Water Policy 21 (2019) 108–126

Rethinking sediments, tidal rivers and delta livelihoods: tidal river management as a strategic innovation in Bangladesh

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Abstract

Many urbanised deltas face development challenges due to growing economies, populations and climate change. Changes in land–water strategies are often required, as 'business-as-usual' solutions are no longer sufficient. The aim of this paper was to study tidal river management (TRM) as a strategic innovation, and trace how it is appreciated by people and used in master plans to address congested rivers and waterlogging in Bangladesh. In this context, a strategic innovation can be categorised as having four features: (i) it is a fundamental reconceptualisation of business as usual strategies; (ii) it is rule breaking and reshapes markets; (iii) it offers value improvement for livelihoods; (iv) it is sustainable. The case study analysis was built from 17 interviews, a focus group discussion and numerous documents. The case analysis revealed that tidal river management is very different (local, natural, complex) from mainstream engineering strategies for tidal rivers and polder systems, and is strongly supported by local people for its potential livelihood improvement. The paper concludes that tidal river management has strategic potential, though is hardly recognised in master plans. To advance practice, reconceptualisations are needed that focus on the diverse benefits of TRM, such as restored tidal rivers, flora and fauna. Further research could elaborate livelihood models that thrive on these benefits, and evaluate their costs and benefits accordingly.

Keywords: Delta management; Grassroots; Innovation; Planning; Silt; Strategic thinking; Transition

1. Introduction

Scientists and practitioners around the world are searching for more sustainable development trajectories for delta regions (the relative flat, fertile plains located between rivers and the coast) as many

doi: 10.2166/wp.2018.212

urbanised deltas face development challenges that are driven by rapidly growing economies and populations, and by the prospects of a changing climate and rising sea levels (Nicholls *et al.*, 1999; Syvitski *et al.*, 2009; Renaud *et al.*, 2013; Giosan *et al.*, 2014; van Staveren *et al.*, 2017a). Strategic delta planning has been introduced as a relatively novel approach to more sustainable development (Norgaard *et al.*, 2009; Seijger *et al.*, 2017; Zegwaard *et al.*, under review). It represents a particular form of strategic planning (Albrechts, 2004) and is defined as a public-sector led process through which a long-term vision (the strategic delta plan) and actions and means for implementation are produced that shape and frame what a sustainable delta is and may become (Seijger *et al.*, 2017). A strategic delta plan sets strategic priorities for development and sketches alternative development options on how a delta could cope with growing economies, populations and the impacts of climate change. Innovations play an important role in delta planning across sectors (e.g. transport, water, food, agriculture) as they give shape to adaptations for a changing environment (Nicholls *et al.*, 2016; Tran *et al.*, 2018a) as opposed to retaining business as usual in a changing environment. Innovations in a delta planning perspective can cover technical and institutional changes, be diffused bottom-up or top-down and transferred from one region to another (Norgaard *et al.*, 2009; Vinke-De Kruijf *et al.*, 2012; Seijger *et al.*, 2017).

This paper explores how innovations in land and water management could enable a shift to more sustainable strategies and livelihoods, in line with directions outlined in a strategic delta plan. The paper focuses on tidal river management (TRM) as an innovation to cope with waterlogging, salinity and congested rivers in the Bangladesh delta (Tutu, 2005; Shampa, 2012). The objective of the paper is to explore the strategic value of TRM and trace how it has been appreciated by different groups of people and in various strategic plans. We study TRM as a strategic innovation (Schlegelmilch *et al.*, 2003) in the context of strategic spatial planning and delta planning. We thus offer a novel perspective on TRM by studying its strategic aspects of reconceptualising business models, values and markets. We therefore supplement a growing body of TRM literature that has covered hydrodynamic modelling (Shampa, 2012; Amir *et al.*, 2013), initial experiences with TRM (Tutu, 2005), historical perspectives (Nowreen *et al.*, 2014; van Staveren *et al.*, 2017b), social learning and conflicts (Mutuhara, 2018), local participation and transdisciplinary implementation (Haque *et al.*, 2015; Gain *et al.*, 2017), and sustainability indicators (Masud *et al.*, 2018).

In Section 2 the importance of silt in the southwest of Bangladesh is summarised and the principal technical features of TRM are introduced. Section 3 reviews theories on innovation and explains the research design and methods. The case analysis of TRM as a strategic innovation is presented in Section 4, and implications of our findings are discussed in Section 5. Section 6 presents conclusions on the role of a strategic innovation such as TRM in re-thinking Bangladesh's delta management.

2. Study area

Deltas are formed and elevated over time as sediments accumulate in the delta plain, instead of being dispersed by waves, tides and ocean currents. The formation of the Ganges Brahmaputra Delta, or Bengal Delta, is characterised by a huge sediment load, tectonic subsidence and a near shore canyon system that resulted in widespread sediment distribution across the delta (Goodbred Jr & Kuehl, 2000; Datta *et al.*, 2008). Two major carriers of sediment are the monsoon river discharges and the daily tidal prisms carrying sediment 120 km inland through tidal channels (Barua *et al.*, 1994; Goodbred

Jr & Kuehl, 2000; Rogers *et al*., 2013). The Ganges and Brahmaputra rivers jointly produce a total sediment flux of 1,060 MT per year, making it the third-largest sediment flux in river systems worldwide, after the Amazon and Huanghe rivers (Milliman *et al*., 1995). Of the 1,060 MT per year, c.30% is deposited in the floodplains, c.40% is deposited in the marine part, c.10% is deposited in the Sundarbans and immature Bengal Delta, and the remaining c.20% is washed away into the Bay of Bengal (Goodbred Jr & Kuehl, 1999; Rogers *et al*., 2013). Active land formation in the delta, driven by sediment influx and river bank erosion, is not delimited to the Sundarbans mangroves that elevate with sea level rise (Rogers *et al*., 2013), but also evident in the thousands of new (is)lands, *chars*, formed in the rivers and coastal edges (Sarker *et al*., 2003).

We recognise the diverse biophysical classifications of the Bengal Delta. Rashid (1991) distinguished between the Maribund Delta, Immature Delta, Mature Delta and Active Delta. Brammer (1996) distinguished the Ganges River Floodplain and the Ganges Tidal Floodplain. Our research area covers a number of these classes and we therefore refer to the more generic term 'Lower Bengal Delta' in southwestern Bangladesh (following Rogers & Overeem, 2017).

TRM in the Lower Bengal Delta can be considered as a partial return to the age-old practice of 'temporal overflow irrigation' (Willcocks, 1930; Tutu, 2005; van Staveren *et al*., 2017b). Yet, instead of inundating the fields with fresh water and sediments, TRM foresees the use of brackish and saline water and sediments to inundate the fields. The shift to tidal waters was needed in the Lower Bengal Delta as upstream interventions like the Farakka Barrage and irrigation projects significantly decreased fresh water flow into the area (Gain *et al*., 2017). TRM (Figure 1) enables the natural movement of sediment-loaded tidal river water into an embanked low-lying area (a 'beel') during high tide. This leads to sediment deposition in the beel as flow energy is significantly reduced. During low tide, the outgoing sediment-free water picks up river sediment, erodes the riverbed and increases the drainage capacity of tidal rivers (Mutahara *et al*., 2017). TRM requires a cut in the river embankment, or a link-canal between the river and the beel, to daily transport water and sediments into the low-lying area for a period of 3–5 years (Shampa, 2012). During these years, the beel is daily flooded with brackish water and sediments. Formal and informal TRM projects in the Lower Bengal Delta in the southwest of Bangladesh are and have been conducted; see Figure 2 and Table 1. As Table 1 shows, TRM is capable of elevating land within the beel between 0.2 m (at the far end) and 2 m (near the cutting point), and increasing river flow as the tidal river deepens (by 9–12 meters) and widens (by 2–8 times the pre-TRM width).

3. Theory and method

To look at TRM as a strategic innovation, we draw on the research of organisational scholars who combined the two topics of innovation and strategy under the joint heading of 'strategic innovation' (Sundbo, 1995; Schlegelmilch *et al*., 2003). Strategic innovation is defined as the fundamental reconceptualisation of business models and the reshaping of existing markets (by breaking the rules and changing the nature of competition) to achieve dramatic value improvements for customers and high growth for companies (Schlegelmilch *et al*., 2003). Strategic innovation thus questions the fundamentals of existing business models and ways of thinking, and the strategy is essentially one of breaking the rules in which people and businesses operate and think (Markides, 1997; Gebauer *et al*., 2012). Although scholars strongly focus on single companies such as Amazon, and how they influence markets

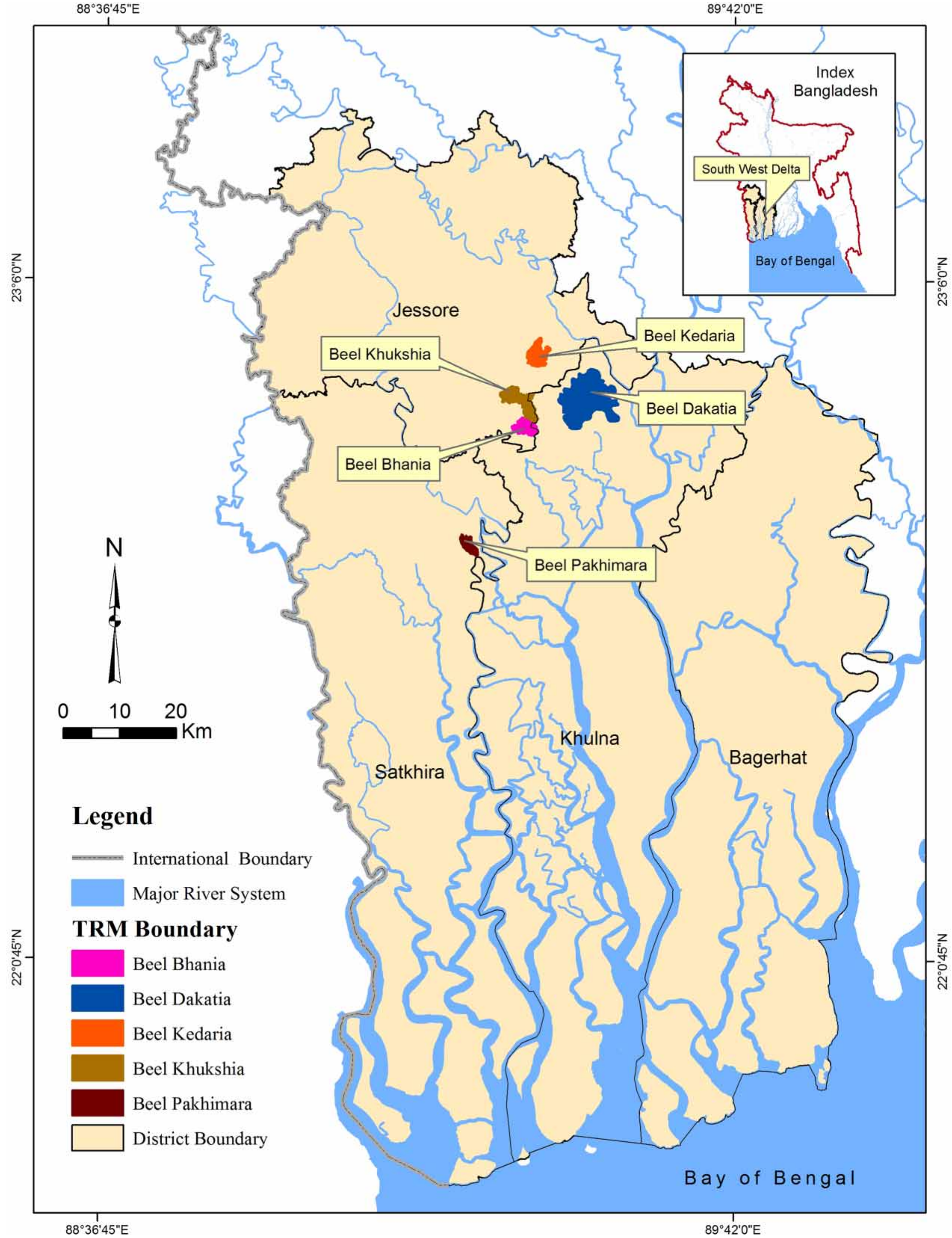

Fig. 1. TRM projects in the Lower Bengal Delta, southwest Bangladesh (*Source:* CEGIS).

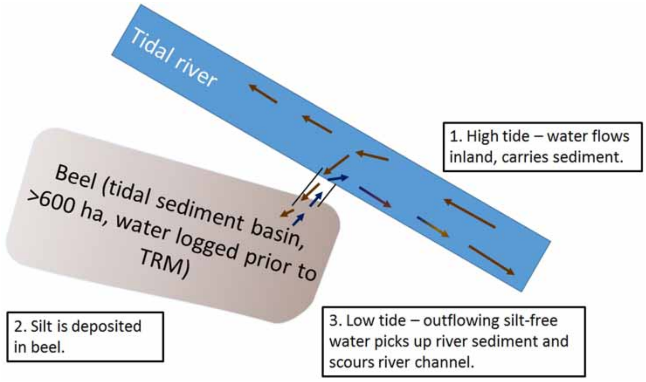

Fig. 2. Conceptual diagram of TRM (after Shampa, 2012).

Table 1. Overview of implemented TRM projects in Lower Bengal Delta.

Beel and tidal river	Type	Duration	Size	Land elevation within beel	River scouring	Source
Beel Dakatia, Shandhar Khal Hamkura river	Informal	1990–1994	c.12.500 ha	>0.5 m on average	depth >9 m, widened >8 times	Nandi (2011)
Beel Bhaina, Hari Mukteshwari river	Informal	1997–2001	600 ha	1.5–2 m near cutpoint, 0.2 m at far ends	Depth 10–12 m, widened 2–3 times	Gain *et al.* (2017); Mutuhara (2018)
Beel Kedaria, Hari Mukteshwari river	Formal	2002–2005	600 ha	Insignificant	Not measured	Mutuhara (2018); Nandi (2011)
Beel Khukshia, Hari Mukteshwari river	Formal	2006–2012	1,100 ha	1.5–2 m near cutpoint, 0.5 m at far ends	Depth 10–11 m near cutpoint	Gain *et al.* (2017)
Beel Pakhimara, Kobadak river	Formal	2015–ongoing	700 ha	ongoing	Ongoing	Gain *et al.* (2017)

and customers (Schlegelmilch *et al.*, 2003), some have addressed strategic innovation in networks (Matthyssens *et al.*, 2006), and in the following section we unpack key elements of strategic innovation in the context of strategic delta planning.

3.1. *Strategic innovation theory for delta planning*

A strategic innovation in the context of strategic delta planning can be characterised by four elements. The first element is the fundamental reconceptualisation of a business model. A strategic innovation shifts away from dominant business models (e.g. how water is managed or how land is being used), and instead a wider range of strategic options is explored beyond conventional logics (Martinsons, 1993; Gebauer *et al.*, 2012). Strategic options reveal how a delta *could* be managed or developed. The options explore strategic choices for ways in which land and water resources could be managed.

Thus, strategic innovations focus on completely different strategies at delta level instead of seeking to innovate and improve existing strategies. For instance, a strategic innovation could exploit the benefits of salinity intrusion and sea level rise, whereas conventional strategies may tend to 'keep the salty water out'. Or, along major rivers, a strategic innovation could focus on the benefits of more natural river channels and restored floodplains, whereas conventional strategies promote river confinement and embankment of flood plains.

The second element is dramatic value improvement for customers (Hamel, 1998b; Schlegelmilch *et al*., 2003). Instead of making marginal improvements for customers – people who live in delta areas – leaps in value could be achieved through strategic innovation. These leaps may be gained just as the limits of conventional strategies are increasingly experienced, and when connections can be made between interests and problems that were not made before. Especially in the context of climate adaptation in deltas, the effects of a changing climate are increasingly felt (e.g. temperature changes and increases in salinity intrusion, droughts and floods), and tend to act as value depressing factors on conventional production and management systems (e.g. rice in the Mekong Delta (Royal HaskoningDHV *et al*., 2013), potatoes in the Dutch delta, cotton in the California delta (Pathak *et al*., 2018)). Counteracting these effects, when already possible, requires high investments in dikes, sluices and reservoirs; investments often attracted through megaprojects and sectoral master plans covering rivers and delta regions (Latrubesse *et al*., 2017; Seijger *et al*., 2017). The investment costs impound the value generation capacity of conventional production models and limits it to a mere continuation of the 'business as usual' strategies. Hence, dramatic shifts and gains in value could be obtained when innovations create value on the impacts of a changing climate. For instance linking mangrove forests with shrimp and rice cultivation in tropical deltas may generate more value than intensive shrimp or rice farming. A recent study in the Mekong Delta showed that farmers are aware of the (depressed) values of conventional triple rice models and increasingly favour alternative farming systems that include flood-based farming (Tran *et al*., 2018b).

The third element focuses on reshaping existing markets and inventing new markets, meaning that a strategic innovation does not seek to improve and extend conventional technologies and markets, but instead has radical superior value, rendering competition with conventional technologies irrelevant (Hamel, 1998a; Matthyssens *et al*., 2006). Such reshaping is easier said than done as it involves rule breaking in the way business is traditionally conducted (Schlegelmilch *et al*., 2003). The reflections on value improvement above indicate that conventional markets become difficult to sustain in the light of climate change impacts and deltas may thus stand to lose their competitive advantage – being flat, fertile and in between coasts and rivers – to other areas in the world. Hence, to sustain economic productivity in the future, new markets have to be invented. Consequently, strategic innovations may focus on values that are compatible with climate change impacts (e.g. seaweed farming in coastal deltas, TRM). Advancing these types of strategic innovations in delta planning implies that many rules have to be broken down. Delta planning takes place in public with rules being structured in diverse domains as policy, science and culture, and these domains may, due to increasing returns (Pierson, 2000), be attached to prevailing strategies and have little interest in strategic alternatives.

Missing in this understanding of strategic innovation is an explicit notion of sustainability. Strategic delta planning processes are undertaken to come to a more sustainable development of a delta (Seijger *et al*., 2017). This is particularly needed as ecosystem services in major deltas such as the Amazon, Ganges-Brahmaputra and Mekong are rapidly being lost and environmental degradation continues under the increasing pressure of economic growth and growing populations (Renaud *et al*., 2013; de

Araujo Barbosa *et al*., 2016; Hossain *et al*., 2016). In addition, delta lands themselves are increasingly at risk due to reduced sediment fluxes and absolute sea level rise, both of which contribute to (future) loss of delta lands (Giosan *et al*., 2014; Tessler *et al*., 2018). Strategic innovations should therefore have a fourth element, namely that they fit in to a 50–100 year perspective of what a sustainable delta is and may become.

In sum, changes of strategies in conventional delta planning are often needed, as 'business-as-usual' strategies cannot resolve the development challenges of urbanising engineered deltas. A strategic innovation may thus offer prospects for the kind of changes and choices to make, in order to move away from conventional thinking and acting. These strategic innovations could be embedded in strategic delta plans, and thereby offer a window of opportunity for initiating and stimulating strategic innovation and associated markets. To further understand how this works we will use the four elements identified to study TRM as a strategic innovation in southwest Bangladesh.

3.2. Research design

TRM in Bangladesh was selected as a case study of strategic innovation as the strategy puts emphasis on suspended river sediments as a valuable resource for people, land and rivers, whereas conventional strategies try to get rid of the sediments (i.e. through dredging) or prevent overflow of sediments into flood plains and low-lying areas (i.e. by using sluice gates and embankments). In addition, Bangladesh has a long history of strategic planning in land and water resources, making it interesting to explore to what extent TRM is included in various master plans, of which the Bangladesh Delta Plan is the latest (being approved by the National Economic Council in September 2018).

The case analysis was created from a set of data sources. Primary data were collected through semi-structured interviews and a focus group discussion, all held in October 2017. Interviewees familiar with TRM or problems of waterlogging in southwest Bangladesh were selected. To protect the anonymity of the research participants, a coded citation system has been applied (see Table 2). Interview questions evolved around awareness and support for TRM, decisions and actions that reflect TRM, and enabling and constraining factors for a wider application. An interview typically lasted 40–60 minutes and, in total, 27 people participated in the interviews. In addition to the interviews, a focus group discussion was held to obtain villagers' perspectives of one TRM project. Major discussion points were opinions on TRM, key processes and constraints in TRM, as well as technical issues. The focus group discussion took six hours. Both the interviews and focus group were recorded and transcribed; in two interviews, notes were taken that were transformed into an interview report. The primary data were analysed through qualitative template coding (Crabtree & Miller, 1999), with categories that specify aspects of innovation dissemination and strategic delta planning. The categories were: strategic thinking, prospective change,

Table 2. Overview of the interviewees and focus group.

Groups	No. interviewees	Interview codes
Decision making at a national level	6	Nos 1 to 5
Bangladesh researchers and scientists proposing and studying TRM	13	Nos 6 to 10
Local governmental agencies	4	Nos 11 to 13
Local non-governmental agencies	4	Nos 14 to 17
Focus group TRM project	21 villagers in 8 groups	Nos 18 to 25

mental models, consent, influenced decisions and plans, where and when practiced, technology and institutions in place, enabling and constraining factors, and others. The resulting coding tables were then transformed into an initial case analysis and revised with the concept of strategic innovation.

The initial case analysis was supplemented with secondary data. Through a desk study, three governmental master plans (Seventh 5-year Plan, Bangladesh Delta Plan, and the Coastal Embankment Improvement Project) and country policy documents from the World Bank and Asian Development Bank (ADB) were studied to assess formal priorities in water and sediment management for the southwest of Bangladesh. Keywords used in screening these documents were: polder, south, drainage, logging, silt, sediment, tidal river. In addition, 15 consultancy and research reports were studied that focused on waterlogging or TRM in the southwest. Furthermore, newspapers were queried online using the keywords 'tidal river management' to see how TRM was reported in the media. The query was undertaken on 13 December 2017 and produced 22 articles in six English-speaking media: Bangladesh Daily Observer BD News 24, Daily Star, Daily Sun, Dhaka Tribune, and Independent. The news items were summarised and put in chronological order. Finally, three field trips were made to Khulna and surrounding areas in 2016 and 2017, to see the field conditions and informally talk with people about their past and current livelihoods in six different polders (Polder Nos 23, 28a, 30, 35/1, 24, 6/8). All secondary data were used to validate and substantiate the initial case analysis built on data from the interviews and focus group discussion, resulting in the case analysis presented in this paper. For reasons of readability, we only present the (anonymised) interviews in the case analysis and do not list the secondary data.

4. Results: TRM as a strategic innovation

The case analysis is subdivided into five sections. The first sections discuss the four separate elements of a strategic innovation for TRM. A synthesis of the case study is provided in Section 4.5.

4.1. A fundamental reconceptualisation

The coastal zone of Bangladesh, including the Lower Bengal Delta, was transformed during the 1960s and '70s from an agro-ecological landscape with overflow irrigation to reclaimed polder lands (Interview Nos 2, 6, 15). Of the 2.8 million ha of land in the coastal zone, nearly 50% has been turned into poldered lands with the construction of 139 polders. The strategic reasons for development choices at that time were protection against salinity intrusion, flood protection and land reclamation for agriculture and settlements (Interview Nos 5, 6, 13).

Interviewees associated the construction of the polder system with a strong preference for hard infrastructure. The polder system was designed and implemented by the Bangladesh Water Development Board (BWDB) which was set up to manage hard infrastructure (Interview Nos 6, 9, 14). Embankments were built and reinforced to keep the river water out, sluices and sluice gates were installed to regulate water flows to and from the polders, and dredging of river channels was undertaken to secure the drainage capacity of the rivers (Interview Nos 2, 5, 6, 9). The hard infrastructure strategies were promoted by saying that the polder system brought stability (Interview No. 5), the system of embankments required strengthening (Interview Nos 2, 5), and that a centralised infrastructure made management and implementation easier for BWDB (Interview No. 9). Reasons mentioned for dredging were: to maintain the polder system (Interview Nos 2, 5), its ease of implementation and thus political attractiveness as it did not involve local participation, whilst also offering an opportunity for rent-seeking behaviour (Interview Nos 6, 10).

TRM represents a fundamental reconceptualisation of the above business model to manage land and water resources in the southwest of Bangladesh. This is perhaps most clearly illustrated by the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) (1993–2003). The project was undertaken to overcome waterlogging, as one in five hectares in the project area had been taken out of agricultural production because of it. Initially, large water regulation structures were proposed to overcome the waterlogging (Interview Nos 3, 6), yet these were heavily criticised for not being effective by local people and NGOs during environmental and social impact assessment studies (Interview Nos 8, 15, 16). The assessments resulted in an entirely different alternative to overcome waterlogging, namely TRM.

The technical functioning of TRM has already been explained in Section 3 above; here, we discuss the main differences it has with hard infrastructural measures. First, interviewees presented it as an idea drawn from local people, that emerged in the KJDRP (Interview Nos 6, 8, 17), and that the idea fits historical practices of cutting embankments to drain out river water (Interview No. 19). Second, it was considered a natural solution, since TRM uses the tide and sediments as a natural process to resolve waterlogging instead of engineering methods (Interview Nos 3, 10, 17, 18, 19), and the natural system – previously stopped by embankments – is reactivated (Interview No. 13). Under the tidal dynamics used in the project, huge amounts of sediment were transported into beel areas, thereby elevating beels while outflowing water increased the conveyance capacity in river channels (Interview Nos 11, 19) and waterlogged land was transformed into elevated ‘dryland’ (Interview No. 12). Though the natural system was reactivated (Interview No. 13), engineering works were still needed in TRM: embankments around the beel had to be constructed, link canals had to be dug when a beel was not directly adjacent to the river, and pre-dredging was advocated by some to bring rivers and beel canals to desired design depths before TRM started (Interview No. 6). Third, TRM was characterised as a complex and conflictful implementation process. Interviewees mentioned that it requires a transparent, participatory, accountable process (Interview No. 14) while all people in a beel should cooperate by abandoning their houses and fields over a three- to four-year cycle for which they should be fairly compensated (Interview No. 9). In many cases these requirements were not met and TRM projects have been marred by violence, lack of participation, improper compensation and rent-seeking behaviour by local administrators (Interview Nos 10, 18, 19, 24).

4.2. Leaps in value

The benefits the traditional polder system offered (i.e. reclaimed fertile land, flood-free settlements) are increasingly contested. Within 10 to 15 years after the polders were constructed rivers started to silt up, as sediment could only settle in the confined riverbeds, resulting today in ‘choked’ river systems in southwest Bangladesh (Interview Nos 1, 3, 18). Due to siltation the riverbeds rose, resulting in raised river water levels that cause prolonged waterlogging in the polders since people can no longer drain away monsoon rainfall (Interview Nos 3, 6, 14, 18, 19). Estimates for the number of people affected by waterlogging differ: some reports discuss numbers between 720,000 and 1 million people directly affected, whilst interviewees mentioned numbers between 1 and 10 million for people now or very soon to be impacted (Interview Nos 1, 8, 15). Direct impacts of waterlogging range from educational institutes closed for several months, to farmers growing less crops since they can no longer cultivate a monsoon rice crop and gradually lose summer crops as well (Interview Nos 6, 13, 14, 18). The more indirect impacts of rivers silting up are the new lands emerging along river banks which have been taken by local elites, and the stagnant water conditions of waterlogging which favour shrimp cultivation which is also undertaken by influential landowners (Interview Nos 1,13, 18). Furthermore, protests and conflicts have emerged due to waterlogging: in the 1990s, people became desperate and cut into the embankments of Beel *Dakatia* (1991) and Beel *Baina* (1997) (Interview Nos 6, 8, 10). In 2011 hundreds of people held a hunger strike to solve waterlogging and in 2016–2017 people demanded permanent solutions to waterlogging in the *Bhabadah* area.

The potential leap in value is most clear when grassroots voices explained that with TRM they are able to get 3–4 crops per year, not only for them but also for their future generations (Interview Nos 18, 19, 22, 24, 25). This leap in value for enhanced livelihood could be achieved when embankments are breached and a beel is connected to the river channel for a period of 3–5 years continuously. Others relate the leap in value to the tidal river system. They stated that TRM is the only way to solve problems of waterlogging as TRM is dredging without spending money while resulting in wider, deeper rivers and increased conveyance capacity (Interview Nos 11, 19). The leap in value for improved river systems could be achieved when, along a river stretch, a TRM basin is continuously opened so that sediment can be deposited in the beel and the river channels scoured.

Yet, is the leap in value for enhanced livelihoods and living rivers widely recognised? Among the supporters and advocates are local people demanding TRM, NGOs (such as Uttaran and Jagrata Juba Shangha (JJS)) who empower local people, research agencies such as the Center for Environmental and Geographic Information Services (CEGIS) (e.g. proposing TRM in impact assessments, improving compensation mechanisms) and Institute of Water Modelling (IWM) (e.g. proposing regional TRM plans), and the United Nations Development Programme (UNDP) piloting TRM innovations. However, interviewees explained there were also locals who were not in favour as they are taken away from their land, crops, homes and livelihoods (Interview Nos 1, 10, 11, 18, 22, 23), and not properly compensated (Interview Nos 3, 18). Interviewees mentioned that large land owners and local leaders are generally against TRM as waterlogging favours shrimp farming which is more profitable than creating drylands through TRM (Interview Nos 2, 13, 18).

Decision makers in Dhaka – the capital of Bangladesh – present ambiguous attitudes: on the one hand, they were sympathetic to local concerns and approved implementation of TRM in the KJDRP and in subsequent TRM projects (*Khuksia*, *Kapalia*, *Pakhimara*). On the other hand, interviewees observed a strong preference for dredging among Dhaka's decision makers (Interview Nos 6, 10, 15), who were privately opposed to TRM and promoted both TRM and dredging in media articles. In the BWDB, interviewees knew some people who personally supported TRM (Interview Nos 11, 17), and others who observed that BWDB was slowly turning to TRM (Interview No. 6). However, interviewees also expressed concerns that senior people in the water board were not convinced about TRM (Interview Nos 6, 11) and others did not observe a real willingness within BWDB to change to more natural solutions (Interview Nos 8, 10, 14, 15, 17). Regarding support from international financial institutions, the ADB did originally support TRM in the KJDRP, but they had no follow-up projects due to its contentious implementation (Interview Nos 15, 17); another interviewee mentioned that the Japan International Cooperation Agency (JICA) and ADB did not want to fund TRM as long as it was associated with conflicts between local people and local government officials (Interview No. 1). These interviewees thereby supported the view that international finance institutions such as the World Bank and ADB have a preference for funding large-scale infrastructure projects (Interview No. 17).

4.3. Breaking rules and markets

Although at least two consultancy reports have shown TRM can be potentially much cheaper than hard infrastructure, it is not the case that local citizens are themselves able to opt for TRM and the beneficial values of enhanced livelihoods and river systems. Decisions about water projects are usually made within the Ministry of Water Resources (of which the BWDB is part) and by the Planning Commission. Several rules would thus have to be reshaped before a market could be created that seizes the values offered by TRM. Here we discuss two examples: breaking the rules of the compensation mechanism; and influencing the market of water projects in which measures are proposed to cope with congested rivers and waterlogging.

Under the revised Water Policy Act of 2013, landowners have a right to compensation when affected by a water project like TRM (Interview No. 14), though the right for compensation is not clearly described. Interviewees mentioned several flaws in the current compensation mechanism and made the case for a fair and proper one (Interview Nos 6, 7, 11, 14, 18, 19, 23). Formally, land owners should receive compensation based on maximum production, as determined by agricultural and fisheries officers (Interview No. 24). Applicants for compensation have to provide a list of documents including land settlement, cadastral survey, state acquisition, mutation records of land ownership and heir certificates. These documents should cover any changes in landownership since the 1960s. Compensation is denied when submitted papers do not match with governments records, when all papers are not submitted at once, when any papers contains a misspelling, or when one of three involved administrators reject the compensation for any of the above reasons (Interview Nos 18, 19, 21). The compensation mechanism is meant for land owners, and thus does not offer compensation for farmers leasing land from other landowners or for day labourers working on other's land. In addition, the complex procedure is easier to fulfil for large landowners than it is for small landowners, farmers without land rights or those who are illiterate (Interview Nos 11, 13, 15). In *Pakhimara* Beel, compensation would be provided for four years (2011–2015), but an inventory conducted by the local NGO Uttaran revealed that only two payments were made, and that these were only partially made: 55% of the budget was distributed for year one, and 15% for year two. Moreover, pre TRM operation compensation was promised, but no compensation was received in the two years of construction works prior to TRM (Interview Nos 11 & 19). Individual accounts revealed instances of no compensation and of land grab (Interview Nos 19, 21) and of spending half of the compensation money on 'speed money' to obtain approval (Interview Nos 19, 20). Consequently, obtaining compensation should be made easier (with fewer forms and less bureaucracy) and fairer (Interview 18, 19, 24), by differentiating between land owners and those who are dependent on beel lands, such as share croppers (land leasers) and day labourers. A pilot for participatory and transparent 'TRM + +' undertaken by UNDP showed the feasibility of compensating land and non-land owners, prior and during TRM, and reducing transaction costs through mobile money transfer (Interview No. 4).

A market that should be influenced by the potential leaps in value TRM could offer to local livelihoods is the water projects' market. In this market, master plans and policies have reflected 'business as usual strategies' that, due to prolonged waterlogging and river congestion, potentially offer less value than TRM. As explained above, the preference for hard infrastructure and dredging to create and maintain the polder system has limited the opportunities for value generation in the southwest polders: the natural flows of the river are increasingly restricted, resulting in widespread drainage congestion and waterlogged livelihoods. This preference for hard infrastructure is visible in a range of master plans that provided people in the southwest with polders and hard infrastructure to regulate water (e.g. embankments, sluices, sluice gates). Examples include the Coastal Embankment Project (mid-1960s), Coastal Embankment Rehabilitation Project 2 (1986–1993, 17 million USD) and KJDRP (1993–2003, 62 million USD). The dredging that was needed to avoid drainage congestion in the tidal rivers created a related market for dredging operations, which was highly contested as interviewees saw no use in dredging in the coastal area, or only when applied in strategic locations (Interview Nos 10, 11). A new series of master plans have recently been developed and they indicate that the values generated by TRM (e.g. natural rivers, improvement in livelihoods, land formation) are not broadly recognised. The Seventh 5-Year Plan (2015) of the Planning Commission mentions, in several instances, the problem of drainage congestion and waterlogging, yet does not list hard infrastructure as a prime cause, and interestingly conceives river dredging as a prime strategy to mitigate waterlogging and congested rivers in the Lower Bengal Delta. Likewise, the Coastal Embankment Improvement Project (CEIP) (400 million USD, 2013–onwards) does not describe causes of river siltation and waterlogging in its formulation document, and merely seeks to strengthen existing embankments after the Government decided to upgrade them. Interviewees confirmed that the CEIP sticks to strategies of river excavation and embankment strengthening (Interview Nos 2, 3, 5, 15, 17). Lastly, the Bangladesh Delta Plan 2100 (2015), with an investment package of 80 projects worth 38,000 million USD, links river siltation to the construction of polders and proposes to overcome waterlogging in the southwest region through their appropriate management. An extensive TRM program has been proposed for the tidal rivers of *Betna*, *Marircharp*, *Kobadak* and *Hari*, whilst, in the investment package, only one project includes TRM and an extensive TRM study is proposed.

4.4. Sustainability

By adopting a sustainability perspective of 50–100 years for what a sustainable Lower Bengal Delta is and may become, it is obvious that the polder system fitted into the sustainability perspective of the 1950s. Polders were the strategic innovation of that time, as coastal areas were fundamentally reconceptualised into agricultural land, offering leaps in value by providing land for settlements and agriculture. Yet, experience increasingly shows that these leaps in value are no longer being attained, as severe waterlogging puts lands out of production and deprives people of their livelihoods. Looming sea level rise and changes in monsoon rainfall (Dastagir, 2015) are likely to make the magnitude and impact of waterlogging more severe, thus giving rise to more conflicts over waterlogging and lead to increased operation and maintenance of the polder system. Based on how TRM has currently been approached and implemented, interviewees indicated three ways to revise it.

First, limited effort has been put into strategic long-term thinking on TRM. The first set of TRM projects (*Dakatia*, *Baina*, *Kedaria*, *Khuksia*, *Pakhimara*) were initiated to address pressing concerns of waterlogging. Little effort was put into a regional TRM perspective. For instance, after beel *Khuksia* was closed, interviewees stated there was no subsequent beel that acted as a sediment reservoir and the river silted up within four years (Interview Nos 8, 9). Respondents therefore mentioned the importance of having a regional plan in which beels rotate, from downstream to upstream (Interview Nos 14, 18, 23). In fact, one interviewee proposed having fixed TRM beels in the tidal river basins and removing silt from these beels periodically, since that would be cheaper and easier to manage than continuously seeking and preparing new TRM projects (Interview No. 11). Regional plans have already been made by Uttaran, CEGIS and IWM in which TRM is proposed in rotation for the southwest tidal rivers, yet these plans have to date not resulted in strong support or formal incorporation into governmental policy and planning. In addition, interviewees questioned how many decades TRM may be effective, and whether the elevated flood-free areas of today would become low-lying beels after decades of TRM, and whether sediment could be reused as a valuable resource for construction or export to sediment-poor neighbours such as Singapore (Interview Nos 6, 8, 9, 10). These questions emphasised that strategic thinking on silt as a valuable resource is emerging, though not widely visible, and in general interviewees stressed that sediment management is badly needed, though not visible in water projects or reflected in statements from decision makers in Dhaka (Interview Nos 6, 10, 18).

Second, whereas TRM is a dynamic strategy in a highly dynamic tidal environment, most attention seems to go to the impacts on people from waterlogging and remarkably little attention has been paid to social-ecological aspects. Few interviewees talked about ecological impacts of river siltation, with one mentioning the killing of tidal rivers and another calling it an ecological disaster when the rivers cannot be saved (Interview Nos 3, 18). Yet the implications of dying rivers for riverine flora and fauna were not mentioned, nor how they could be put to productive use for local communities. For instance, the aquaculture capacity of inundated beels has not been explored, though there seems to be support for fish-based livelihoods during TRM, as in a CEGIS study on different compensation mechanisms for TRM, in which the option of ‘cash crop compensation and free fishing’ was ranked second out of seven options (‘cash crop compensation’ was number one). One report explored livelihood options under waterlogged conditions (e.g. fish cultivation with cages or pens, floating vegetables, floodplain aquaculture), yet these livelihood options should then be temporary livelihoods and not interfere with sediment deposition. The latter happened in *Pakhimara* beel, where shrimp nets near the cutting point blocked sediment transport further into the beel (Interview Nos 23, 25).

Third, the conflicts that are now associated with implementation of TRM should be reduced within the current institutional setting to make TRM a more desirable alternative. These could partly be reduced by disseminating the benefits and technical principles of TRM to local communities, implementing agencies like the BWDB and local political leaders (Interview Nos 7, 9). In addition to adjusting the compensation mechanism (see above), self-organisation at the local level is needed to increase support for TRM, across land owners (large and small), dryland and shrimp farmers, and land leasers and day labourers. A resolution has to be found with shrimp farmers, as they undermine TRM projects, favour waterlogged conditions and offer limited employment (Interview Nos 16, 19, 24). Zoned commercial shrimp farming could be a promising option, with shrimps thriving on the natural tidal environment and cultivated in a more labour-intensive system.

4.5. Tidal river management: putting strategic innovation into practice

From the previous sections it can be concluded that TRM represents a strategic innovation for the management of land and water resources in the southwest of Bangladesh. The four aspects of a strategic innovation discussed above each reveal strategic considerations. TRM is a completely different strategy for managing the tidal rivers and polder systems in the southwest (fundamental reconceptualisation). The major differences, when compared to conventional hard infrastructure, are the use of local people’s strategy versus engineers’ knowledge, and a nature-driven solution instead of an engineering approach.

In addition, TRM can count on the strong support of local people and research institutes for its long-term leaps in value for stable livelihoods, land formation and natural rivers (leaps in value). However, support and recognition for the value leaps has not been universal, neither at a local level (e.g. shrimp farmers, smallholders), nor with organisations that are influential in decision making. It is not surprising, therefore, that the value leaps possibly offered by TRM have not yet convinced the major players in the 'market' of water projects to change project proposals for the southwest delta to include strategies that thrive on natural flows of water and sediment. Markets for TRM are thus not yet operational or responsive to the new values they offer (reshaping rules and markets). Finally, from the long-term sustainability perspective, it becomes apparent that the TRM strategy has to evolve further before markets respond or emerge and rules are broken. Three sustainability concerns emerged, namely: the need to think strategically about TRM as a strategy for the Lower Bengal Delta (the rotation of beels, longevity, silt as a resource); a broader focus on the diverse benefits and values of TRM for people and the environment; and the need to seek ways that multiple values can be distributed to land users, leasers and labourers to reduce conflict on TRM.

In sum, TRM offers a compelling vision of how the southwest delta could be developed, with potential value generation for local livelihoods on tidal river flows and sediment. Presently, TRM is at best a theoretical alternative, since a strategic choice for sediment flows in tidal rivers and adjacent lands for enhanced livelihoods has not been made. To turn TRM into a widely practiced strategy, a further reconceptualisation of TRM would be needed on the sustainability concerns outlined above. When this reconceptualisation can be made, the leaps in value may be more visible and can then be distributed to a more diverse group of people, resulting in stronger agreement with TRM at local and national level and hence a higher likelihood that TRM will be incorporated in plans and policies for the Lower Bengal Delta.

5. Discussion

The objective of this paper was to explore the strategic value of TRM and trace how it has been appreciated by different groups of people and included (or not) in various master plans. The case analysis revealed the strategic potential of TRM (completely different strategy, possible leaps in value), though appreciation by people and master plans is not yet sufficient, which thus makes TRM at best a theoretical strategic alternative for how the Lower Bengal Delta could be developed. Here we explore three novel lines of thinking that emerged from the strategic innovation perspective, as this is the first study to operationalise and apply the strategic innovation concept in the context of strategic planning; see, for example, Noble & Nwanekezie (2017), Partidario & Vergragt (2002). The new lines of thinking signal analytical contributions that support strategic thinking on the linkages between sediments, rivers and livelihoods at a delta level.

First, TRM should be reconceptualised beyond the immediate benefits of land elevation and stable livelihoods. Instead, the multiple values that TRM potentially offers should be explored (e.g. restored tidal rivers, estuarine flora and fauna, silt as a valuable resource), so that these values are distributed to diverse local groups and reduce conflict between land owners, leasers, shrimp farmers and government officials. Moreover, our research indicates that hard infrastructure (e.g. embankments, sluice gates) represents the conventional or business as usual strategy that dominates the 'market' of master plans and megaprojects; by contrast, TRM could offer a way out of maintenance strategies (e.g.

dredging, embankment reinforcements) requiring large investments that become increasingly difficult to recoup as the effects of climate change decrease conventional value generation possibilities. Further research could focus on the expected costs and benefits of livelihoods that could thrive on the benefits of restored tidal river systems (e.g. return of hilsha fish, crab-mangrove hatcheries, and the aquaculture capacity of inundated beels). Hydro-economic studies (Harou *et al.*, 2009) could model expected costs and benefits of different livelihoods and generate quantified estimates of the value of water-sediment-salinity in different water management scenarios. In addition, studies would be needed into the short-term social implications of TRM, the 3–5 years when a beel is inundated, and how these could be overcome. Although the terms 'clients', 'customers' and 'markets' are not commonly used in strategic spatial planning (Healey, 2009; Albrechts & Balducci, 2013) or in delta planning (Norgaard *et al.*, 2009; Zegwaard *et al.*, under review), they offer – we think, surprisingly – a refreshing frame of reflection. By focusing on (re)conceptualisation, value generation, rule shaping and strategic sustainability concerns, we have offered new insights into well-known TRM implementation hurdles (e.g. reducing conflict, fairer compensation, learning, rotational TRM) which have been reported by other scholars (Gain *et al.*, 2017; Mutuhara, 2018).

Second, a focus on strategic innovations has brought TRM out of the project sphere and instead focused on tidal rivers and adjacent lands, and on the long-term considerations for TRM and (re)-use of silt, even though our analysis also showed that such strategic thinking still enjoys a limited uptake. This is novel as, in the interviews but also in TRM literature, TRM is frequently approached from a beel and project level (Tutu, 2005; Gain *et al.*, 2017; Mutuhara, 2018), since that is where experience has come from. In general terms, the point of deltas requiring sediment to keep growing/maintaining their elevation with sea level rise has already been made (Syvitski *et al.*, 2009; Giosan *et al.*, 2014). TRM is one example of how sediment flows can be beneficially used to support such delta formation processes. So, strategic innovations have the potential to uncover and re-think strategic concerns for delta management while they offer glimpses of what a more sustainable delta could look like, and clarify development choices and dilemmas (e.g. opting for free sediment flow through tidal rivers and adjacent lands, or not). Therefore, thinking about strategic innovations does not only entail a focus on examples and strong images that could facilitate transformations (Kiehl, 2016) but also clarifies the underlying strategic choices that delta planners and government officials are confronted with when preparing delta plans. Ongoing discussions on silt in other deltas suggest there is a strong societal relevance to rethinking at a strategic level how sediment is used: American scholars have provided recommendations for re-thinking sediment as infrastructure for the California delta (Milligan & Holmes, 2017), Vietnamese researchers have reported attempts to trap sediment for agriculture and aquaculture (Manh *et al.*, 2014) and a study of mangrove restoration programs in tropical regions emphasises the importance of sediment trapping for land formation and protection (Phillips *et al.*, 2017).

Third, through this paper, a number of principles can be derived for identifying strategic innovations in deltas: they contain a fundamental reconceptualisation, have potential significant leaps in value, reshape markets, and fit in a long-term perspective of what a delta is or could be. Polders may have been a strategic innovation of the past, and are today kept in place through maintenance and rehabilitation programs. Alongside TRM, other strategic innovations in the Bangladesh delta can be identified, such as the 'blue economy' through which attempts are made to seize the benefits of Bangladesh's marine resources extending 370 km into the Bay of Bengal (Jafrin *et al.*, 2016). Recognising strategic innovations is one thing, but can we also derive recommendations to initiate them? We see this point as still challenging, as we have mostly identified the properties of a strategic innovation and not so much the how-to's. However, the properties may offer entry points to actively work on strategic innovations in deltas: for instance, to take a closer look into the mainstream strategies and their value generating capacity, and which alternatives may exist to challenge mainstream values. The reshaping of markets and fitting into a long-term perspective are second-tier aspects, while they depend on the reconceptualisation and value sharing for 'customers'. A possible outcome of such thinking is a critical delta-wide reflection on alternative strategies, as more dikes, dams and land reclamation projects reduce sediment dynamics and impede delta formation in the long run (Boyce, 1990; Twilley *et al*., 2016).

6. Conclusion

The case study on Tidal River Management (TRM) in the Lower Bengal Delta of Bangladesh confirmed the relevance and applicability of the key elements of strategic innovation – fundamental reconceptualisation, leaps in value, breaking rules, and sustainability – in re-thinking delta strategies. The case analysis revealed that TRM can be a feasible strategic alternative for coping with congested rivers and waterlogging in the southwest part of Bangladesh. Though there is a strong and persistent support at local level for TRM, and TRM offers a new 'business-model' with promising values such as living rivers and dynamic sediment-water flows for stable livelihoods, markets (which were examined through past master plans and water projects), have to date hardly responded or emerged. As a result, TRM has not yet been able to spread across the southwest delta of Bangladesh. To strengthen support for TRM and secure its inclusion in delta master plans and policies, reconceptualisations are needed to explore its multiple diverse values (restored tidal rivers, flora, fauna, silt as a valuable resource) and how these values could be distributed to diverse local groups of land owners, leasers and shrimp farmers, taking social and economic implications during beel inundation into account.

By introducing the concept of strategic innovation to strategic spatial and environmental planning, a refreshing corporate vocabulary is offered to question both mainstream and alternative strategies for sediments, rivers and livelihoods. Moreover, many concerns for delta management are uncovered as strategic innovations offer glimpses of what a sustainable delta could look like, and can clarify the strategic dilemmas that decision makers and planners face (e.g. opting for free or confined sediment flows) when strategising about delta futures. When delta planners and policy makers decide to work on a particular innovation, the concept of strategic innovation could be used to critically reflect upon the preliminary innovation, its value spreading across diverse 'customers', and which rules and markets have to be reshaped to arrive at a wider diffusion of novel strategies such as TRM. Finally, the four elements of strategic innovation could be used by scholars and practitioners in other deltas as principles to identify and actively work on strategies that move beyond 'business as usual' for land, water and sediment management.

Acknowledgments

We are grateful to the interviewees for sharing their insights with us. Many thanks to research assistants at Khulna University and CEGIS who assisted in data collection and analysis. We appreciate the dedicated comments of two anonymous reviewers that enabled us to critically revise the paper. This research is funded by the Urbanising Deltas of the World Programme of the Netherlands Organisation for Scientific Research (NWO) under Project Number W 07.69.106.

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Received 31 May 2018; accepted in revised form 27 September 2018. Available online 16 November 2018