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RIVER DELTAS: SCALING UP COMMUNITY-DRIVEN APPROACHES TO SUSTAINABLE INTENSIFICATION

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IN PARTNERSHIP WITH:

Bioversity International · CIFOR · CIAT · CIP International Potato Center · FAO · ICARDA · ICRISAT International Crops Research Institute for the Semi-Arid Tropics · IFPRI International Food Policy Research Institute · ILRI International Livestock Research Institute · RUAF Foundation · World Agroforestry Centre · WorldFish

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SERIES INTRODUCTION

Raising global food production is essential to eradicate hunger and achieve food and nutrition security. But agriculture has become the world's single largest driver of environmental degradation, and it is pushing Earth beyond its natural boundaries. **Sustainably feeding future generations requires a fundamental shift in global agriculture.**

Since its inception in 2012, the CGIAR Research Program on Water, Land and Ecosystems (WLE) has developed scientific evidence and solutions for **sustainably intensifying agriculture**. For WLE, sustainable intensification means more than minimizing agriculture's environmental footprint; it means making sure that agriculture adds value to the environment, while it supplies global populations with sufficient food, nutrition and income.

More than 500 million smallholders worldwide stand to benefit from sustainable intensification of agriculture. Historic commitment to the UN Sustainable Development Goals (SDGs) and the Paris Climate Agreement further highlights the need for investing in sustainable and resilient agriculture.

But achieving sustainable, healthy food systems requires identifying **incentives** for sustainable farming. Likewise, it hinges on social and institutional innovations to **mitigate trade-offs and achieve synergies**, and **enable equitable access** to knowledge and resources. Not least, integrated solutions that work across sectors, disciplines and scales will be essential to realizing such a fundamental shift. Such innovations are what WLE has worked to develop. The Program's findings are summarized in this series of briefs, titled ***Towards sustainable intensification: Insights and solutions***.

Key Reading

Rockström, J.; Williams, J.; Daily, G.; Noble, A.; Matthews, N.; Gordon, L.; Wetterstrand, H.; DeClerck, F.; Shah, M.; Steduto, P.; de Fraiture, C.; Hatibu, N.; Unver, O.; Bird, J.; Sibanda, L.; Smith, J. 2017. Sustainable intensification of agriculture for human prosperity and global sustainability. *Ambio* 46(1): 4-17.

ABOUT THE WLE FOCAL REGION PROGRAM

From 2014 until the end of 2016, WLE implemented an innovative set of projects in response to a call for more demand-driven and locally led initiatives in support of agricultural intensification at a regional scale. Researchers partnered with local actors to co-design projects that used an ecosystem-based approach to influence investment and decision making in support of more equitable management of natural resources. In total, 33 projects were implemented in 18 countries with 175 partner organizations in four regions: The Ganges; the Greater Mekong; the Nile-East Africa; and the Volta-Niger.

This briefs draws in part on past research funded by the Department for International Development in the UK (DFID) and carried out under the CGIAR Challenge Program on Water and Food (CPWF), a predecessor to WLE. It also reports specifically on research results from two projects from WLE's focal region portfolio, namely one in the Greater Mekong region and one in the Ganges region, as detailed below. These findings are also presented in a forthcoming book chapter (Merry et al. Forthcoming).

- River Food Systems from Villagers' Perspectives in the Mekong Delta, led by WARECOD and implemented in partnership with the Vietnam Television 2, MekongNet (Dragon Institute, Can Tho University), College of Aquaculture and Fisheries and the Center for Water Resources Conservation and Development.
- Community water management for improved food security, nutrition and livelihoods in the polders of the coastal zone of Bangladesh, led by IRRI in collaboration with the Bangladesh Rice Research Institute; BRAC; Shushilan; IWMI; and the Institute of Water Modelling (IWM) in Bangladesh.

SUMMARY

The residents of the Ganges and Mekong River deltas face serious challenges from rising sea levels, saltwater intrusion, pollution from upstream sources, growing populations, and infrastructure that no longer works as planned. In both deltas, scientists working for nearly two decades with communities, local governments and nongovernmental organizations (NGOs) have demonstrated the potential to overcome these challenges and substantially improve people's livelihoods. There are cost-effective solutions to improving the totality of ecosystem services and market opportunities for young women and men.

Recommendations

- In both the Ganges and Mekong deltas, prioritize strengthening and reforming local water management institutions to improve their performance and equity.
- Implement physical improvements that are driven by local communities themselves, when the local water management organizations (WMOs) are strong enough, have agreed on what is needed, and are willing to make a reasonable commitment of resources to implement the improvements.
- Promote sustainable agroecological diversification in ways that are appropriate to the specific conditions encountered by men and women farmers, and prioritize strengthening the value chain, for example, by improving access to effective input and output markets to increase profitability.
- To address complex and entrenched gender inequality, and disaffected youth, work with interested women and youth to identify attractive opportunities, such as new crops, production technologies and business models that would enable them to benefit more.

INTRODUCTION

The livelihoods of people living in tropical coastal deltas are being undermined by multiple insidious trends. Historically, deltas have attracted large numbers of people because they combine highly fertile land, multiple marine and freshwater resources, and rich biodiversity. Deltas are often the national 'breadbasket' or 'rice bowl'. However, deltas face growing threats to their integrity and productivity. The origins of these threats are both anthropogenic and natural. They include the impacts of growing urbanization; over-extraction of groundwater; agricultural intensification; alterations of flow paths and floodplains; upstream water consumption and pollution; trapping of sediments; sea level rise, the effect of which is amplified by sinking land levels; and extreme events such as river flooding and tidal surges (Renaud et al. 2013; Syvitski et al. 2009).

Tropical developing country deltas are especially at risk. A great deal of infrastructure, such as embankments and irrigation schemes, has been constructed in recent decades to cope with the uncertainties of deltaic agriculture. Many of these structures no longer provide adequate protection from storm surges, salinization and rising sea levels. This is in part because upstream interventions such as dams have changed water flows and are often poorly maintained and managed, but also because the structures themselves have seriously modified water flows and sedimentation in ways that damage local ecosystems.

The Ganges River delta in Bangladesh and India and the Mekong River delta in Vietnam and Cambodia are prime examples of tropical deltas at risk, where poverty and malnutrition are high. This is why the CGIAR Research Program on Water, Land and Ecosystems (WLE) and its predecessor, the CGIAR Challenge Program on Water and Food (CPWF), have invested in identifying potential solutions that could reverse the negative trends and achieve positive future outcomes.

THE CONTEXT IN THE TWO DELTAS

The Mekong delta

With a total area of 5.9 million hectares (Mha), the Mekong is the third largest delta in the world. Most of it, 3.9 Mha, is in Vietnam, where about 2.4 Mha are used for agriculture and aquaculture. The Vietnamese delta population is currently about 18.6 million people. The delta is Vietnam's rice bowl, producing approximately 60% of the country's rice, 80 to 90% of the country's

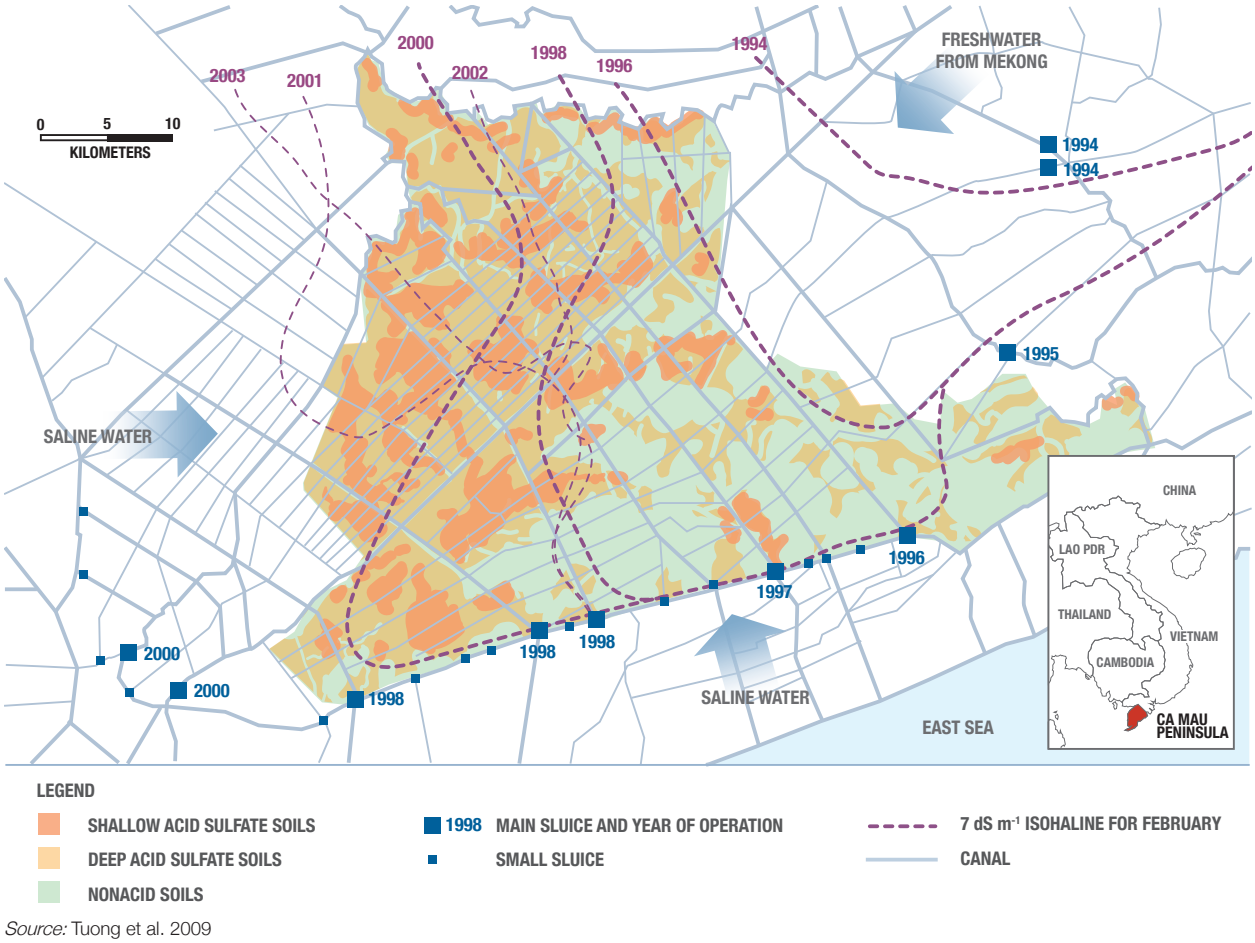
rice exports and a substantial portion of its fruit, fish and shrimp exports. Over the past three decades, Vietnam has invested heavily in water control projects: development and rehabilitation of irrigation and drainage systems, controlling brackish water and flood protection, domestic water supply and roads. These investments, combined with increased use of fertilizer and significant policy changes, enabled many farmers to grow up to three rice crops per year (Renaud et al. 2013; Le et al. 2015).

However, cultivating three rice crops annually is becoming ecologically unsustainable. Production of rice and other crops and even the quality of the domestic water supply are now threatened by the ominous trends described above. Declining fish catches are a key indicator of environmental degradation: fish are disappearing from the rivers, streams and canals and, along with aquatic species such as shrimp and frogs, are becoming less common in paddy fields. This reduction in freely available traditional protein sources greatly affects poorer households (Glendinning 2017; Le et al. 2015; Van et al. 2016; Berg et al. 2017).

Broadly, the delta can be subdivided into three subregions. The subregion closest to the coastline is dedicated to farming shrimp in brackish water. The upper delta subregion has freshwater throughout the year but is seriously affected by flooding during the rainy season. Between these is a large subregion that is protected by a system of dikes, enabling intensive rice farming and vegetable crop cultivation, with two to three crops per year. There is also a buffer zone for a mixture of rice cultivation during the rainy season and shrimp farming during the dry season. All these subregions face serious threats to their sustainability and productivity. Engineering solutions alone will not stabilize the system, but need to be combined with adaptations of the agricultural production system to increase resilience (Renaud et al. 2013, 2014; Smajgl et al. 2015; Tran and Weger 2017).

Research carried out in Vietnam's Bac Lieu Province in the southern tip of the Mekong delta between 1994 and 2000 highlighted how policy reform can foster beneficial changes to production systems. Here, the government had installed 10 large sluices to prevent saline water inflow during low-flow periods for an area of 260,000 ha, while leaving the large band between a highway and coastal dike for mangrove and marine habitats (Fig. 1). Freshwater from the Mekong is

FIG. 1. MAP OF BAC LIEU PROVINCE, VIETNAM, WITH THE LOCATION OF SLUICES AND THEIR YEAR OF COMPLETION



Source: Tuong et al. 2009

still flowing into the protected area through a dense canal network. These investments enabled many rice farmers to produce two to three rice or upland crops per year, but restricted the supply of saline water required by shrimp producers. As rice prices fell and shrimp prices rose, farmers were no longer able to make a decent profit. The research supported a policy change from an exclusive focus on rice to a broader land and water management policy. Modeling was used to identify how to operate the sluice gates to supply suitable water for both brackish water shrimp and rice production, including the buffer zone where shrimp and rice are grown in rotation during the dry and wet seasons, respectively (Hoanh et al. 2003; Wichelns et al. 2010). This work set the scene for the WLE research described below. Recently, increasing intrusion of saline water and pollution from overuse of agricultural chemicals have led to deterioration of aquatic resources (fish, shrimp, frogs) and declining rice yields.

The Ganges delta

The Ganges-Brahmaputra-Meghna river system, stretching across India, China, Nepal, Bangladesh and Bhutan, is the world's third largest freshwater outlet to the sea. The Ganges delta is the world's largest, with an area of 10.5 Mha in Bangladesh and India. It is a highly regulated system with dams, barrages and extensive embankments on nearly every tributary, diminishing dry season water flow. About 250 million people depend on agriculture and aquaculture for their livelihoods (Renaud et al. 2013).

Climate change is likely to have a serious impact on the reliability and intensity of the southwest monsoon, the intensity of cyclones, and river flows. Both droughts and floods have become more common, severely affecting agricultural production and people's livelihoods. River tributaries are often heavily polluted with municipal and industrial wastes. Arsenic in the groundwater is a serious problem. The delta is also threatened by both reduced aggradation and accelerated compaction combined with rising sea levels (Syvitski et al. 2009). Renaud et al. (2013) argue that if the current status quo prevails, the socio-ecological system "could very well tip into an unfavorable configuration" – i.e., the damage would be irreversible and lead to unpredictable systemic transformations.

The Bangladesh coastal zone is characterized by a vast network of river systems and an ever-dynamic estuary. Since the late 1960s, 139 polders have been constructed for rice production and to protect people from floods. A polder is a low-lying area between the rivers, protected from tidal flooding and salinity intrusion by an earthen embankment, with internal canals linked to gated outlets in the embankment used to manage water levels within the polder. About 54 polders are located in the Ganges coastal zone of Bangladesh, covering 1.2 Mha and inhabited by about eight million people (Khan et al. 2015). In low and medium salinity regions, polders are used to cultivate rice during the rainy season, and pulses and sesame during the dry season. In the more saline regions, polders are used to raise brackish water shrimp and fish both for sale and household use, and in some areas, brackish water shrimp farming is carried out in rotation with rice during the rainy season, as in parts of the Mekong delta (Faruque et al. 2016; Dey et al. 2013).

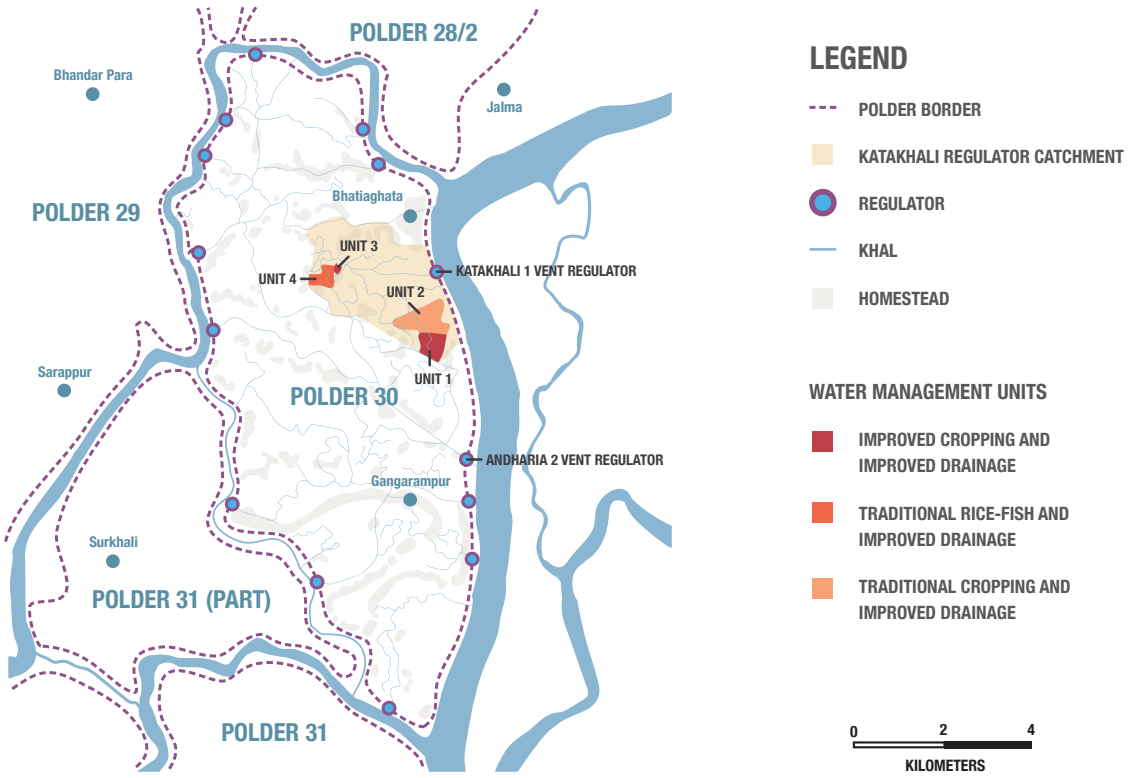
Polders are extremely vulnerable to flooding, largely due to high rainfall during the rainy season, lack of separation between low and high lands internally, poor drainage management and cyclones. Saline water intrusion occurs sporadically in patches during cyclonic storm surges or because of damaged or missing sluice gates and poor management of the gates. Agricultural production is much lower than in the rest of Bangladesh, and food and nutrition insecurity and poverty rates are higher (Tuong et al. 2014; IRRI 2017). Farmers are increasingly vulnerable to shocks from a combination of physical factors (floods, droughts, storms, saltwater intrusion), a deteriorating resource base, weak economic conditions, and limitations of existing formal and informal institutions (Huq et al. 2015).

As is the case for the Mekong delta, the WLE project built on the results of the CPWF and earlier research (Rural Livelihoods Evaluation Partnership 2004). CPWF followed a systems approach to assess water supply and demand to outscale the *Aman-Boro*[1] rice cropping pattern in Polder 30 of Khulna District (Fig. 2), and hydrologic modeling to predict water depth across selected polders (including Polder 30) in response to rainfall.

Polder 30 has a population of 38,240 people and covers 6,445 ha with a net cultivable area of 4,240 ha. A 40.27 km embankment protects the area against tidal and storm surges as well as salinity intrusion. There are multiple drainage and flushing sluices and six inlets to the area. Internal drainage congestion and external siltation had made some land unsuitable for crop production.

[1] *Aman* is the December-January season; *Boro* is March-May; *Aus* is July-August. *Aman* is the most important for rice cultivation.

FIG. 2. MAP OF POLDER 30 SHOWING WLE AND CPWF STUDY SITES



Source: IRRI 2017.

RESULTS OF COLLABORATIVE PARTICIPATORY RESEARCH

In both deltas, a great deal of technical research and modeling has been done starting with DFID-supported research projects and subsequent CPWF research, as reported by Hoanh et al. (2006, 2010). This brief focuses on key intervention strategies that can lead to more sustainable, equitable and profitable intensification of agriculture and aquaculture. The results demonstrate that achieving sustainable agricultural intensification in such complex systems requires a multi-scale, whole-systems, landscape or agroecological approach.

Reversing deteriorating agroecological systems in the Mekong delta

An evaluation of past efforts to promote more resilient production systems in Vietnam's Bac Lieu Province showed significant positive impacts (McDonald 2011), and the results of the ongoing WLE project are also very positive. The project lead WARECOD, a Vietnamese NGO based in Hanoi, is conducting *Thaibaan* research. *Thaibaan* is a participatory research method that is led by the farmers, not the scientists—a form of 'citizen science' (Vaddhanaphuti 2005; Myint 2016). It empowers local people to take responsibility for understanding and revealing knowledge about their connection with natural resources. From conception to dissemination, villagers themselves are the principal researchers. Local officials are also involved to ensure their buy-in. An innovation has been the combination of photovoice[2] and *Thaibaan* methods, in which the village people—especially women—are trained to use photographic techniques and storytelling.

This research has helped community members understand their own role in managing water resources, notably on how pesticide use and rubbish disposal can affect their livelihoods. Special efforts have been made to ensure women and ethnic minorities participate in the research. Farmers have already adapted their livelihood strategies to include extensive shrimp farming, which uses brackish water and has minimum impact on the environment. Farmers grow rice when freshwater flows through the channels and change to shrimp farming when the seawater arrives (Glendinning 2017). Other research has suggested that the local water management institutions need to be strengthened to enable farmers to play a fully active role and to reduce the obstacles to women's active participation (Le et al. 2015).

[2] 'Photovoice' involves training people in using cameras, photographic techniques, storytelling for local researchers, and is especially aimed at women.

The results support those of recent research in Ben Tre, another Mekong coastal province (Renaud et al. 2014). That study examined historical changes in agroecosystems in a district that is seriously affected by salinity intrusion to understand what enables effective adaptation and increased resilience of rice–shrimp socio-ecosystems. It concluded that the option currently favored by policy makers, i.e., adding or upgrading engineered infrastructure, may provide short-term benefits, but will reduce the capacity to adapt to change in the longer term. The alternative is to offer farmers more freedom of choice in how they adapt, and support their efforts to find solutions, for example, by diversifying their agroecosystem. Collectively, the results suggest there is now sufficient research-based evidence to support scaling up more flexible institutions and policies for land-use planning and agricultural production in the Mekong delta.

Building resilience and increasing productivity in the Ganges delta

Previous CPWF research had shown that the path to shifting to high-yielding rice varieties, sustainable intensification and crop diversification in the polders was improving water management—especially drainage during and immediately after the rainy season. The CPWF research demonstrated the potential benefits of creating small community water management units within the polder, based on the hydrology of the landscape and the common aspirations of farmers (CPWF 2014; WLE 2014; Humphreys et al. 2015).

A recent WLE project built on these results by implementing a pilot project in three villages in Katakhali sub-polder of Polder 30 (Fig. 2). It was led by the International Rice Research Institute (IRRI) and implemented in collaboration with the Blue Gold Development Program. This is a Dutch and Bangladesh government effort to strengthen value chains and WMOs, and rehabilitate and upgrade water infrastructure (CEGIS 2015; Buisson et al. Forthcoming). The project implemented high-yielding, diversified and climate resilient production systems, whose productivity was two to three times higher than traditional farmers' practices. The research confirmed the importance of organizing the community around hydrological units within sluice gate catchments and of synchronized cropping within these units (IRRI 2017).

An evaluation of the short-term socioeconomic impacts of both the WLE and Blue Gold interventions in Polder 30 found that the marketing of high-yield rice varieties and other crops, such as sunflower, faced challenges (Buisson et al. Forthcoming). Nevertheless, the evaluation confirmed that a community-managed drainage system significantly reduces waterlogging risks. Improved water management enabled the use of high-yielding, early-maturing rice varieties, followed by high-value, dry-season crops like sunflower. The project also showed that integrating community fish culture with rice in low-lying lands during the wet season can improve food production and household incomes (IRRI 2017; Dey et al. 2013), benefiting most households in the community. Further, new livelihood and business opportunities for youth and women became attractive, for instance, through establishing rice mat nurseries and homestead sunflower oil production (IRRI 2017). Even landless people can benefit: in one village, more than 60 landless and landowners were trained to collectively manage fish production in the rice land. The landless people fed the fish, guarded the rice-fish area at night and helped harvest the fish. They harvested 3.5 tons of fish, of which three tons were sold and 500 kg were self-consumed, bringing much needed protein into an otherwise poorly diversified diet (IRRI 2017).

A previous CPWF project had analyzed water management policies and their outcomes in coastal Bangladesh (Dewan et al. 2014, 2015). The current policy advocates de-politicized, community-based WMOs, with limited involvement of local government institutions. The researchers found that such organizations are neither effective nor sustainable as they tend to be initiated externally, lack transparency and accountability, are dominated by elites, and only nominally involve women. Consequently, they cannot address underlying inequities and often amplify them.

Recognizing the inherent political nature of participatory WMOs is critical for success. Organizations working on coastal water management should focus on formalizing the role of local government and ensuring the WMOs have access to permanent maintenance funds. The researchers argue this could lead to more effective democratic decentralization. The study also advocated creating a 'trust fund' to solve the problem of 'deferred maintenance'. Under this arrangement, all polders would be eligible to receive funds for repair and maintenance from the interest accruing to the fund.

The Mekong water management institutions offer an interesting model that supports this view. There is greater cooperation between local government entities and the WMOs than is the case in Bangladesh. More work is needed on three issues: strengthening the value chain to enable farmers' profits to be

increased; improving the capacity of the farmers to collectively manage water more effectively; and ensuring the benefits are shared more equitably. It is notable that the United States Agency for International Development (USAID) Sustainable Intensification Innovation Laboratory (SIIL) is supporting a project that is extending the WLE approach to the remainder of the sub-polder and beyond to other polders.

CONCLUSIONS

Even though WLE's research is on a small pilot scale, the nearly two decades of research has demonstrated interventions that work, i.e., are effective and sustainable. The evidence base provides a sufficient foundation to scale up the approaches in both deltas. Combining 'soft' adaptations such as land-use changes with appropriate infrastructure investments is critical. The delta communities need external support to sustainably intensify their agroecological systems and improve their livelihoods. Following a flexible participatory implementation strategy will be critical for long-term success.

Finally, it is important to emphasize that the Mekong and Ganges delta research programs demonstrate the value of long-term, multidisciplinary, socio-ecological systems research. The solutions that have been produced would not have been possible with a normal short-term project.

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