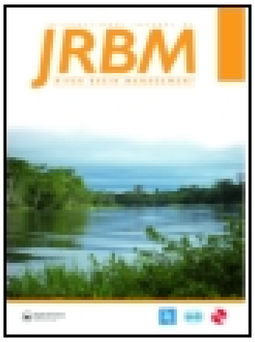

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RESEARCH PAPER

Adaptive delta management: a comparison between the Netherlands and Bangladesh Delta Program

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ABSTRACT

In the Netherlands, the central government, water authorities, provinces and municipalities are working together on a new Delta Program on Flood Risk Management and Fresh Water Supply (DP). Its primary goal is to protect the Netherlands against floods and ensure the availability of fresh water, now and for future generations. The DP has developed a new, adaptive management concept: the Adaptive Delta Management (ADM) approach. ADM is defined as 'a smart and intelligent way of taking account of uncertainties and dependencies in decision-making on Delta Management with a view to reducing the risk of overspending or underinvestment'. Important features of DP are: (i) involving multiple stakeholders in a joint decision-making process to enhance ownership, legitimacy and feasibility; (ii) taking a risk-based perspective; (iii) adopting a flexible approach in possible strategies by valuing flexibility with regard to the timing of implementation and (iv) interlinking various investment agendas and looking for opportunities for mainstreaming with planned investments.

Along similar lines, a Bangladesh Delta Plan 2100 (BDP 2100) is being devised to achieve long-term sustainable socio-economic development and provide safety in the face of disasters through adaptive water governance in Bangladesh. It embodies a holistic, integrated vision, adaptive strategies and a long-term investment agenda for the Bangladesh Delta. The Plan is scheduled to be finalized in 2017. ADM is not an approach that can be transferred easily from one country to another as it demands a fundamental change in institutional capacity at multiple levels including new knowledge and skills, relationships and policy frameworks, and, hence, depends on the local socio-economic characteristics, culture and governance. This paper explores the challenges and opportunities for successful formulation and implementation of BDP 2100.

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1. Introduction

The challenges for flood risk and fresh water management strategies of river basins and deltas are manifold, as water safety issues interact with a wide range of environmental and socio-economic sectors including health, agriculture, biodiversity, industry, navigation and tourism. In addition, in trans-boundary river basins differences in legal frameworks, historical and cultural backgrounds add to the complexity (Timmerman and Langaas 2005). Management of river basins requires a flexible and adaptive programmed approach including the supporting capabilities such as integrated and adaptive policy frameworks and the institutional capacity at multiple levels and across different jurisdictions and countries to exploit these interactions, create synergies and avoid undesired outcomes (Huntjens *et al.* 2011, Rijke *et al.* 2012). The flexibility depends on the capacity of the decision makers to learn from the arrival of new information and their willingness and ability to revise investment decisions based upon that learning.

Based upon the principles of adaptive management (AM) and started in 2003, the TE2100 project is probably one of the first to propose an adaptive approach to manage flood risk. The project aims to protect London and the Thames Estuary from tidal flooding and proposes a series of possible interventions until 2100 that can cope with large ranges of change if needed (Reeder and Ranger 2011). This approach has demonstrated to be instrumental for decision makers to understand the suite of options open to them and how they can be combined into 'decision pathways' that create a portfolio of measures through the century (Reeder et Ranger 2009). Inspired by TE2100, the Dutch Delta Program adopted this adaptive approach (referred to as Adaptive Delta Management (ADM)) to deal with the difficulties of anticipating climate change and socio-economic developments in protecting the Netherlands against flooding and to safeguard future fresh water supply in 2010 (Ministry of Transport, Public Works and Water Management 2010). In the first years (2010–2014), the Delta Program has delivered a coherent set of five major 'Delta decisions' and six regional adaptive strategies (Ministry of Infrastructure and Environment 2014). In the coming decades, the emphasis will shift towards further elaboration of the adaptive strategies and implementation of the measures.

Along similar lines, a Bangladesh Delta Plan 2100 (BDP 2100) is being devised to achieve long-term sustainable socio-economic development and provide safety in the face of disasters in Bangladesh through ADM. With the 'delta vision' to *ensure long-term water and food security, economic growth and environmental sustainability while effectively coping with natural disasters, climate change and other delta issues through robust, adaptive and integrated strategies, and equitable water governance*, and six *delta plan goals* linked

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with the *'Sustainable Development Goals'*, the plan foresees a paradigm shift in implementation of the plan through ADM. Following the ADM principles, analytical frameworks, delta scenarios, strategy framework and adaptive pathways have been developed to achieve these goals by dividing the country into six predominant 'hotspots' or representative planning units. The plan includes an investment plan and an implementation framework which envisions establishment of a 'Delta Commission' and a 'Delta Fund'. BDP2100 aims to built upon the first lessons learned from the Delta Program in the Netherlands, *but is adjusted to the Bangladeshi conditions and policy frameworks where it will be integrated into the 5-year economic development plans in which provide a framework to ensure the integrative character of the plan as well as the implementation of the plan.* The development of BDP 2100 is scheduled to be completed in 2017. The relevance of ADM for developing countries lies in the possibility it offers to develop adaptive and integrated strategies logically underpinning investment decisions in domains characterized by significant uncertainties about the future, such as water safety and freshwater supply (Bloemen 2014, personal communication).

ADM is not an approach that can be transferred easily from one country to another as it employs a relative strict methodology and given the long-term scope, a consistent policy for the short and long terms. Hence, it demands a fundamental change in institutional capacity at multiple levels including new knowledge and skills, relationships and policy frameworks and a meaningful inclusive planning approach. Socio-economic conditions, culture and governance are important factors to be considered in this transformation process. This paper attempts to identify the challenges and opportunities for successful formulation and implementation of BDP 2100 based on an intercomparison of the geographical and institutional context of Bangladesh and the Netherlands.

2. Background: recent trends in flood risk management

Flood risk management strategies change over time, often incrementally, but sometimes more radical changes have been considered and implemented. In many countries of the world, the scope shifted over the past three to four decades from indigenous, local-scale flood protective measures to large-scale interventions, such as flood embankments, drainage systems and channelization. This transition process from small- to large-scale engineering solutions has mainly been supported by economic development and technological innovation (Zevenbergen *et al.* 2013). These large-scale infrastructure systems performed satisfactorily in many countries as the number of fatalities and normalized flood damages decreased, such as in the UK and the Netherlands, and the food production showed a steady increase, such as in Bangladesh. A common feature of these large-scale engineering systems is that their design is based on the assumption that external drivers, such as climate change and economic growth, are stable or change only slowly in comparison with the expected lifetime of these infrastructure systems (Goodess *et al.* 2007). However, since the last decade, it is increasingly recognized that the circumstances for which these systems have been designed, are more severe and/or volatile, than originally predicted. (e.g. Gordon and Little 2009). This lack of appreciation of the 'non-stationarity of drivers' resulted in inappropriate design assumptions and thus in a false sense of full safety (Milly *et al.* 2008).

Climate change is now considered as a trend breaker: the notion that climate change is impacting the hydrological variables and existing statistical distributions of flood probabilities has important implications for the way flood management strategies are now being shaped. It calls for a paradigm shift from the prevailing 'predict and control' regime to a 'flexible and adaptive' regime in which the long-term horizon of climate change (and socio-economic changes) and associated scientific uncertainties are explicitly taken into account. Strategies which address these challenges have in common that they recognize that there is no best solution, and embrace a future, which '*fits into a distribution of events that will not come as a surprise*' (Pahl-Wostl 2007). In that sense, climate change provides new incentives for the need to plan ahead and to anticipate extreme events.

3. The principles of AM

AM has emerged in the US since the 1990s to support natural resource management policy as a response to short-comings of the 'traditional' approaches to manage natural resources. It is defined as a systematic process of learning from the outcomes of management actions, accommodating change and thereby improving management (Gunderson 1999). Hence, it entails a systematic and structured process for continuing improving management policies and practices acknowledging our limited understanding of natural system's behaviour.

AM is considered as an effective strategy if (i) uncertainty is acknowledged and 'information gaps' are identified, and thus when learning is needed to achieve certain management goals, (ii) there are good prospects for learning and experimenting in order to narrow down information gaps over time and (iii) the socio-economic and physical changes warrant to adjust management directions (interventions) as a consequence of lessons learnt (Doremus *et al.* 2011). It is not surprising that there is a growing interest in AM in many river restoration efforts and more recently in flood management programs. Well known examples of the first category are typically from the US including the Mississippi River Basin, the Colorado river and Colombia River Basin. Examples of the second category comprise the previously mentioned Thames Estuary project (TE2100) and the Dutch and Bangladesh Delta Program.

In spite of these promising prospects, several attempts to develop and implement AM have failed due to institutional constraints, a lack of stable (long-term) funding and resources for information gathering and monitoring, reluctance of decision makers to admit and embrace uncertainties in making policy choices, and lack of leadership in implementation (Lee 1999, Walters 2007). To overcome these challenges, three enabling elements are deemed necessary to successfully implement AM in practice: (i) a system approach, (ii) participatory decision-making and (iii) learning and experimentation (Berkes 2009, Huitema *et al.* 2009, Van Herk 2014). In addition, continuity in implementation has to be provided by institutional arrangements on leadership, funding and legal aspects (Van Alphen 2013).

4. Bangladesh: geographical and institutional context

Bangladesh is located at the junction of the Ganges, Brahmaputra and Meghna rivers in the world's largest river delta. About 93% of the combined river basins are located outside of the country. The tropical climate of Bangladesh is monsoon driven, with about 80% of the annual rainfall occurring between June and September. The resulting seasonal cross-border and domestic runoff is therefore tremendous and far exceeds the drainage capacity of channels and rivers. Monsoon-driven flooding inundates about 20% of the country annually (Mirza *et al.* 2002), while about 90% of the country is prone to extreme flood events that apart from riverine flooding also include flash floods, storm surges as well as pluvial flooding which is especially problematic in peri-urban and urban areas (e.g. Brammer 2004). Other water-related challenges are river bank erosion, storm surges and salinization in the coastal region, droughts, pollution of surface water, arsenic contamination of ground water. With a population of about 156 million and one of the highest population densities, these water challenges have a big impact on the lives and livelihoods of the inhabitants. Many of these issues are exemplified by the capital Dhaka, which is one of the world's fastest growing megacities with an annual growth rate exceeding 4%. The extensive rural–urban migration that drives this growth is reflected in Dhaka's unplanned urbanization, which together with a poor urban drainage system, result in severe water logging due to drainage congestion by solid waste as well as encroachment of rivers and illegal land-filling of surface water bodies (Khan 2006, Ahmed and Ahmed 2012).

Since 1950, Bangladesh has been facing 16 catastrophic floods (Bangladesh Delta Plan 2100 2017). After the particularly devastating flood of 1988 which submerged more than two-third of the country, the Flood Action Plan (FAP) was developed. The Government of Bangladesh (GOB)-initiated plan aimed at fully embanking major rivers in Bangladesh (World Bank 1989) including the Ganges, Jamuna – Brahmaputra and the Meghna. Apart from the protection of urban areas, the plan aimed at ensuring food security by protecting and managing crop fields and polders. While the FAP might have decreased the country's vulnerability to flood hazard, the initially estimated at USD 155 billion plan proved to be too ambitious. Apart from lack of funding, it was doubtful if the economic returns from protecting the agricultural lands would outweigh the estimated costs. Furthermore, the FAP was facing strong opposition from the civil society due to the top-down institutional hegemony associated to its formulation and implementation as well as social and environmental concerns (Brammer 2010). This led to a comprehensive review of the Bangladesh national water policy, which resulted in the National Water Management Plan (WARPO 2001) emphasizing small-scale flood proofing measures (Rahman *et al.* 2010). Since the programme was not included in the 5-year development plans which provide the cornerstones of Bangladesh policy, almost no proposed measures were actually implemented. More successful were measures related to cyclonic storm surge flooding in the coastal area. After the disastrous floods of 1970 (500,000 fatalities) and 1991 (135,000 fatalities), a large early warning and shelter program was implemented in the coastal polders. As a result, the 2007 cyclone Sidr resulted in only 3400 fatalities, a reduction of about 99%. Still Bangladesh remains vulnerable to flooding. With steady economic growth rates of 6% damage to assets, transport infrastructure and power supply, as well as the functioning of the capital Dhaka become relevant, as was illustrated during the severe floods in 2004 and 2007. It should be noted here that the prevailing 'protection with embankment' approach has created long-term problems such as de-linking river–floodplain connectivity (impact on fisheries), pumped drainage approach creating urban flooding.

Over the past 40 years, the Netherlands has a longstanding involvement with the Bangladeshi water sector through its development cooperation. The development of the polders along the coast, the creation of the water management organizations by the water users and the increased number of rural people with drinking water supply and sanitation are examples of the Dutch support. However, as Bangladesh is moving fast towards a mid-income country, the development cooperation will be phasing out in future. Various government and semi-government agencies are involved in urban land use, land and water management in Bangladesh. The existing institutional setting, with e.g. 13 ministries affiliated with water management, makes it difficult to deliver timely responses to the growing needs of a rapidly expanding urban population. There are many challenges in the rapidly growing cities of Bangladesh. For example, there have been several master plans for urban development for Dhaka. The actual development never followed these plans completely. The deviation was the result of failure to implement/execute the plans – not only because of the lack of finance or realistic investment plans but also because of the lack of institutional accountability for implementation and the lack of political will. Coordination between the agencies and some degree of decentralization is deemed necessary (Zaman *et al.* 2010). In this context, strengthening of land management policies through coordination between the various related agencies and some degree of delegation of authority is considered to be conditional to meet the urban development situation (Zaman *et al.* 2010).

5. The Dutch Delta Program

In the Netherlands, the national government, water boards, provinces and municipalities are working together on a new Delta Program on Flood Risk Management and Fresh Water Supply (DP). It comprises a cohesive set of projects (measures) for the short term (up to and including 2028) and also looks ahead to the medium term (up to 2050). The rationale behind this long-term approach is threefold: (i) investments in land use and water-related infrastructure (dams, dykes, sluices, storm surge barriers) have typical life times of many decades to a century or even more. In addition, they determine the future prospect of spatial planning and land use. With these life times, the potential impact of climate change may become serious and has to be considered in the design and decision-making. (ii) Experiences with other major water management programs in the Netherlands show that the implementation of these programs takes many decades. Therefore, to be prepared for climate change in 2050 the preparations should start now. (iii) With implementation times of many decades, it is inevitable that new knowledge and new techniques have to be absorbed and that political priorities change. For a successful implementation a common vision, as a framework for policy goals, is necessary, with flexible routes to achieve, no 'blue prints'. This insight has prompted the DP to develop a new, AM strategy: the ADM approach (Isoard and Winograd 2013). The Delta Program defines ADM as '*a smart and intelligent way of taking account of uncertainties and dependencies in decision-making on Delta Management with a view to reducing the risk of overspending or underinvestment*' (Van Alphen 2013). It is pivotal in the Delta Program that, starting from a common vision, decision-making on flood risk management measures needs to take account of a medium- to long-term planning horizon as (unforeseen) future developments could influence the efficiency of these measures, for example, in terms of use of space. Some developments may lead to higher costs, e.g. building over spaces that could later have been more usefully deployed for water storage or water discharge. While other developments could lead to cost reductions, e.g. combining river widening with the replacement of sluices approaching end-of-life. Therefore, decisions on short-term measures should be taken in such a way as to avoid the unnecessary mounting of long-term costs, while agreements should be made on actions that could be linked efficiently. ADM aims to ensure that any short- to medium-term adaptation decision is set within a framework that will not be maladaptive, if future developments (e.g. sea level rise) are different from what is currently predicted to be 'the most probable' (Reeder and Ranger 2011). A new element of ADM compared to AM is the inclusion of Adaptation Tipping Points (ATPs). ATPs are defined here as points where the magnitude of change due to external pressures such as sea level rise or peak discharges is such that the current strategy will no longer be able to meet the objectives and thus the measure is no longer adequate (Kwadijk *et al.* 2010). Combining the defined ATPs with climate change scenarios provides information about the need for additional measures. The ATP analysis can, therefore, help to develop Adaptation Pathways (Haasnoot *et al.* 2012, 2013). These refer to coherent sequences of measures and potential options, which may be triggered before an ATP occurs. Adaptation Pathways provide insight into the options, lock-ins and path dependencies, and introduces the flexibility to adapt to a wide range of future developments. Hence, Adaptation Pathways aim to be particularly useful in the context of long-term planning and to link the implementation of strategies for flood risk management with other investment agendas (Rhee 2012). Figure 1 illustrates the Adaptation Pathways developed for the Rhine-Meuse Delta Decision of the Delta Program. The pathways visualize alternative measures needed in the short and long terms, as well as measures that are needed to keep long-term options open. Following this approach, decision makers aim to minimize the risk of both under and over investing.

The objective of ADM is to provide a transparent and structured management process, which takes uncertainty into account in investment decisions of future developments. The Delta Program defines the following objectives and means to operationalize ADM (Van Alphen 2013):

(1) taking a systems approach that takes into account various spatial scales, linkages between main and regional water systems, upstream–downstream relations, and interaction between flood risk management and fresh water supply;
(2) involving multiple stakeholders in a joint decision-making process to enhance ownership, legitimacy and feasibility;
(3) adopting a scenario-based approach in the possible strategies by valuing flexibility with regard to the timing of implementation, allowing to switch from strategies through adaptation pathways;
(4) interlinking various investment agendas and looking for opportunities for mainstreaming with planned investments in, for example, urban development or nature restoration.

The next step will be the application of ADM in the implementation phase of the program and subsequently to monitor external drivers (climate change), regularly evaluate the effectiveness of associated measures and determine whether acceleration (deceleration) or a transition to another strategy is necessary. The emphasis will therefore shift from the development of adaptive strategies towards their implementation and management in practice. This implies that ADM is still in its early stage of development and its effectiveness needs to be proven in the implementation phase.

6. The Bangladesh Delta Plan

Through a partnership of the GOB and the Embassy of the Kingdom of the Netherlands (EKN), a consortium of Bangladeshi and Dutch knowledge institutions, private and public sector representatives has been appointed to develop a BDP that should address the many water issues in Bangladesh and provide a feasible future strategy. Learning from past initiatives, the plan has to accommodate for future uncertainties and should be mainstreamed into the 5-year development plans to ensure adoption and implementation. A key issue in the plan is to develop an operational adaptive planning framework that can accommodate several future strategies, thus providing the required flexibility to shift between pathways when external conditions dictate change. Such an approach should avoid the development of a 'top heavy' plan that depends on a unique set of conditions to be implemented (e.g. funding). Currently and along similar lines as in the Netherlands, the consortium is opting for an ADM methodology including Adaption Tipping Points and Pathways. An example is given in Figure 2. While by now this methodology is well established (e.g. Kwadijk *et al.* 2010), application in a developing country is not necessarily straightforward and might require modification of some of the procedures.

7. Discussion and conclusion

In this final section, the four objectives of ADM have been used to explore the applicability of the adaptive approach to the context of Bangladesh.

Taking a systems approach that takes into account various spatial scales

In the DP, the Dutch delta[1] is conceived as a coherent set of interconnected subsystems of rivers, lakes, estuaries and coastal areas: interventions implemented in one subsystem will impact or put restrictions on other subsystems. In order to set a baseline and to monitor changes, an understanding of the system's behaviour is considered a pre-requisite for ADM. The DP has adopted a hierarchy in decision-making: policy frameworks on national level (such as on flood protection standards) determine decisions taken at a regional scale.

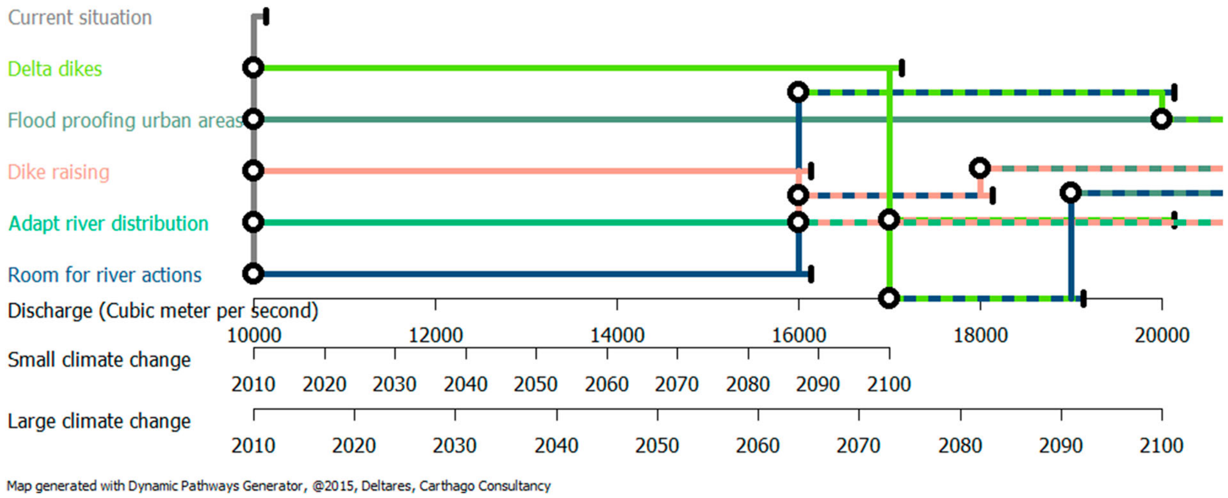

Figure 1. Adaptation pathways map developed for the Rhine-Meuse Delta Decision of the Delta Program (Delta Programme Commissioner, 2014). For the current situation, targets start to be missed after several years. There are five options (coloured lines). Following these lines, the point at which the paths start to diverge can be considered as a decision point (taking into account a lead time for implementation of actions, this point lies before an adaptation tipping point). In both scenarios (small and large climate change), the targets will be achieved within 50 and 70 years, respectively.

The Delta model[2] was used to enable comprehensive analysis of the interaction between different water systems in times of high and low water. The need to consider the Ganges–Brahmaputra delta as one complex system, which needs to be managed in an integrative way, is widely accepted amongst the water authorities in Bangladesh. The Ganges–Brahmaputra Delta is the world's largest delta and is situated in the tropical wet climate zone with the occurrence of frequent cyclones. People living on the delta have adapted to the occurrence of frequent flooding. One of the greatest challenges people living on this delta may face in the coming years are the impacts of rising sea levels caused by subsidence in the region and climate change. Compared to the Dutch delta, however, our understanding of the actual functioning of this complex delta system is still limited which implies that the consequences of interventions in the water system such as river channelling to its overall functioning are still difficult to assess. Another complicating factor is that 93% of the river basin is outside Bangladesh which limits the level of control over the system.

Table 1. Summarizing overview of the main commonalities and differences between the Ganges–Brahmaputra Delta and the Rhine–Meuse Delta.

Ganges–Brahmaputra Delta (Bangladesh)	Rhine-Meuse Delta (the Netherlands)
The Ganges Brahmaputra Delta is the world's largest delta with a surface area of some 100,000 km^2. Approximately two-thirds of the delta is in Bangladesh, the rest constitutes the state of West Bengal, India	The Rhine-Meuse delta plain has a surface area of about 7500 km^2. Large parts of the lower delta plain lie below sea level (down to −6 m)
With some 130 million inhabitants, the Ganges delta belongs to the most densely populated areas in the world (1300 inh/km^2)	A population of 6.5 million living in this delta (representing 40% of the population of the Netherlands). This delta hosts the four largest cities of the country as well as Europe's largest seaport and fourth largest airport (Schiphol) (870 inh/km^2)
Annual average discharge 29,300 m^3/s. Highly complex and dynamic delta. With meandering rivers. Some parts are highly urbanized and others are in rural areas. Systematic development of large-scale embankments for flood control started in the 1960s (protection levels between 1/50 and 1/100 years for river dikes). About 24% of the total land area and 39% of the net cultivated area have been protected since then	Annual average discharge of the Rhine is 2.300 m^3/s and 230 m^3/s of the Meuse Heavily managed rivers with channel modifications and flood storage reservoirs. The river length is significantly shortened from the river's natural course due to canalization projects completed in the nineteenth and twentieth centuries. The delta is protected by coastal dunes, dams and dikes. Safety levels are 1/10,000 years for the coastal defense and 1/1250 years for river dikes. Recently river dikes have been strengthened
Annual river flooding. Floods have caused devastation floods in Bangladesh throughout history. The most significant floods were in 1966, 1987, 1988 and 1998	In 1993 and 1995, extreme peak discharges but no dike breaches

The population density of the Dutch delta and Ganges–Brahmaputra delta is in the same order of magnitude and both deltas are to a great extent cultivated. Despite these similarities, there are also significant differences between the two. In particular, in the Dutch delta, the rivers are relatively small and less dynamic, have been trained, and coastal protection engineering has stabilized the coastline, whereas in the Ganges–Brahmaputra delta the rivers are huge and coastlines are constraint only to a limited extent. The Ganges–Brahmaputra delta is therefore more dynamic and variable, and less impacted by human interventions. The development of new river control structures, global sea level rise and climate change will likely have a large impact on these dynamics in the near future and projections of these changes are surrounded by large uncertainties. This also accounts for the projected socio-economic changes in this delta. It is tempting to postulate that given these differences in dynamics and associated uncertainties between both deltas, the application of the ADM approach to the context of Bangladesh will require new methodologies and tools as the current ones have been developed for a different system's scale, volatility and uncertainty.

A summarizing overview of the commonalities and differences between the two deltas is given in Table 1.

Involving multiple stakeholders in joint, a decision-making process to enhance legitimacy and feasibility

In the Netherlands, the design, planning and implementation are performed in close collaboration with other administrations and stakeholders. The process of decision-making governs the development of new knowledge. Joint fact finding is applied to include the knowledge and expertise of all parties involved. In addition, this approach improves trust and acceptance of the measures (Verkerk *et al.* 2014) and

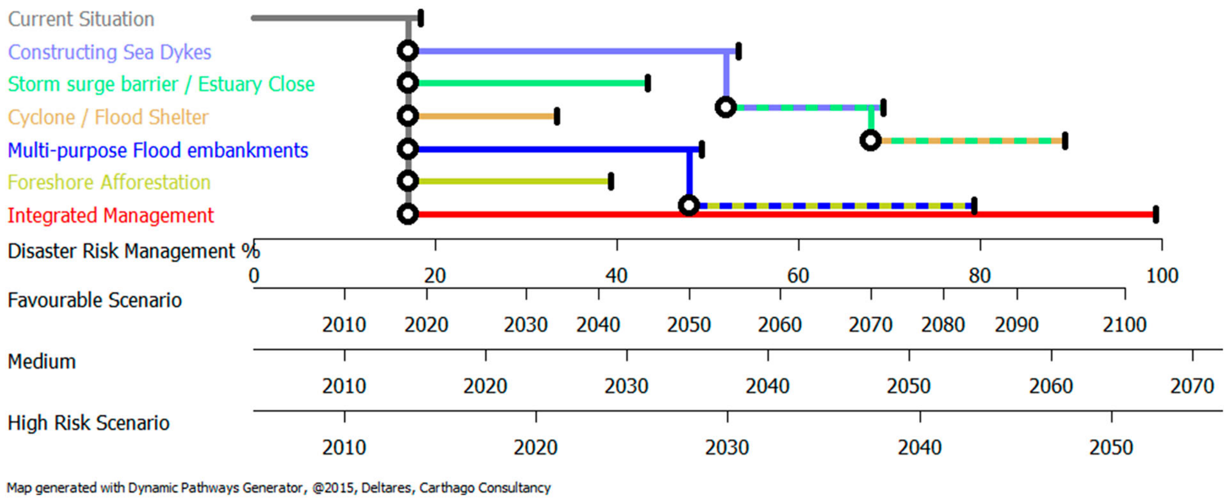

Figure 2. Adaptation pathways map developed for the BDP 2100 (Bangladesh Delta Plan 2100 2017).

enhances ownership for the implementation. In Bangladesh, a top-down orientated delivery of policies, little coordination and collaboration between the different water authorities combined with limited financial resources and absence of inclusive and realistic planning are amongst other factors that hampers the transition to integrated water management in Bangladesh. It is increasingly recognized that a fundamental change in institutional capacity at multiple levels including new knowledge and skills, relationships and policy frameworks is needed. This is certainly a pressing need at local stakeholder level as the capacity and resource availability to engage in these collaborations are very limited. Yet knowledge development is often highly centralized and exclusive; knowledge is conceived as a commodity and sharing is not common practice. This is hampering the dissemination and use of common knowledge foundation across stakeholders. The BDP process aims to create the incentives for collaboration between sectors and intergovernmental cooperation, and thus may contribute to the overall quality of governance and institutional arrangements.

Adopting a flexible approach in the possible strategies by valuing flexibility with regard to the timing of implementation

'ADM requires well-established policy goals, a subsequent normative framework and a set of corresponding indicators and thresholds to evaluate the performance of many components in the water system' (Van Alphen 2013). In Bangladesh, many of these thresholds have been already exceeded (e.g. urban drainage standards) or are outdated or absent (e.g. flood risk standards). This means that an alternative appraisal framework needs to be developed (BDP 2014). This certainly applies to the perspectives of adopting a flexible approach in the possible strategies of ADM. A flexible approach allows to switch from strategies through adaptation tipping points (ATP), and adaptation pathways, keeping options open, and requires continuous monitoring and evaluation. It still needs to be seen whether such a flexible approach of ADM can be effectively applied into practice in both countries as within the time scales of decision-making detection of climate change is a difficult task. For tipping points related to slowly changing conditions it may work, but for those conditions that are effected by extreme events such an approach runs the risk of being too late (Haasnoot *et al.* 2013). Due to the fact the implementation of actual measures is still very limited in Bangladesh, marginal experience in monitoring and adapting currently exists in the domain of water-related infrastructure. This needs to be setup from scratch including the technology, procedures and institutional embedding. Up till now, there has been little room for experimentation in Bangladesh (as opposed to the situation on the Netherlands). Exception is for instance tidal river management (controlled flooding to allow land accretion inside the polder and naturally dredge deposited sediment in the river), where local knowledge in collaboration with land owners, farmers and implementing agencies has been mainstreamed to create a regional policy.

Interlinking various investment agendas and looking for opportunities for mainstreaming with planned investments

ADM calls for the development of adaptive and integrated strategies, which are logically based on investment decisions in domains characterized by significant uncertainties about the future, such as water security and freshwater supply (Bloemen 2014, personal communication). Financing and advising organizations such as the OECD and the World Bank (e.g. WDR2014) are becoming more and more interested in ADM as this approach may provide incentives for finding external financing of (water-related investment) projects in developing countries. Hence, the availability of stable long-term (public) funding and resources is considered conditional for ADM. However, basic infrastructure, such as drainage systems and flood defenses, provides a direct investment opportunity to attract other funding opportunities and/or private investment if it can be linked to other benefits such as a broader upgrading or redevelopment strategy for an area. As it demands a long-term scope, ADM has the potential to help to merge various investment agendas and create added value by mainstreaming with planned investments. This trajectory requires to involve multiple stakeholders in joint decision-making process to enhance legitimacy and feasibility. It needs to be seen whether the prospects of 'multiple functions and synergistic mainstreaming' will be feasible and thus realistic for widespread uptake as they substantially differ from the current practice of conventional single purpose project developments in both countries.

In conclusion, ADM has up till now been developed and applied in a relatively stable context of the Dutch delta, facing only a limited range of long-term uncertainties. To successfully apply the approach in a more volatile and complex context of a developing country requires modification of the method, and tools as well as a 'learning by doing' mentality to gain experience and apply the necessary pragmatism to implement an effective and result driven policy framework that both embraces uncertainties and manages to adopt a long-term horizon.

Notes

1. Dutch delta or Rhine-Meuse delta comprises the delta of the rivers Rhine and Meuse.
2. Delta model: "*a model for the Delta Program in order to be able to carry out the underlying calculations" (Deltacommissaris,* 2011).

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