulnerability. The security implications become particularly pronounced in low-lying coastal and deltaic regions where environmental hazards interact with social and economic vulnerabilities. South 24 Parganas represents one of India's most important examples of this emerging climate-security nexus. The district extends from the metropolitan environment of Kolkata to remote riverine and coastal settlements along the Bay of Bengal. According to the district administration, 84% of the population lives in rural areas, while the Sundarbans extends across thirteen of the district's twenty-nine development blocks. The administration identifies recurrent cyclonic storms and breaches of earthen embankments as continuing threats to life, agriculture and property.

The environmental significance of the district is inseparable from the Sundarbans,

a globally important mangrove ecosystem distributed across India and Bangladesh. The region functions simultaneously as a biodiversity reserve, a livelihood base and a natural protective system against coastal hazards. However, its ecological functions are increasingly pressured by climate change, salinity, erosion, cyclones, habitat degradation and anthropogenic activities. Recent official assessments reinforce the urgency of the problem. India's National Centre for Disease Control identifies South 24 Parganas as one of the West Bengal coastal districts requiring particular attention because of high population density and exposure to extreme weather events such as cyclones and floods. The Ministry of Environment, Forest and Climate Change's coastal planning material also identifies erosion, biodiversity loss, livelihood vulnerability and climate-related risks to coastal populations and infrastructure as major concerns for West Bengal. The significance of the present study therefore lies in connecting environmental change with security. Instead of treating cyclones, salinity, erosion and mangrove degradation as isolated environmental problems, the article conceptualises them as interconnected risks affecting human welfare, livelihoods, ecological resilience and strategic stability.



Source: World Bank, *Coping with Climate Change in the Sundarbans: Lessons from Multidisciplinary Studies* (2020), photograph by Sunando Bandyopadhyay.

Fig 1: Coastal erosion and embankment vulnerability in the Sundarbans, South 24 Parganas, West Bengal.

The Contemporary Environmental Security Context

Environmental security traditionally concerns the protection of environmental systems and resources necessary for human survival and societal stability. Contemporary environmental-security thinking has expanded this understanding by examining how ecological stress can intensify poverty, displacement, competition over resources and institutional pressures. In coastal India, climate change produces a particularly complex security environment. Cyclones can destroy houses, roads, embankments, agricultural land and fisheries infrastructure within hours, while salinity and erosion produce slower but persistent forms of insecurity. This distinction between sudden shocks and chronic environmental stress is important for understanding the Sundarbans. South 24 Parganas illustrates this dual vulnerability. The region is exposed to extreme weather while simultaneously experiencing long-term pressures on agricultural productivity, freshwater resources and coastal ecosystems. The West Bengal climate-health

assessment specifically identifies the Sundarbans and the coastal districts of South and North 24 Parganas as areas requiring enhanced monitoring because of their combination of climatic and demographic vulnerability. The environmental-security challenge is consequently not simply whether a cyclone will occur. It concerns whether households, ecosystems and institutions possess sufficient capacity to absorb, recover from and adapt to repeated environmental shocks.

Climate Vulnerability of South 24 Parganas

South 24 Parganas is characterised by a complex network of rivers, tidal channels, islands, wetlands and mangrove forests. Its low-lying geography makes many settlements highly sensitive to tidal flooding and storm surges. Official coastal planning documents describe the Sundarbans as a deltaic system strongly influenced by tidal processes, with tidal ranges that can reach several meters.

Table 1: Climate-Security Response Framework for South 24 Parganas

Security challenge	Short-term response	Long-term adaptation strategy	Responsible stakeholders
Cyclones	Early warning and evacuation	Climate-resilient shelters and infrastructure	State government, district administration, NDRF, local bodies
Embankment failure	Emergency repair	Climate-resilient embankment systems + nature-based protection	Irrigation Department, district administration
Mangrove degradation	Emergency restoration	Community-based mangrove conservation	Forest Department, communities, NGOs
Salinity	Freshwater distribution	Rainwater harvesting and resilient water systems	Panchayats, PHED, NGOs
Livelihood loss	Relief and cash support	Diversified climate-resilient livelihoods	Agriculture, fisheries, rural-development agencies
Migration	Temporary assistance	Local employment and adaptive livelihood programmes	Government, NGOs, private sector
Coastal erosion	Temporary protective structures	Integrated coastal-zone management	State and central agencies
Information gaps	Hazard alerts	GIS-based climate-risk monitoring	Universities, research institutions, government

Source: Compiled by the author based on District Administration, South 24 Parganas (2025) ^[1]; MoEFCC (2024); NIDM (2024); and ICAR (2025) ^[1].

Cyclones remain among the most visible hazards. Events such as Aila, Bulbul, Amphan and Yaas have demonstrated the capacity of extreme storms to damage embankments, homes, agricultural fields and livelihood assets.

The security consequences continue long after the cyclone itself has passed because damaged infrastructure and saline contamination can constrain recovery.

Table 2: Major Climate-Environmental Security Risks in South 24 Parganas

Environmental risk	Principal drivers	Immediate impacts	Long-term security implications
Cyclones and storm surges	Warmer ocean conditions, extreme weather, coastal exposure	Deaths, housing damage, embankment breaches, crop losses	Recurrent displacement, livelihood insecurity and high reconstruction costs
Sea-level rise	Global warming, regional subsidence and tidal dynamics	Inundation and loss of low-lying land	Permanent displacement and pressure on settlement patterns
Coastal erosion	Tidal currents, storm surges, sediment dynamics and human intervention	Loss of agricultural and residential land	Land insecurity and climate-induced migration
Salinity intrusion	Storm surges, tidal penetration and embankment failure	Contamination of ponds and agricultural soils	Food insecurity, freshwater stress and livelihood transformation
Mangrove degradation	Cyclones, erosion, land-use pressure and resource extraction	Biodiversity loss and weaker natural protection	Reduced ecosystem resilience and greater disaster vulnerability
Livelihood insecurity	Climate shocks affecting agriculture, fishing and forest resources	Income loss and indebtedness	Migration and increased socio-economic vulnerability
Governance challenges	Institutional fragmentation and insufficient long-term adaptation	Delayed or uneven responses	Reduced adaptive capacity

Source: Compiled by the author based on District Administration, South 24 Parganas (2025); MoEFCC (2024); NCDC (2025) ^[1]; NIDM (2024); and relevant climate-vulnerability assessments.

Sea-level rise and coastal erosion represent a different but equally serious threat. The loss or degradation of land affects settlement security and agricultural production while forcing communities to adapt to changing geographical conditions. Where erosion removes agricultural land or weakens protective embankments, environmental change becomes directly connected with household economic insecurity. Salinity represents another major concern. Saltwater intrusion reduces the suitability of land for conventional agriculture and compromises freshwater sources. The problem is particularly important because many households remain dependent on agriculture and natural-resource-based activities.

Environmental Degradation and Livelihood Security

The environmental-security problem cannot be understood without examining local livelihoods. Agriculture, fishing, aquaculture, honey collection, forest-resource use and wage labour constitute important components of the regional economy. Climate change can therefore produce multiple simultaneous livelihood effects. A cyclone may destroy agricultural crops and fishing equipment; saline intrusion may subsequently reduce agricultural productivity; erosion may remove productive land; and ecological degradation may reduce access to fisheries and forest resources.

Table 3: Environmental Change and Human-Security Consequences

Environmental change	Affected human-security dimension	Likely consequence
Increasing cyclone intensity	Physical security	Injury, mortality and destruction of settlements
Salinity intrusion	Water security	Declining availability of safe freshwater
Agricultural land degradation	Food and livelihood security	Reduced agricultural productivity
Coastal erosion	Housing and territorial security	Loss of land and displacement
Mangrove degradation	Ecological security	Reduced protection against storm surges
Declining fisheries	Economic security	Income reduction among fishing communities
Repeated disasters	Social security	Debt, poverty and livelihood disruption
Loss of productive land	Migration security	Seasonal or permanent migration

Source: Compiled by the author based on NCDC (2025), NIDM (2024), MoEFCC (2024), and ICAR (2025).

The table demonstrates why the environmental-security perspective is particularly useful: one environmental stressor can generate multiple forms of human insecurity simultaneously. recent scientific and government-supported research highlights the importance of livelihood diversification. An ongoing Indian research project on alternative livelihoods in the Indian Sundarbans identifies climate change, catastrophic cyclones, floods and saline-water intrusion as major threats to economic resilience and notes the significance of out-migration as a coping response. This suggests that environmental adaptation should not focus exclusively on physical infrastructure. Building household-level economic resilience is equally important.

Mangroves as Natural Security Infrastructure

The mangrove ecosystem of the Sundarbans should be understood not only as a conservation asset but also as a form of natural security infrastructure. Mangroves can reduce wave energy, stabilise sediments, support fisheries and provide important ecosystem services.

The National Institute of Disaster Management has emphasised mangrove conservation and restoration as part of a broader resilience strategy for the Sundarbans. Its recommendations include multi-hazard risk assessment, ecosystem restoration, early-warning systems and sustainable livelihood development. Consequently, the

destruction of mangroves represents more than biodiversity loss. It can reduce the ecological protection available to coastal settlements and increase their exposure to future hazards. The strategic importance of ecosystem conservation becomes particularly clear when environmental protection and disaster management are considered together. Investment in mangrove restoration can simultaneously contribute to biodiversity conservation, climate adaptation, livelihood support and disaster-risk reduction.

Human Security, Migration and Social Vulnerability

The climate-security nexus is ultimately experienced at the household and community level. Repeated environmental shocks can produce income loss, indebtedness, food insecurity, water stress and migration. Migration should therefore not automatically be understood as a failure of adaptation. In some circumstances, temporary migration can provide households with additional income and strengthen resilience. However, when migration becomes involuntary because land, water or livelihood opportunities are lost, it may represent a form of climate-induced displacement. The resulting social consequences may include fragmented households, increased care burdens and greater vulnerability among women, children and elderly people. Recent livelihood research in the Indian Sundarbans demonstrates the importance of designing adaptation strategies around economically marginalised communities rather than relying exclusively on large infrastructure projects. A recent ICAR initiative in Gosaba Block of South 24 Parganas provides an important example. The programme, implemented in October 2025, focused on climate-resilient livelihood diversification among vulnerable communities, including women affected by tiger-related livelihood losses. The initiative demonstrates the growing importance of community-led adaptation and livelihood diversification in environmental-security planning.

Governance and the Emerging Policy Response

Environmental security requires institutional coordination because environmental risks cross administrative boundaries. Agriculture, irrigation, fisheries, forests, disaster management, health, rural development and local government all have roles in coastal resilience. The introduction of the South 24 Parganas District Environment Plan 2025, represents an important contemporary governance development. The plan, published by the district administration, indicates a formal effort to strengthen environmental planning at the district level. At the broader state level, West Bengal's Integrated Coastal Zone Management framework identifies coastal erosion, biodiversity loss, livelihood vulnerability, infrastructure risks and climate adaptation as interconnected policy concerns. However, the effectiveness of these initiatives depends upon implementation at the local level. Policies must be translated into village-level risk assessments, resilient infrastructure, functioning early-warning systems, accessible shelters, freshwater security, livelihood diversification and ecosystem restoration.

Strategic Implications for Environmental Security

The environmental challenges of South 24 Parganas have implications beyond local ecological management. The district forms part of a strategically significant coastal and

deltaic environment adjacent to Bangladesh and the Bay of Bengal. Environmental instability can affect infrastructure, population mobility, disaster-response requirements and livelihood security. This does not mean that climate change automatically produces conflict or conventional national-security threats. Rather, environmental stress can act as a risk multiplier by intensifying existing socio-economic vulnerabilities and placing additional pressure on governance institutions. The appropriate security response is therefore preventive rather than exclusively coercive. Strengthening ecological resilience, improving disaster preparedness, ensuring freshwater availability, developing sustainable livelihoods and strengthening local governance can reduce the conditions under which environmental stress becomes a wider security problem.

Policy Priorities for 2026 and Beyond

A contemporary environmental-security strategy for South 24 Parganas should prioritise five interconnected areas.

- First, ecosystem-based adaptation should be expanded through scientifically planned mangrove restoration, wetland conservation and protection of natural coastal buffers.
- Second, climate-resilient infrastructure should replace repeated emergency repair as the dominant approach. Embankments, roads, bridges, cyclone shelters, drinking-water systems and public buildings should be designed against projected future hazards.
- Third, livelihood diversification should receive greater attention. Climate-resilient agriculture, sustainable aquaculture, fisheries management, eco-tourism, skill development and small-scale enterprises can reduce dependence on highly vulnerable activities.
- Fourth, early-warning and anticipatory action should be strengthened. Warnings must reach remote islands and villages rapidly and should be connected with evacuation, shelter, transport and relief arrangements.
- Fifth, integrated governance and scientific monitoring should become central to environmental-security planning. Universities, research institutions, local panchayats, NGOs and government agencies should collaborate on GIS-based vulnerability mapping, shoreline monitoring, salinity assessment, climate projections and community-level adaptation planning.

Conclusion

The contemporary environmental-security situation in South 24 Parganas demonstrates that climate change is no longer merely an environmental issue. It is simultaneously a question of livelihood security, food and water security, disaster resilience, public health, migration, ecological conservation and strategic governance. The Indian Sundarbans illustrates the complexity of this relationship particularly clearly. The region's ecological wealth provides essential protection and livelihood resources, but its low-lying geography and socio-economic vulnerabilities make it exceptionally sensitive to environmental change. Recent government assessments, the 2025 ^[1] District Environment Plan, new livelihood initiatives and disaster-management recommendations indicate that policy attention is increasingly shifting towards resilience. The central policy challenge is therefore to move from a reactive model of disaster relief towards an anticipatory model of climate resilience and environmental security. Such a transition

requires the integration of ecosystem restoration, resilient infrastructure, scientific monitoring, livelihood diversification, community participation and coordinated governance. For South 24 Parganas, environmental protection and human security are inseparable. Protecting mangroves protects communities; securing freshwater protects health and livelihoods; strengthening local economies reduces displacement pressures; and improving disaster preparedness strengthens overall resilience. Environmental security should consequently become an integral component of India's broader coastal-security and sustainable-development strategy.

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