

Review

From Flood Control to Water Management: A Journey of Bangladesh towards Integrated Water Resources Management

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Abstract: Integrated Water Resources Management (IWRM) is considered as a practical approach in solving water-related problems, which are socio-ecologically complex in nature. Bangladesh has also embraced the IWRM approach against its earlier attempt to flood control. In this paper, we evaluate the current status of IWRM in Bangladesh through the lens of policy shifts, institutional transitions and project transformations using seven key dimensions of IWRM. Looking at IWRM from such perspectives is lacking in current literature. A thorough review of policy shifts suggests that all the key dimensions of IWRM are “highly reflected” in the current policy documents. The dimension of “integrated management” is “highly reflected” in both institutional transition and project-level transformation. Most other dimensions are also recognised at both institutional and project levels. However, such reflections gradually weaken as we move from policies to institutions to projects. Despite catchment being considered as a spatial unit of water management at both institutional and project levels, transboundary basin planning is yet to be accomplished. The participation of local people is highly promoted in various recent projects. However, equity and social issues have received less attention at project level, although it has significant potential for supporting some of the key determinants of adaptive capacity. Thus, the IWRM dimensions are in general reflected in recent policies, institutional reforms and project formulation in Bangladesh. However, to solve the complex water-problems, basin scale management through transboundary cooperation and equity and social issues need to be implemented at institutional and project levels.

Keywords: flood control; IWRM dimensions; policy shift; institutional transition; project transformation; Bangladesh

1. Introduction

Integrated Water Resources Management (IWRM) is considered as one of the main policy paradigms in water resources management [1]. According to Global Water Partnership [2], IWRM approach promotes the coordinated development and management of water, land and related resources considering the three pillars of sustainability, i.e., economy, equity and environment. Even though IWRM has attained some degree of acceptance worldwide, some scholars (e.g., Biswas [3]) criticise it. Nevertheless, IWRM is still a central theme at the level of global cooperation such as the Rio+20 Conference and Goal 6 of Sustainable Development Goals (SDGs) [4,5]. Implementation of IWRM including through transboundary cooperation as appropriate at all levels is one of the priority targets of Goal 6 of SDGs to be achieved by 2030 [1,5]. A United Nations status report on IWRM prepared

for the Rio+20 Conference documents the progress in the inclusion of IWRM in national policies and legislations. Although many developed countries have adopted IWRM, it is not yet clear whether they are actually implementing it in its totality [6]. A key challenge is the understanding of its concept, which is defined differently by different authors and practitioners [3]. Especially, the implementation challenges in the developing world are severe. Consequently, the actual implementation of IWRM is lagging behind. However, the implementation of IWRM and the realisation of the respective programmes need to be accelerated.

Among the developing countries, Bangladesh is facing ever-growing multiple challenges in managing flood risks, climate change impacts, water demand, supplying safe drinking water, improving water quality, reversing the decline of fisheries, and protecting natural ecosystems, in particular coastal wetlands and marshes [7–10]. Bangladesh ranks as the sixth most vulnerable country in the world for floods and the first for tropical cyclones, but has also severe regional water deficits during the dry season [11].

During the 1960s, the country's first Master Plan for water management was prepared based on a strategy of massive flood control and drainage improvement mainly for increasing agricultural production, overlooking fisheries, ecosystems and societal needs. Since 1980s, the plan and policy documents slowly incorporated multiple issues with an integrated management focus. Recently, the water policy documents have been adopted the IWRM principles. From 1960s to recent date, it is a long journey of Bangladesh towards IWRM. How and to what extent the IWRM approach has been reflected in the country's policy shifts, institutional transitions and project transformations is yet unclear. In addition, looking at IWRM from these three perspectives together is lagging in current literature. This study attempts to assess the status of IWRM implementation in Bangladesh through a review of relevant policies, legislations, organisational changes and project-level transformation. The assessment is made using seven key dimensions of IWRM [12], which reflects multiple and complex notion of the concept. For a complete implementation of IWRM concept, high performances for all these key dimensions are expected to be achieved. However, such achievement can only be found in an ideal case where economic, social and institutional capacity is high and where practice of democracy has a long history.

The paper is organised such that, in Section 2, seven key dimensions of IWRM are discussed. The historical development of key water management policies and plans in Bangladesh is discussed in Section 3. Following that, an assessment is made how IWRM approach has been adopted in different water management organisations including planning, regulatory and implementing organisations through their reorganisation, reconstitution and transition. We then assess how far IWRM is implemented or at least reflected in various water development projects. Thereafter, we evaluate and discuss the policy shift, institutional transition and project transformation using seven key dimensions of IWRM. Conclusions are drawn in the final section.

2. Dimensions of Integrated Water Resources Management

Gain et al. [12] suggested an original framework to evaluate IWRM implementation in a country (see also [13]). In their framework, the status of implementation of IWRM was proposed to be evaluated using six key dimensions: (i) integration among different water-related components—water quality, climate adaptation, agriculture and energy production; (ii) hydrologically-relevant scales, e.g., river basin, for management; (iii) institutionalisation of IWRM across different levels and actors; (iv) stakeholder participation—local communities and individuals, businesses, civil societies, policy-makers and public organisations; (v) valuation of water resources—IWRM encourages valuing water as an economic and social good; and (vi) demand management by increasing efficiency in water use, rather than increasing water supply. In this study, we propose some modifications in their framework. As demand management is considered as an economic tool for managing various resources, e.g., water, energy and food [14,15], this dimension can be integrated with the economic dimension. In addition, gender and equity issue is one of the key priority agendas for water resources

management [2]. Hence, instead of integrating the social good with the economic good dimension, the gender, equity and social good is proposed as a separate dimension of IWRM in this study. In addition, water plays a key role for ecosystems and environment. For managing water resources, the ecological and environmental issues [16] need to be taken into account separately as a dimension of IWRM. Thus, the original six dimensions of IWRM proposed by Gain et al. [12] are modified into seven to make them socio-ecologically balanced and more useful. The final list of key dimensions of IWRM used in this study are: (i) integrated management; (ii) river basin as spatial scale; (iii) water governance/policy; (iv) multi-stakeholder approach; (v) economic good; (vi) gender equity and social good; and (vii) ecology and environment.

3. Shifts in Water Management Policies in Bangladesh

3.1. Key Policies in Bangladesh

After the two consecutive devastating floods in 1954 and 1955, the Krug Mission of United Nations recommended a 20-year Water Master Plan. Following the recommendation, the International Engineering Company (IECO) of the USA prepared the master plan in 1964 [17]. The objective of the plan was to increase agricultural production through surface-water based engineering solutions such as construction of massive flood control structures and drainage improvement to be followed by irrigation facilities. A major deviation from surface-water based large scale flood control projects was found in 1972, when the International Bank for Reconstruction and Development (IBRD) recommended small scale water projects, proposing the use of low lift pumps and tube-wells for surface and groundwater withdrawals, respectively. This measure significantly contributed to journey towards food self-sufficiency in Bangladesh.

Subsequently, the Government of Bangladesh recognised the need for institutional reforms and for a new Master Plan. In preparation for the National Water Plan (NWP) Phase-I, a Master Plan Organisation (MPO) was created in 1983, though the NWP itself was not completed until 1986, as the development of the plan was a lengthy process requiring the collection of large quantities of baseline information. An assessment was made in the plan document on the availability of water from various sources and the plan also projected the future demand for water by different sectors.

Bangladesh experienced two consecutive severe floods in 1987 and 1988 which brought the issue of flood control and flood management on the agenda of international forums. In December 1989, the Flood Action Plan (FAP) was endorsed by the representatives of the Government of Bangladesh with the aim of stabilising food production and maintaining the country's capacity to feed an expanding population [18]. At the second conference on the FAP in 1992, the Flood Plan Coordination Organisation produced a set of guidelines for better participation in management projects [19]. These Guidelines represented an important milestone, because people's entitlement to participate was officially recognised for the first time.

In 1991, National Water Plan (NWP) Phase-II was completed by the MPO which included the development of a number of planning models and analytical tools for defining and evaluating strategies. During this phase, the country was divided into 173 catchments which were grouped into 60 planning areas, and further aggregated into five major hydrological regions. At the end of FAP in 1995, the Bangladesh Water and Flood Management Strategy was produced, and was the first long-term strategy for the water sector in Bangladesh. It envisaged both the formulation of a National Water Policy (NWPo) and the preparation of a National Water Management Plan (NWMP) which would include national, regional and basic programmes for water management.

The adoption of the National Water Policy (NWPo) at the end of 1999 was a milestone towards institutionalization of IWRM in Bangladesh. Major institutional reforms and the roles of the government, the private sector and civil society in the management of water resources were clearly defined in the NWPo [20]. The NWPo also played an important role in accelerating the development of

sustainable public and private water delivery systems, with appropriate legal and financial measures and incentives including formulation of water rights and water pricing.

To facilitate the implementation of the NWPo, the government approved a 25-year NWMP in 2004. The plan provides guidelines to develop programmes for better management of water resources in the country. The main elements of the NWMP are its multi-use approach to water (not just flood protection but also irrigation, drinking water and other uses) and its emphasis on “soft” approaches incorporating socio-economic dimensions instead of just hard engineering approaches [21]. The Bangladesh Water Act was enacted in 2013 to integrate the management, development, utilisation and protection of water resources [22]. Basic water availability has been recognised as a fundamental right for people in the act. Implementing any water resources project without considering biodiversity, aquatic environment, spawning areas of fishes and natural drainage system is prohibited in the law. This Act has emphasized the optimum use of water resources, water rights and conservation of nature.

Based on an Integrated Coastal Zone Management approach, the Ministry of Water Resources (MoWR) formulated the Coastal Zone Policy in 2005 [23]. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) integrated climate change issues in planning and designing processes to support economic growth and poverty reduction [24]. The Ministry of Environment and Forests (MoEF) has also prepared the National Adaptation Programme of Action (NAPA) for Bangladesh. The NAPA provides guidance on the coordination and implementation of adaptation initiatives in the country through building synergies with other water and environmental programmes [25].

In order to ensure sustainable development for all people, the Government of Bangladesh has also prepared the Vision 2021 [26] and Sixth Five Year Plan [27] for coordinated management and planning of different activities in the country. Insights of key policy documents are summarised in Table 1.

Table 1. Insights of major policies for water management in Bangladesh.

Key Policies	Year	Insights of Key Policies
IECO Master Plan	1964	shifts from fragmented management to top-down centralised approach; high engineering approach for flood control, drainage and irrigation; major focus is on surface water
IBRD Report	1972	besides engineering approach, introduction of small scale water resources projects; the conjunctive use of both surface and groundwater
National Water Plan (NWP) phase I	1983–1986	projected the future demand for water by different sectors
FAP reports	1989–1995	introduced “stakeholder involvement” in water management
National Water Plan (NWP) phase II	1991	introduced catchment scale planning and carried out comprehensive assessment for water resources
National Water Policy	1999	accelerating the development of sustainable public and private water delivery systems, with appropriate legal and financial measures and incentives including formulation of water rights and water pricing
National Water Management Plan	2004	multi-use approach of water resources; provides guidelines for implementation of water management programmes
Coastal Zone Policy	2005	developed based on Integrated Coastal Zone Management (ICZM) approach for management of coastal regions of the country
NAPA	2005	developed adaptation strategies following sustainable development goals and objectives through participation of stakeholders
BCCSAP	2009	integrate climate change issues to support economic growth and poverty reduction
Vision 2021	2010	development scenario for achieving a higher standard of living through better education, social justice, protection of environment
Sixth Five Year Plan	2011	a key focus on strategies, policies and institutions to help guide the private sector in helping Bangladesh achieve the goals set in Vision 2021
Bangladesh Water Act	2013	enacted to integrate the management, development, utilisation and protection of water resources

3.2. Evaluation of Policy Shifts

According to Cook [28], the diversity of knowledge for water management in Bangladesh is growing slowly, which increases complexity. The growth of differing perspectives introduces knowledge founded on fundamentally different assumptions and objectives, for example, juxtaposing poverty reduction, gender equality, damage reduction and environmental sustainability [28]. The emphasis from flood control has shifted to water management, from purely structural engineering solutions to a combination of structural and non-structural measures designed to meet a broader range of water management needs. Among the seven IWRM dimensions represented in Section 2, the “integrated management” approach is “highly reflected” in policy shift. The adoption of NWPo in 1999 [20] declared all means and measures to manage the water resources of the country in a comprehensive, integrated and equitable manner. Following the NWPo, the NWMP, BCCSAP and the Sixth Five Year Plan have all considered integration among different sectors for economic development, poverty reduction, food security and protection of natural environment. The NWPo highly acknowledges transboundary cooperation among co-riparian countries. There is a clear move towards institutionalization of IWRM in different policies [29]. Bangladesh has made good progress in creating scope for people’s participation in development and management of water resources. Involvement of different groups of stakeholders is highly recognised in several key policy documents such as NWPo, NWMP, NAPA and the Sixth Five Year Plan. The policy documents including NWPo and Bangladesh Water Act highly recognise water as an economic good by implying pricing and cost recovery. Key policy documents such as NWPo, NWMP and Bangladesh Water Act highly acknowledge the access to safe water by marginal sections and poor people at affordable prices. These policy documents also recognise the role of women for efficient management of the resources. Finally, the major lapses in water resources planning and management in Bangladesh appeared to be inadequate harmonization of environmental and ecological issues in development cycles. Ecological and environmental issues are highly recognised in policy documents.

4. Transition of Water Management Institutions in Bangladesh

4.1. Key Water Management Institutions

The activities of key institutions for current water managements in Bangladesh are summarised below.

4.1.1. Bangladesh Water Development Board

After its creation in 1959 and renamed in 1972, the original mandate of the Bangladesh Water Development Board (BWDB) focused on providing infrastructures for flood control, drainage and irrigation (FCDI). Subsequently, the enactment of the BWDB Act in 2000 required the agency to be guided by the NWPo and NWMP, requiring attention to IWRM. However, BWDB has been increasingly criticised on the grounds that its organisational culture has been slow to adapt to changing priorities. In response to the criticism and revised mandate, institutional reforms have been made in BWDB during the late 1990s. For achieving cost recovery in its surface water irrigation projects (e.g., Ganges-Kobadak (G-K) Irrigation Project), BWDB currently charges a nominal fee (less than 10% of the operation and maintenance cost) at a flat rate for supplying irrigation water to the farmers. While the reforms have contributed to some improvements in efficiency, challenges still remain for: (i) meaningful involvement of stakeholders; (ii) developing mechanisms to work with non-governmental organisations; and (iii) providing effective operation and maintenance of infrastructures for the benefit of local stakeholders.

4.1.2. Local Government Engineering Department

The Local Government Engineering Department (LGED) has been involved in small-scale water resources development for several decades. This involvement was initiated in the early 1960s under the Thana Improvement Programme and the Rural Works Programme and subsequently through the national canal digging programme in the mid-1970s and then through a number of small-scale projects to improve water management within selected Upazillas. The LGED gained experiences large scale flood control projects of BWDB, as the performance of these projects often remained below expectations. The failure of these large projects was due to poor maintenance with serious lack of involvement of target beneficiaries. As knowledge leads and policy follows [15,30,31], this early experience helped LGED to recognise the need for a stakeholder responsive integrated approach to water management. The LGED policy towards small scale water projects was influenced by the Global Water Partnership (GWP). Subsequently, LGED undertook strategic restructuring to position the organisation to accommodate a more integrated approach to water management. LGED initiated IWRM activities with the establishment of an IWRM unit in early 2003. At its headquarters, the IWRM Superintending Engineer is supported by three Executive Engineers and a multidisciplinary team comprising an Agriculturist, Sociologists and Fishery Biologists.

4.1.3. Water Resources Planning Organisation

In order to separate the macro planning of water resources from the implementing agency BWDB, a new organisation called WARPO was created in 1992. Its activities include: (i) clearing water sector projects; (ii) advising both the Executive Committee of NWRC (ECNWRC) and NWRC; (iii) overseeing NWMP implementation; and (iv) promoting the IWRM concept throughout the country. WARPO is a multi-disciplinary organisation with engineering, water resources, economics, agriculture and environment sections. The major achievement of WARPO has so far been the preparation of NWMP in 2004 which reflects a shift from agricultural focus of water management to its more holistic purpose. Recent enactment of the Bangladesh Water Act gives WARPO substantial authority to oversee water resource management of the country. However, WARPO is yet to establish itself as a fully responsible organisation.

4.1.4. Bangladesh Haor and Wetlands Development Board

Haor Basin (Figure 1) is a large bowl shaped floodplain depression in the northeastern part of the country encompassing an area of 8000 km². Bangladesh Haor and Wetlands Development Board (BHWDB) was formed in 2000 to coordinate the development activities in the Haor areas in an integrated manner. This is the first example of a basin wide integrated development approach undertaken in Bangladesh. The Board is chaired by the Prime Minister and represented by six ministries including Water Resources, Agriculture, Fisheries & Livestock, and Environment & Forests. Three Members of the Parliament representing the area are also on the Board. In 2012, BHWDB prepared a Master Plan for integrated development of the Haor area to preserve, protect and restore the ecosystem as well as to protect the people of this area from natural disasters and to improve the livelihood of the poor people. Extensive public consultations were carried out in preparing the plan.

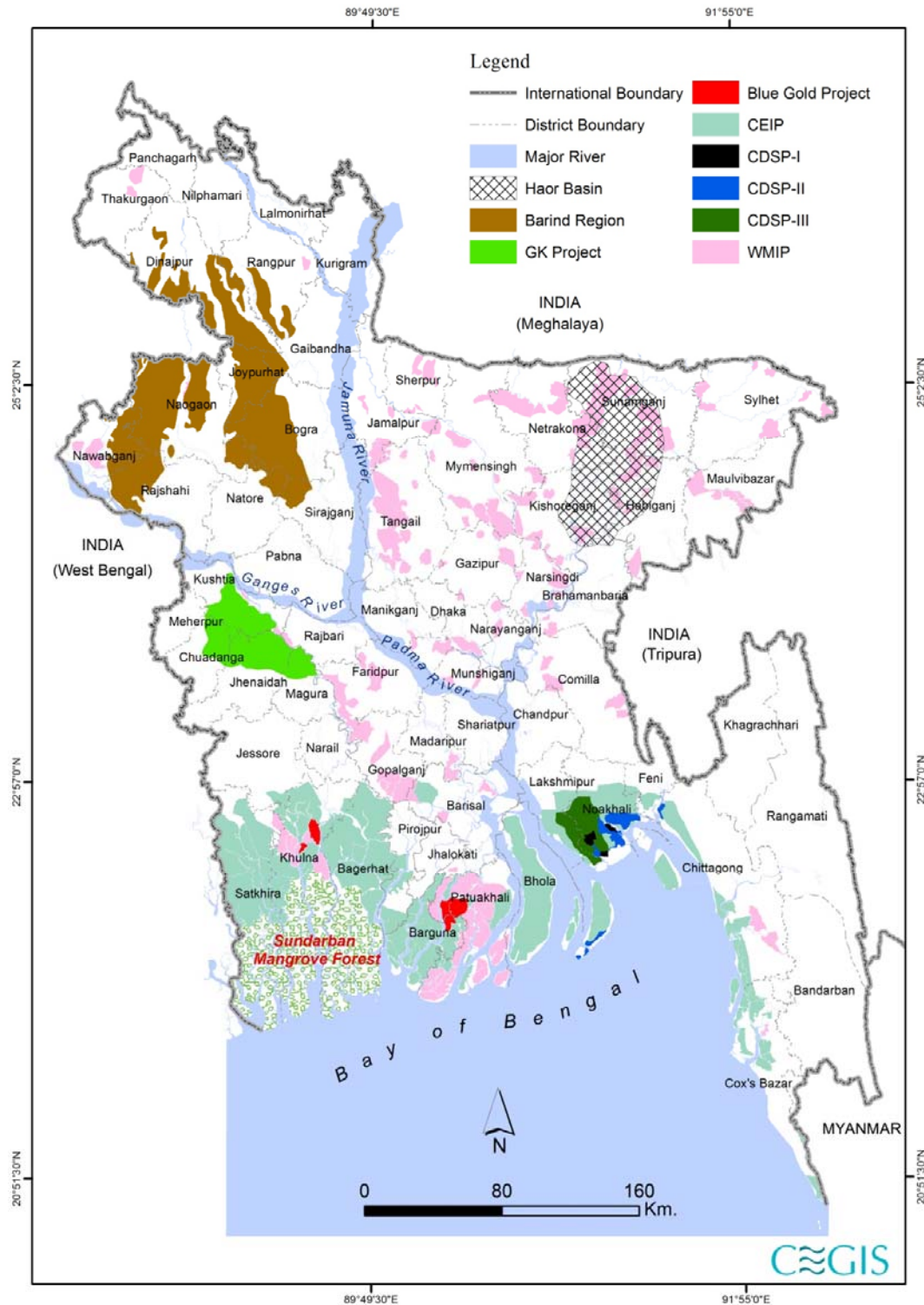


Figure 1. Locations of important geographical regions and water projects in Bangladesh.

4.1.5. Barind Multipurpose Development Authority

Barind Tract in the northwest region of Bangladesh (Figure 1) is a slightly elevated terrace. Lack of surface water is a major constraint for agricultural development in the area. In order to develop this backward area, the Barind Multipurpose Development Authority (BMDA) was formed in 1992 under the Ministry of Agriculture. Major focus of BMDA was to develop a groundwater based irrigation system using mainly deep tube wells (DTWs) for agricultural development of an

area encompassing 7679 km². Due to the subsequent irrigation development, cropping intensity in the project area increased from 141% in 1991 to 200% in 1999 [32]. BMDA also introduced various associated programmes like afforestation, re-excavation of ponds, construction of cross-dams, and installation and electrification of DTWs. BMDA is also the pioneer in introducing volumetric irrigation fee and pre-paid metering system in DTWs. These led to substantial cost recovery of irrigation water supply.

4.1.6. Ministry of Water Resources

Formerly designated as the Ministry of Irrigation, Water Development and Flood Control, the MoWR was established in 1994. MoWR is the principal executive body responsible for all aspects of water management including expansion of irrigated areas, water conservation, surface and groundwater use, and river management. The renaming and subsequent activities of the MoWR reflect the recognition of integrated nature of water resources management, a shift from sectoral approach.

4.1.7. National Water Resources Council

The NWRC is the highest national body for the formulation of water policy, including inter-agency co-ordination among different water sector agencies, and for the preparation and implementation of the NWMP. The present NWRC is a 48-member body chaired by the Prime Minister. Besides the Minister for MoWR, other members of the council include the Ministers from the Ministry of Agriculture, Ministry of Ports, Shipping & Inland Water Transport, MoEF, and Ministry of Fisheries & Livestock. Key areas of future activities are therefore expected to include adoption and oversight of the NWMP and its updates, resolution of inter-agency conflicts, and adoption of common standards for the water sector. NWRC in its meeting in 2004 approved the NWMP, while in its meeting in 2012, it directed WARPO to update the plan. In the last meeting, it also emphasised on quick formulation of the water act, integrated management of surface and groundwater, and protection of urban wetlands.

4.1.8. Joint Rivers Commission

For transboundary water management, Joint Rivers Commission (JRC) was established in 1972 and first agreement was signed in 1977 between Bangladesh and India for a 5-year treaty on water-sharing, but this duly expired in 1982 without being renewed. Later in 1996, again a 30-year comprehensive treaty was signed between Bangladesh and India. Through this treaty, both nations were able to cooperate in harnessing the water resources. The treaty also permits the construction of barrages and irrigation projects in Kushtia and the Gorai-Madhumati River in Bangladesh, draining the southwestern districts and thus preserving the environment, natural and economic resources.

4.1.9. Institute of Water and Flood Management

The Institute of Flood Control and Drainage Research, an Institute of the Bangladesh University of Engineering and Technology (BUET) was established in 1974 and later renamed as the Institute of Water and Flood Management (IWFEM) in 2002 with a modified mandate. The Institute pursues research and capacity development in the field of water and flood management that is vital for economic development and social prosperity of the country. The most important mission of the institute now is to promote IWRM, whereas the original aims and objectives were heavily geared towards engineering solutions to water resources problems. This shift in focus and ultimately renaming itself came from the gradual realisation of its faculty of the importance of multi-disciplinary approach in flood management especially during the FAP era. The Institute now carries interdisciplinary researches and multi-disciplinary academic programmes. Institutional transitions for water management in Bangladesh are summarized in Table 2.

Table 2. Insights of institutional transition for water management in Bangladesh.

Key Institutions	Original Mandate	Transitions
BWDB	providing infrastructures for flood control, drainage and irrigation	institutional reforms (restructuring of the Board of Directors into a Governing Council with stakeholders' representatives); partial implementation of cost recovery; stakeholder involvement
LGED	small-scale water resources development	establishment of IWRM unit; multi-disciplinary team of experts
WARPO	water management focused on only agriculture	holistic focused; multidisciplinary team of experts
MoWR	responsible for irrigation, water development and flood control	responsible for all aspects of water management including expansion of irrigated areas, water conservation, surface and groundwater use, and river management
NWRC	formulation of water policy, including inter-agency co-ordination among different water sector agencies	adoption and oversight of the NWMP and its updates, resolution of inter-agency conflicts, and adoption of common standards for the water sector
IWFM	research on flood control and drainage	research and capacity development in water and flood management, through promoting IWRM approach
BHWDB	providing catchment-wide integrated development approach	extensive public consultations were carried out in preparing the master plan
BMDA	groundwater based irrigation system using mainly deep tube wells (DTWs)	introduced afforestation, re-excavation of ponds, construction of cross-dams, and installation and electrification of DTWs; implemented cost recovery of irrigation water supply

4.2. Evaluation of Institutional Transition

The “integrated management” approach is “highly reflected” in institutional transition. Establishment and reorganisation of various institutions played a central role for integration and coordination among different sectors. WARPO and NWRC, for example, coordinate with different ministries and sectors for integrated management of water and related resources. Academic transformation of IWFM also reflects inter-disciplinarity in its water education. Despite JRC was established for transboundary water management, however, full implementation of basin-scale management would not be feasible given the prevailing socio-political environment of the region [33] and as 92% of the catchment areas of the country lie outside its boundary [34]. Various institutions, such as BHWDB and BMDA, adopted catchment-scale planning for water management. There is a clear move towards institutionalization of IWRM in different organisations. Bangladesh has made good progress in creating scope for people’s participation in development and management of water resources, which is reflected in various institutions. LGED works directly with the local people and their elected representatives from project formulation to implementation. For managing water resources efficiently, several institutions such as LGED and BMDA have adopted economic principles, e.g., cost recovery, pricing and tariffs. Within the organisational structure, there are portfolios for gender specialist, who are supposed to take care of gender issues and the interest of the poor and marginalised. Ecological and environmental issues are also recognised in institutional setup, such as WARPO and BWDB.

The above institutional transition in Bangladesh is driven by several physical and socio-political factors [35–37]. Multiple challenges in Bangladesh such as climate change induced extreme events (e.g., severe floods, drought, cyclones), arsenic contamination, saline intrusion and environmental degradation, upstream withdrawal along with poverty and vulnerability led to more comprehensive and integrated approaches. The detrimental effects of large scale water projects of BWDB on other sectors led to coordination among different institutions. After independence in 1971, the practice of democracy in the country has been started slowly since 1991 which also play a role for the institutional transition. In addition, international agencies as well as donors played a key role for advancing IWRM in Bangladesh.

5. Transformation of Water Related Projects

5.1. Water Related Projects

Apart from the changes in water policies and transformations in water management organisations, changes in conceptualisation, design, operation and management have occurred in water development projects over the years since 1960s. Presently, about 800 water development projects are in operation with provision for irrigation, flood control and drainage improvement to an area of 6.1 million hectares. These projects have facilitated an additional production of about 10 million tons of food grains per annum and helped attain rice self-sufficiency of Bangladesh. However, the journey of Bangladesh towards this achievement has not been smooth and a lot of transformations have taken place in project level based mainly on learning by doing.

5.1.1. Coastal Projects

The Coastal Embankment Project (CEP) was initiated in 1961 to enhance agricultural production in the coastal zone by offering protection against tidal floods and salinity intrusion. Continuous investment since then has resulted in 139 polders with a length of 6000 km. However, many polders did not perform well and the agricultural production and associated economic benefits were not as expected. The weak performance is attributed inter alia to poor maintenance of infrastructures, less than optimal water management, weaknesses in agricultural support, and lack of people's participation in the design and operation. These weaknesses were overcome in "Coastal Embankment Rehabilitation Project (CERP)" during 1995–2003 for effective maintenance of embankment through afforestation. Beneficiary participation was encouraged for the first time in a BWDB project, though only for maintenance of embankments. The location for CEP and CERP is same as Coastal Embankment Improvement Project (CEIP) shown in Figure 1.

The Integrated Planning for Sustainable Water Management (IPSWAM) project (same location of Blue Gold Project, see Figure 1), implemented during 2003–2011 with the Netherlands funding, aimed at finding an operational approach of participatory and integrated management of water resources. The participatory approach was found to have worked well and it had substantially exceeded the planned outputs in a number of important aspects. The Water Management Groups and Water Management Associations formed and trained under the project were vibrant and active, and the women participation in earthwork, monitoring and meeting was overwhelming.

Initiatives are being undertaken to rehabilitate and improve 17 polders with the new provisions of protection against frequent storm surges, afforestation in the embankments, and social mobilisation and stakeholders' participation in the Coastal Embankment Improvement Project (CEIP) (Figure 1). Polder committees are being formed and water management organisations are being involved in all stages of project implementation. The recently initiated "Blue Gold" programme (Figure 1) coupled participatory water management with development of business and market linkages in some coastal polders. Along with the proper management of water and water infrastructures for creating an environment conducive of improved production, the programme paid more attention to the producers' cooperative as a driver for economic development. The programme was conceived as a partnership between the producers, government agencies, non-governmental organisations, knowledge centres and private sector. The consequences of climate change and upstream developments are being taken into account. In this programme, there is a clear move towards multi-sector, multi-agency, demand-driven and bottom-up approach in water resources management.

5.1.2. Southwest Area Integrated Water Resources Management Project

The concept of IWRM became more prominent during the formulation of the Southwest Area Integrated Water Resources Management Project (SWAIWRMP), funded by the Asian Development Bank. The SWAIWRMP project area includes southwestern part (Satkhira, Khulna, Bagerhat, Narail, Jessore, Magura, Jhenaidah, Chuadanga, Meherpur and some parts of Kustia, Rajbari, Faridpur,

Madaripur and Gopalganj districts) of Bangladesh, The project took a bottom-up approach through development of participatory IWRM plans for subproject areas based on stakeholder consultations. Improvement of water management facilities and other infrastructures in the project was also based on a participatory process. In addition, the project comprised of appropriate institutional arrangements and adequate capacity building for operating, monitoring and updating the IWRM strategies, plans and programmes at regional and selected hydrological levels. Income generating activities with specially directed programmes for women were under the focus of the project to enhance rural livelihoods. Thus, there was a deliberate and necessary attempt in designing and implementing the SWAIWRMP in pursuit of IWRM principles.

5.1.3. Char Development and Settlement Project

An integrated management of land and water resources was targeted in the Char Development and Settlement Project (CDSP) (Figure 1). A number of government agencies were engaged in the project to implement the project activities in an integrated and coordinated manner over its implementation period of 1994–2010. BWDB was responsible for implementing the water management interventions and for promoting participatory water management following the principles of IWRM and the NWPo. Department of Public Health Engineering (DPHE) was in charge of carrying out the works related to drinking water supply and sanitation. Ministry of Land (MoL) was responsible for land settlement and records, Department of Agricultural Extension (DAE) for advisory and extension services to farmers on crop production, and Department of Forest (DoF) for social forestry and foreshore and mangrove plantation and stabilisation of newly accreted land. Local Non-Governmental Organisations (NGOs) worked directly with char dwellers. The issue of social equity was better addressed in the project as it directly worked with the poor people. Priority was given to women representation in farmers' forum, social forestry and land settlement. The project is considered successful as substantial improvement in livelihoods of participant households in terms of food security, income, housing condition, asset holding, etc., are observed due to the implementation of the project.

5.1.4. Water Management Improvement Project

The Water Management Improvement Project (WMIP) is being implemented to increase agricultural and fisheries production and to improve conservation of ecology by promoting an integrated approach in water resource management. WMIP is also progressively transferring local-level water management functions from government agencies to water management organisations (WMOs) of local communities. To date a total of 797 Water Management Groups (WMGs) and 72 Water Management Associations (WMAs) have been formed in the 67 project area financed under WMIP. In the project, the centralised, top-down approach was devolved gradually into a decentralised, participatory approach for efficient and sustainable operations and management of the existing FCD/FCDI systems. Following the government's policy of participatory water management, the local communities (e.g., WMOs) were involved in all stages of the participatory scheme cycle management (PSM), from identification up to monitoring and evaluation. This project also sought to enhance institutional performance of the country's principal government water organisations—BWDB and WARPO. The project supported social mobilisation and capacity building to make the Water Management Organisations fully functional and sustainable, and to enable BWDB field offices to implement PSM approach.

5.1.5. Small-Scale Projects

Apart from the large-scale water projects, small-scale projects, called subprojects/schemes having command areas of 1000 hectares or less, made significant contribution to the country's water control and development. The objective was sustainable increase in agricultural production and income for the poor small marginal farm households and establishment of sustainable operation and maintenance systems of the subprojects through beneficiary participation. All these projects were implemented in

three phases. The third phase of the project called “Participatory Small-Scale Water Resources Sector Project (PSSWRSP)” has three components: institutional strengthening, participatory development and infrastructure. An independent evaluation of the first and second phase [38] subprojects concluded that the PSSWRSP has demonstrated an innovative approach for sustainable operations and maintenance of the subprojects through establishment of Water Management Cooperative Associations and deserves to be continued.

5.2. Evaluation of Project-Level Transformations

Among IWRM dimensions, “integrated management” approach is noticed extensively in various projects. Afforestation and plantation of embankments in CERP and CEIP, the titles themselves of the SWAIWRMP and IPSWAM projects, and development of business and market linkages and consideration of potential impacts of climate change and upstream interventions in the Blue Gold project are all examples of integrated management at project level. The best example of sectoral integration at project level is probably the CDSP, in which an integrated management of land and water resources was pursued and drinking water, sanitation, social forestry, livelihood enhancement, disaster management, and human rights and social equity were within its purview.

Within the country, natural hydrological boundary was taken into consideration in planning a number of projects, e.g., polders in the coastal areas. In some cases, projects were undertaken in terms of the areas that the projects could serve, e.g., Options for the Ganges-Dependent Area, the Teesta Barrage project and the G-K Irrigation project. The demand-supply gap in water delivery and a poor operation and maintenance have been the major problems for the poor performance of these projects, rather than a scale issue. The WMIP was undertaken to implement BWDB reforms which include restructuring and strengthening it as a water resources management organisation rather than just a development agency, and supporting initiatives to make its operation more effective, efficient and transparent. The PSSWRSP is being implemented to strengthen the IWRM unit of LGED and to establish organic links with other relevant agencies.

Local people’s participation has been a key element in all recent projects including CERP, IPSWAM, CEIP, Blue Gold, SWAIWRMP, WMIP and PSSWRSP. As the earlier projects failed to achieve their targeted objectives due to lack of participation of local people [39], an added emphasis was put on participation. This was also to devolve the operation and maintenance responsibility of a project from the public line organisations to the local beneficiaries to ensure its financial viability and long-term sustainability. The recent notion of participation has been even deeper and includes gender and equity dimensions of participation. In contrast to the above findings, some recent studies (e.g., [40,41]) found that true participation is not happening at field level.

It is implied that any water development project is implemented with an ultimate goal of economic development. Thus, economic consideration has always been inbuilt in any project, though cost recovery and financial sustainability have been under question. In the public projects mentioned earlier, the emerging trend is to devolve the operation and maintenance responsibility to local beneficiaries and let them bear the routine repair and maintenance cost from their own generated fund. Given the demand-supply gap in many surface water projects such as the G-K Irrigation project in the southwest and the Teesta Barrage project in the northwest, the farmers have already resorted to demand management by using surface and groundwater conjunctively, switching to low water consuming crops, adopting alternate wetting and drying technology. However, when it comes to the actual implementation, most projects do lack in articulating the specific needs of the poor, women and vulnerable groups for their socio-economic development and bringing those as project components. Though environmental impact assessment is a requisite for getting approval of a new project from DOE, there are lapses in the approval process. In a few projects, such as IPSWAM, located in the coastal areas, the effects of climate change, sea level rise and upstream interventions were not taken into consideration. However, these might cause colossal consequences in future and make the project ineffective and unsustainable.

6. Discussion

Based on seven dimensions of IWRM, we summarize the extent of policy shifts, institutional transitions and project transformations that have been successful in IWRM implementation in Bangladesh. The qualitative judgement (summarized in Table 3) is based on analysed policies, institutions and projects. In Table 3, dimension with “++” refers that strong emphasis is given for that indicator, while “+” refers that the indicator is mentioned but appropriate importance is not given. Similar qualitative value judgement is applied in other studies (e.g., [12,42]). In general, the table shows that the IWRM principles are well reflected across the dimensions although the reflection weakens from policies to institutions to projects. As an outcome of incorporating multiple dimensions of IWRM, Bangladesh made significant progresses for achieving millennium development goals (MDGs): currently 86.9% of the population of Bangladesh is using improved/safe drinking water (which was 76% in 2000); 60.6% of population is using improved sanitation (which was 45.4% in 2000). The implementation of water act has increased water use efficiency along with improvement of ecological functioning.

Table 3. Dimensions of IWRM reflected through policy shifts, institutional transitions and project-level transformations in Bangladesh.

Dimensions of IWRM	Degree of Reflection ^a		
	Policy Documents	Institutions	Projects
Integrated Management	++	++	++
River basin as spatial scale	++	+	+/-
Water governance/policy	+	+	+
Multi-stakeholder approach	++	+	++
Economic good	++	+	+/-
Gender, equity and social good	++	+	+/-
Ecology and environment	++	+	+/-

Notes: ^a ++ highly reflected; + reflected; +/- reflected or not (case dependent); – not reflected at all.

Overall, IWRM is well reflected in the policies, legislations, organisational set-ups and project documents of Bangladesh. However, as we move from policies to projects, the dimensions get less reflected. If actual implementation of IWRM principles in the project level is examined, which is not attempted in this study, it can be reasonably assumed that such reflection will weaken further. Our results are consistent with the recent study by Gain and Schwab [42], in which they found that according to policy documents, water governance have significantly improved historically, but the actual implementation of water policies seems to be far behind what the policy documents indicate.

For a complete implementation of IWRM concept at project level, several improvements are required: capacity building needs to be improved among stakeholders; the monitoring based evaluation of performance of IWRM activities is necessary; legal enforcement of law and policy need to be improvement.

The adoption of IWRM in Bangladesh also followed a top-down approach. Therefore, the downstream transmission of its principles has been slow and is expected to take time for its full uptake at all levels. In order to hasten the uptake process, typical engineering education system, which basically pursues a mono-disciplinary curriculum, needs to be reoriented. The experiences at IWFEM indicate that it usually takes time to appreciate the value of IWRM by both faculties and students and requires sensitisation and capacity development through education and trainings. Different organisations, both within and outside Bangladesh, can design their IWRM implementation plans based on the findings of this paper, in particular looking at the transformation of IWFEM.

Complete implementation of IWRM concept depends on socio-political settings of a country. Internal challenges and conflicts lead to develop and implement integrated approach such as IWRM.

However, economic capacity, education, institutional capacity also play major roles for successful implementation of IWRM.

7. Conclusions

Bangladesh has a long history of fighting against natural hazards including flood. It started with hard engineering solutions of controlling flood in 1960s, gradually moved to water management in 1970s and 1980s, then to IWRM in 1990s and 2000s, and finally in recent years to water management with livelihood enhancement and market and business linkages. The country traversed this long journey through “learning by doing”. The overall lesson learnt during this water route is that multi-sector, multi-agency, participatory and collaborative approaches are needed to manage complex water management issues for which IWRM can be a practical pathway. The policy, organisational and project documents reviewed do not indicate any major barriers towards adoption of IWRM principles in Bangladesh.

We find that all the proposed seven key dimensions of IWRM are “highly reflected” in current policy documents of Bangladesh. Despite catchment being considered as a spatial scale in IWRM, transboundary basin planning is yet to be negotiated with co-riparians, particularly India. For mainstreaming of IWRM in Bangladesh, transboundary cooperation between co-riparian countries (e.g., India, China, Nepal, Bhutan, and Myanmar) needs to be increased. The role of JRC needs to be strengthened for such cooperation. The involvement of stakeholders has highly increased in various recent projects. However, equity and social issues need more attention at project level. The long journey of Bangladesh towards IWRM and the institutional transformation, particularly of IWF, indicate that it takes time to appreciate the value of IWRM, and the development of human capital is a prerequisite for that. For a successful implementation of IWRM, more lessons need to be incorporated from other developed countries (such as Australia, US etc.) and other river commission such as the Mekong River Commission (MRC) and the Murray-Darling Basin Authority (MDBA).

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