Building Resilience with Real-world Labs: Integrating Livelihoods, Governance, and Nature-Based Viability in transboundary Sundarbans

Renforcer la Résilience dans les Sundarbans : Intégration des Moyens de Subsistance, de la Gouvernance et des Solutions Fondées sur la Nature

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RÉSUMÉ

Les habitants des Sundarbans, une plaine deltaïque inférieure soumise aux marées dans le bassin du Gange-Brahmapoutre-Meghna, sont confrontées à une vulnérabilité socio-écologique sévère en raison des impacts du changement climatique, tels que l'élévation du niveau de la mer, les cyclones, la salinisation et l'érosion côtière. Le projet ENGAGE4Sundarbans analyse ces effets en cascade à Kumirmari (Bengale-Occidental, Inde) et Pratap Nagar (Satkhira, Bangladesh) à travers une approche transdisciplinaire impliquant chercheurs, praticiens et habitants locaux.

Cette étude examine les causes profondes de la vulnérabilité en utilisant des observations ethnographiques, des entretiens avec les parties prenantes, des enquêtes auprès des ménages (389 par site) et des discussions en groupes de réflexion. Les résultats préliminaires révèlent que la salinisation des sols, la dégradation des habitats, l'accès restreint aux terres et l'insuffisance des services essentiels exacerbent les risques socio-écologiques. Des stratégies d'adaptation portées par les communautés, notamment le renforcement des digues et des solutions fondées sur la nature (NbS) comme la pêche intérieure et la régénération agroécologique, sont appliquées sur le terrain par les participants au projet.

Pour mettre en œuvre des solutions durables, le projet établit des "laboratoires de vie réelle" comme espaces expérimentaux pour co-développer des pratiques de pêche durable et d'agriculture agroécologique intégrée. Les conclusions soulignent la nécessité d'un soutien institutionnel, d'une gestion équitable des ressources et d'une amélioration de l'accès aux marchés. En s'appuyant sur la gestion communautaire des biens communs, l'initiative favorise la cohésion sociale et la résilience, visant à créer un modèle évolutif d'adaptation climatique dans les régions deltaïques vulnérables.

ABSTRACT

The Sundarbans, a tidally active lower deltaic plain in the Ganges-Brahmaputra-Meghna basin, faces severe socio-ecological vulnerability due to climate change impacts such as sea-level rise, cyclones, salinization, and coastal erosion. The ENGAGE4Sundarbans project investigates these cascading effects in Kumirmari (West Bengal, India) and Pratap Nagar (Satkhira, Bangladesh) through a transdisciplinary approach involving researchers, practitioners, and local inhabitants.

This study examines the root causes of vulnerability using ethnographic observations, stakeholder interviews, household surveys (389 per site), and focus group discussions. Preliminary findings reveal that soil salinization, habitat degradation, restricted land access, and inadequate essential services exacerbate socio-ecological risks. Community-driven adaptation strategies, including embankment reinforcement and agroecological regeneration are explored.

To implement sustainable solutions, the project establishes "real-world labs" as experimental spaces to co-develop sustainable fisheries and integrated agroecological farming. Findings emphasize the need for institutional support, equitable resource management, and market access improvements. By leveraging community-managed commons, the initiative fosters social cohesion and resilience, aiming to create a scalable model for climate adaptation in vulnerable deltaic regions.

KEYWORDS

Agroecology, Livelihoods, Nature-Based Solutions (NbS), Resilience, Sundarbans

Agroécologie, Moyens de subistance, Solutions fondées sur la Nature (SFN), Resilience, Sundarbans

1. INTRODUCTION

The Sundarbans, a fragile deltaic coastal region shared by India and Bangladesh, face social and ecological vulnerabilities that exacerbate social challenges. Its environmental vulnerability is characterised by rapid critical coastal erosion, land salinisation due to storms, cyclones, sea level rise, subsidence sea-level rise, land subsidence and land salinisation (Ashraful Islam et al. 2016; Das et al. 2021; Ghosh and Mistri 2021). The fragility of the mangrove ecosystem and loss of biodiversity (fish, crabs and other animals) are exacerbated due to the growing impacts of land use change and industrial development (Banerjee et al. 2023; Cremin et al. 2024). Shrimp farming displaces agroecological practices, increasing inequalities, while chemical farming harms biodiversity and soil health (Ahmed et al. 2013; Paul and Røskaft 2013; Afroz et al. 2017; Ahmed and Ambinakudige 2024).

The solutions based on the polderisation of the delta without integrating grassroots initiatives have also led to a misreading of the delta's issues and maladaptive measures (Dewan 2021). Geodynamical factors are aggravated by the weakness of the **embankment issues** (Gain et al. 2019)**.**

The inhabitants of the tidally active lower deltaic plain of the Ganges-Brahmaputra-Meghna basin are highly exposed to the cascading effects of cited hazards, while their socio-economic conditions driven by limited access to education, healthcare, and clean water increase their social vulnerability. The social vulnerability is interlinked with ecological stresses within the social-ecological system of the delta.

Developed within the framework of the ENGAGE4Sundarbans project, this solution-oriented research aims to identify the root cause of the social-ecological vulnerability, identify the needs of the communities and co-develop sustainable agroecological solutions to support livelihoods while preserving ecosystems and enhancing social resilience in vulnerable communities.

During the phase of implementation, we question the adaptative capacities provided by cooperative models, common management and Nature-based solutions (NbS) and the upscaling of the methods identified to enhance social resilience in the river delta (Gain et al. 2022).

This Solution-oriented research project takes place in two sites of the transboundary Sundarban River Delta: one in India, the island of Kumirmari in West Bengal, and the other one in Bangladesh, Pratap Nagar, a ward of the Assassuni Upazila in Sathkira district in south-west Bangladesh.

2. METHODOLOGY

The transdisciplinary team composed of researchers, practitioners and inhabitants have used a set of qualitative and quantitative tools. Archival research aimed at investigating the delta's management of hazards during colonial and post-colonial times. In-depth ethnographic observations, interviews with multiple stakeholders, and Focus Group discussions with inhabitants were employed to identify the more recent root causes of risks and vulnerabilities. A household survey took place in both areas (India and Bangladesh) involving 390 households in each site and provided a quantitative dataset.

At the same time, through place-based and transdisciplinary approaches, both teams have organised Focus group discussions and workshops engaging social stakeholders and community actors to identify solutions for local sustainable development. With a focus on transformation, addressing socio-economic and ecological dimensions of everyday life.

3. REFLECTIONS ON PARTIAL RESULTS

3.1 Root causes of vulnerability

Geographical and Socio-Economic Comparisons (Kumirmari vs. Assassuni)

The root cause of vulnerability differs from site to site.

The table below shows geographical and socio-economic comparisons between Kumirmari island and Prata Nagar, Assasuni Upazila.

Identification of main factors of social-ecological vulnerability

Social vulnerability is high in both sites due to insufficient access to basic services. In both sites, the social vulnerability is also increased by the social inequalities related to the caste system in India and to the class system in Bangladesh. This social susceptibility also correlates with financial capital. In both cases, poor households struggle to access land which limits their sustainable livelihoods.
Ecological vulnerability is higher in Pratap Nagar, where the polder has been breached several times, and the mangrove is far away from the site. Initial results show that **several climate and geodynamic factors** cyclones, soil salinisation, coastal erosion, loss of forest habitats and limited access to land and essential services, contribute to socio-ecological vulnerability.

Land conversion to shrimp farming

In Pratap Nagar, shrimp farming and other saline-based aquaculture have involved the voluntary release of saline waters by investors into the small farmer's rice and vegetable cultivations.

Lack of communities' participation in decision-making

Communities have not been sufficiently involved in the decision-making process regarding the embankment and land use, showing a governance deficit**. Locally made** sandbag maintenance is unsustainable against tidal pressures.

3.2 Identification of solutions and adaptation strategies

Several solutions and adaptation strategies have been proposed by the communities, such as strengthening embankments, however, after an in-depth consultation with community members during FGDs and in regard to sustainability, our project has decided to support initiatives around inland fisheries in India and to regenerate agroecological practices as nature-based solutions (NbS) in Bangladesh. The initiative proposed by communities was aiming to become a real-world lab initiative.

3.3 Implementation of "Real-world" labs to build social resilience

3.3.1 Grassroots Participation in Agroecological initiatives: Building knowledge and practices

To support rural communities in this socio-ecologically fragile region, the project implements "real-world labs" as experimental spaces to translate knowledge into actionable community-driven solutions. These labs explore sustainable fisheries and integrated agroecological market farming, guided by local ecological knowledge and community collaboration. Knowledge Sharing is identified as a main tool for building resilience. It relies on combining local expertise with external input to co-create sustainable practices.

In Kumirmari, our project members have worked with communities to enhance the best agroecological expertise in fish farming, crops, and vegetables.

In Pratap Nagar Assassuni, our team members have supported the consolidation of kitchen gardens and identified salt-tolerant crops (paddy) that can grow in degraded soil conditions. Moreover, land Restoration and remediation are needed to address salinisation and nutrient depletion.

3.2.2 Access to Land and Commons

All agroecological initiatives must consider the land ownership dynamics. Indeed, small farmers struggle with disaster-damaged lands and government-appropriated plots. Private land leasing and cooperative farming hold potential. The management of commons is also considered to empower marginalised groups through access to shared resources like water bodies and river islands under public ownership (*khas land*).

Community and government efforts must be aligned to stabilise canal dredging and drainage and ensure the revitalisation of canals as a Commons.

4. DISCUSSIONS AND RECOMMENDATIONS

1.1.1 Governance Innovations and Support Mechanisms

Initial findings reveal that agroecological practices require collective action and institutional support for long-term sustainability and innovative strategies for resource management. The project proposes leveraging community-managed commons, such as canals and tidal plains, through collective use and governance. Our team supports **communities' empowerment by creating** platforms for discussion and training on agroecological and integrated farming techniques. We also recommend creating cooperatives for resource and commons management when possible. However, we also recommend always linking agroecological solutions to local governance structures.

At the national level, we recommend incorporating NbS into local and national governance frameworks (**Policy Integration)** and institutionalising advisory committees for inclusive decision-making. Creating and managing new commons aims to strengthen social cohesion, promote collective work, and enhance community resilience.

4.2.1 Strengthening Market Linkages

Market access emerges as a significant obstacle for rural communities. We have observed poor access to the market and a high dependency on middlemen, which reduce the earnings of small farmers. Consequently, we suggest supporting direct market access through farmer-producer organisations, diversifying livelihoods with inland fisheries and value-added products and building capacity in sustainable practices and market strategies to generate incomes for small farmers. The next step requires reconstructing community governance, equitable resource management, and improving market linkage through farmer-producer organisations

1.1.2 Restoration, agroecological practices and Nature-based solutions (NbS)

Integrated Agroecology also involves reducing chemical inputs to support biodiversity and promote composting and organic farming practices. We also recommend working on ecosystem restoration to support the mangrove enrichment that will mitigate erosion and retain sediments. This goes by addressing gaps in mangrove plantations to sustain biodiversity. Monitoring and evaluation by establishing biodiversity benchmarks and documenting successful models for replication are also required to upscale the initiatives.

1.1.3 Transformational Goals

Upscaling Agroecological Practices involves promoting equity through cooperative farming, addressing political barriers to land restoration and common access and disseminating locally relevant knowledge for wider impact. **Amplifying Local Voices** can be achieved by Highlighting grassroots resistance to exploitative practices and empowering communities for resilience-building.

Strengthening Partnerships and Coordination of NGOs that operate in the regions is also crucial. It is important to collaborate with 20+ NGOs to share data and coordinate to create projects that could be scaled (scalable solutions). This will help to minimize intervention redundancy by fostering cohesive strategies. Finaly, creating an Integrated Framework for Transformation would be needed to prioritize land use, governance, and resilience-building for regional replication.

2 CONCLUDING REFLECTIONS

The **ENGAGE4Sundarbans project** exemplifies the integration of ecological, social, and economic dimensions to build resilience. Insights from **Kumirmari** and **Assassuni** underscore the importance of tailoring solutions to local contexts. The project sets a transformative example for sustainable development in vulnerable regions by fostering collaboration, amplifying grassroots voices, and sharing knowledge.

The project aims to strengthen social resilience and promote sustainable livelihoods through cooperative models led by community participation and commons management in governance frameworks and build partnerships to develop a replicable model of resilience and sustainability in vulnerable regions.

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