Article

Hydro-Political Dynamics and Environmental Security in the Ganges-Brahmaputra-Meghna Basin

The case of Bangladesh-India Trans-boundary Water Relations

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Abstract

This paper analyses the hydro-political dynamics and reviews the various challenges to environmental security in the context of trans-boundary water relations between Bangladesh and India, in South Asia. Environmental security is understood as the state of "absence of conflicts, explicit or latent" in the socio-economic and ecological space of human existence. The spatial scope of trans-boundary waters is defined in the present study as the physical extent of the Ganges-Brahmaputra-Meghna (GBM) basin, with the role of the river construed as a channel for the movement of water; generation, transport and deposition of sediments by the flows; and support to ecosystems and biodiversity. The paper then moves on to identify and discuss the ecosystem processes and services provided by the flows, highlights the critical linkages between human interventions and environmental security. It emphasizes that the present perceptions of reductionist engineering have generated a hydro-political situation prone to generation of

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disputes over the sharing of flows, especially during the lean season, in the numerous trans-boundary rivers shared between Bangladesh and India. It discusses the need for ensuring overall environmental security related to the trans-boundary flows that need to be based on an ecological perspective. By addressing the limitations of the reductionist engineering vision of trans-boundary waters, this paper emphasizes the need for a framework of an ecologically informed holistic engineering for reducing hydro-political tensions. The need is for a model of hydro-diplomacy in the region based on a negotiated balance between the totality of ecosystem processes and services as well as human well-being.

Keywords : Environmental Security, Bangladesh-India Relations, Trans-boundary Waters, Hydro-politics, GBM Basin, Ecosystem services and livelihoods, Institutional Perspective.

1. Introduction

In addressing issues related to the use of the natural environment, the Malthusian creed of "scarcity induces conflicts" has been the dominant thinking in the policy literature of many parts of the developing world. Such ideas have not eluded the evolution of water policy in South Asia (Bandyopadhyay and Ghosh, 2009; Rasul, 2014). However, there is already a worldwide consciousness that the way water is being managed in river basins, led by this Malthusian creed, is socially and ecologically unsustainable, as well as prone to generation of conflicts. Over the past several years, such concerns have been expressed from the highest international professional platforms (Cosgrove and Rijsberman, 2000: xxi), and in diverse contexts by many leading water professionals (see for example Falkenmark et al., 2000; Gleick, 1998). With such concerns, the last few years have witnessed the ubiquitous call for a change in our existing visions of water systems and way of their utilization (Bandyopadhyay, 2009). The emerging vision, enriched by continuous accrual of new

knowledge, both disciplinary and interdisciplinary, involves the replacement of the present paradigm of reductionist water engineering by a new ecologically informed interdisciplinary paradigm of water-systems management. Here, the term "paradigm" is used in the way defined by Kuhn (1962) in *The Structure of Scientific Revolutions*. The term Integrated Water Resource Management (IWRM) describes one such approach (Allan, 2006; Hassing et al., 2009). This paper hypothesizes that the prime challenge to environmental security in the context of Bangladesh-India trans-boundary waters has arisen due to the reductionist perceptions of looking at rivers as mere 'stock of water' that can be extracted and shared. Such reductionist thinking based on arithmetic hydrology is incapable of identifying and recognizing the issues related to environmental security. In the case of trans-boundary rivers shared by Bangladesh and India, the volume of flow as the sole description of rivers (without consideration of eco-hydrology, fluvial geomorphology, sediment dynamics and associated ecosystem services, and related issues) has restricted the scope of joint management of shared waters to quantitative division of the volumes over short periods of the lean flow season.

2. Notions defined: Trans-boundary Water Regimes and Environmental Security

2.1 Trans-boundary Water Regimes

Water is a fugitive resource that is prone to cross boundaries. Recent literature defines "trans-boundary" waters as waters flowing across any boundary including the sectoral (Beach et al, 2000). Trans-boundary issues over water take place not only between nations, but also between federal states of a nation, and occur even between districts within federal state, villages within a district and also between sectors (Ghosh, 2009). Therefore, trans-boundary water disputes happen not only between nations, but also between federal states, and occur even between districts within a federal state and at times go even further down to occur

between the ultimate micro-level units of a society or an economy, like village level organizations.

On the other hand, sectoral water conflicts have become more frequent. Inter-sectoral water disputes are not necessarily trans-boundary in the physical sense. Though, they do not literally involve crossing of political boundaries, they can be thought to be emerging from transfer of water from one sector of use to another. At a certain point in time, a finite resource used in agriculture, cannot be used for other sectors. In a majority of the cases, agriculture accounts for the largest proportion of the water consumed. Often, under conditions of scarcity, the reprehensible squandering of water in agriculture causes problems for the urban and industrial sectors by reducing the amount of available water.

The competing uses of water in industry, irrigation and urban sectors comprise the use of water in an economy, and the sectors together are known as the economic sectors. The existing literature, at times explicitly, and at times tacitly, has acknowledged these competing uses (e.g. Bandyopadhyay, 1995 and 2007; Bouhia, 2001; Holden and Thobani, 1996; Rasul, 2014). However, the realization that urban water crises often arise due to the extensively low-efficiency usage in the agricultural sector has not really come to the fore except, for example, in an account provided by Ghosh (2009).

In the past two or three decades, inter-sectoral water conflicts have taken a new shape with the emergence of Integrated Water Resource Management (IWRM), where the allocation of water for the continuation of ecosystem processes and services has received increasing acceptance (Aylward et al., 2005; UNEP 2009). At a broader qualitative dimension, the two major competitors for water use are the economic sectors based on ex-situ uses and the ecological sector based on in-situ uses (Lemly et al., 2000). Many nations have recognized the importance of the ecosystem services, and kept water for in-stream uses, because of egregious impacts of the constructionist regimes. As noted by Flessa (2004) and Ghosh (2009), in the Colorado Delta and Imperial Valley in the Western

United States, and in the northern Gulf of California, the environmental impacts of water diversion and the conversion of land to agriculture have been severe. Considering the holistic aspect of rivers, nearly 700 dams in the USA and elsewhere have already been removed and the movement towards river restoration is accelerating (Gleick, 2000).

Therefore, on the basis of the available literature, the scope of "trans-boundariness" in this paper in the context of the international boundary between Bangladesh and India is delineated by further including needs and demands on water across sectors, including for maintaining the ecosystem processes and services.

2.2 Environmental Security

The problems of environmental security are usually offered by the spatial inequity in the availability of ecosystem services of the natural environment. Otherwise, unwise uses of the natural environment as sinks of unwanted outputs of human economic activities, as in the case of the GHGs in the atmosphere, often generate problems for environmental security. These have often been the potential drivers of environmental conflicts. Chalecki (2002) attempted to define "environmental security" by describing the notion in terms of the ability of a nation or a society to withstand scarcity of environmental assets, environmental risks, adverse changes or environment-related tensions or conflicts. The idea comes close to Homer-Dixon's *Ingenuity* thesis, where he stated that the ability of a nation to combat resource scarcity is through generation of new ideas, which he called "ingenuity" (Homer-Dixon, 2000). Steiner (2006) expresses that environmental security is an overarching term that entails energy security, climate security, water security, food security and health security. He defines environmental security as a state when cleaner technologies and renewable energy sources can co-exist with economic growth with environmental and social objectives. Myers (1989, 2004 and 2008), one of the long-standing scholars working in

the arena of environmental security, feels that the nature of the concerns for environmental security have been changing because of the changing nature of the relation between human societies and their ambient environment. Environmental security, therefore, needs to be construed in terms of humankind and its institutions and organizations anywhere and at anytime (Myers, 2004).

This interpretation of Myers (2004) is a very important entry point to the entire discourse on environmental security as, essentially, the interaction of human societies with nature and their resulting dynamic relationship have been at the core of post-Cold War interest (Stucker, 2006). Human activities have transformed the natural environment to such an extent that in many instances the security of humans themselves has often been threatened as a result. This state of symbiotic relation between the changing natural environment and security of human societies is one of the ways of looking at Environmental Security (Myers, 2008; Homer-Dixon, 1994).

One important concern here is the state of the social stress created by resource scarcity, degradation or extreme natural events, thereby often leading to conflicts. The other important concern is environmental changes that often act as a stressor at the socio-ecological stratum of human existence (Homer-Dixon, 1994). Therefore, a conflict-prone state may exist within the human societies with nature acting as the stressor, while there might also be a state of conflict between the human society and nature that poses a threat to environmental security. The context of conflict within human societies for natural resources is well-evidenced and well-understood. They can be evidenced from the various cases of conflicts, over forests, water systems, agricultural land-use, oil resources, etc. The lesser understood aspect is related to human interventions in the ecosystemic processes and natural resource flows for short term promotion of economic growth, eventually threatening those very ecosystemic processes and services. As an example, anthropogenic interventions in the natural hydrological flows of rivers have often proved counter-productive in the long-

run, despite yielding short-run economic benefits, as has already been stated earlier. Such interventions have negatively affected human livelihoods further downstream by affecting ecosystem services (Bandyopadhyay and Ghosh, 2009). These are all concerns for environmental security.

Thus, environmental security can be defined as *a state of absence of conflicts* in the complex and interconnected relations in and between the biological, social, economic and cultural processes of human societies and the natural environment. One may state that environmental security depends on the dynamics in the natural environment, population change, degree of access to the natural environment, etc. Interaction between and among the determinants of environmental security sets the stage for addressing the related challenges.

3. Trans-boundary water regimes between Bangladesh and India

The Bangladesh-India trans-boundary water regime, in the widely accepted holistic sense, consists of the flow of water, sediments, and biodiversity. Individually, all the three constituents of the flows are significant and have created the fertile region known as the Bengal delta or the Ganges-Brahmaputra-Meghna (GBM) delta. At the southern end of the GBM delta exist the Sundarbans, the largest mangrove forest of the world. The basin can be divided into three sub-basins of the Ganges, the Brahmaputra (Jamuna in Bangladesh) and the Meghna (Fig. 1). A number of smaller streams in the GBM delta, which are vital for the ecological stability of the Sundarbans, drains directly into the Bay of Bengal.

Spread over the South Asian countries of Bangladesh, Bhutan, India, Nepal, and vast areas in the Tibet region of China, the GBM basin (1,745,400 sq km) is the third largest river flow system in the world, after the Amazon and Congo-Zaire. The annual run-off of the basin is about 1,150 billion cubic meters (BCM) and the peak

Fig. 1: Map of the Ganges-Brahmaputra-Meghna Basin

Source: http://en.wikipedia.org/wiki/File:Ganges-Brahmaputra-Meghna_basins.jpg

outflow at the estuary is 1,41,000 cumecs (Bandyopadhyay, 1995). The flow of the Ganges is contributed by numerous tributaries, draining the Himalaya, from Kosi in the east to Yamuna in the west. The river gets the name Ganges at Devaprayag in the Indian state of Uttarakhand, where the tributaries of Alakananda and Bhagirathi meet. Emerging from the Himalaya at Hardwar, the Ganges flows south-eastwards along the Himalayan foothills for about 1500 km through the Indian states of Uttar Pradesh and Bihar. In Bihar, the Ganges turns southwards, crosses the Indian state of West Bengal, to enter Bangladesh, downstream of Farakka. Just after Farakka the flow of the Ganges gets divided into two. The mainstream Ganges enters Bangladesh (locally called *Boro Ganga* or the larger Ganges), while a smaller distributary, the Bhagirathi-Hooghly remains within the Indian state of West Bengal and flows by the port-cities of Kolkata and Haldia before emptying in the Bay of Bengal near Sagar island. The mainstream of the Ganges flows eastwards into Bangladesh, where after Brahmaputra (Jamuna)

meets the river, it gets the name Padma. A few centuries ago a stream called the Saraswati that flowed a few kilometers west of the Bhagirathi-Hooghly, used to carry much of what Bhagirathi-Hooghly carried during the last 200 years or so (Dasgupta, 2011). Satga was a port town on Saraswati that Portuguese traders had established. However, with rapid silting up of Saraswati, the Portuguese shifted the port town to Bandel located on the Hooghli-Bhagirathi. This is an indicator of the very dynamic geo-morphological nature of the GBM delta.

The Brahmaputra is created by the flow of three important tributaries from the eastern Himalaya near Sadiya in the Indian state of Asom. They are the Luhit, the Dibang and the Siang or Dihang. The Siang / Dihang is known in the upstream areas in Tibet region of China as Yarlung-Tsangpo. As the Yarlung river enters India from China it is known as Siang and further downstream as Dihang. The Brahmaputra, like the Ganges, receives many tributaries draining the South aspect of the Himalaya, from Buri Dihing in the east to Teesta in the west. Both rivers also receive

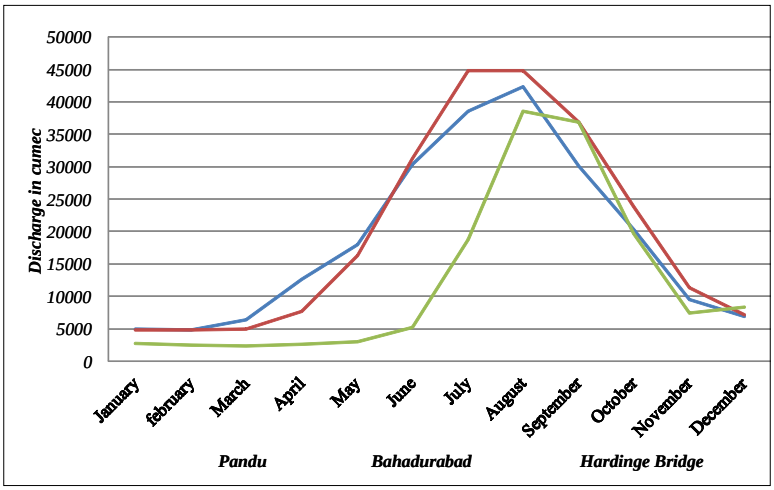

Fig. 2

smaller tributaries from the Central Indian uplands and the Meghalaya Plateau respectively. The Brahmaputra (Jamuna) and the Ganges meet upstream of the town of Goalundo and the joint flow is known as Padma. This flow meets the Meghna river further downstream and the combined flow of the Ganges, Brahmaputra and Meghna outpours into the Bay of Bengal as Lower Meghna. Between the Meghna and the Bhagirathi–Hooghly, lies the GBM Delta.

Due to the interaction of the summer monsoon with the hills in North-east India and the eastern Himalaya, the eastern parts of the GBM basin receive substantially high summer rainfall with Mawsynram in the Meghalaya hills recording 11,873 mms of average annual precipitation. In stark contrast, in the western parts of the basin, semi-arid areas in Rajasthan in India and in southern Tibet, annual precipitation can be as low as 300 mm. This makes the GBM a basin of large spatial disparity in precipitation. This disparity in precipitation is further aggravated by the wide temporal inequity as around 75 per cent of the total annual precipitation occurs during the three and half months of summer monsoon starting in June (Fig. 2). The monsoon precipitations cause various types of floods in diverse regions in the basin (Bandyopadhyay, 2009:49-100). Another important feature of the flow in the basin is that the two main rivers, the Brahmaputra and the Ganges, carry water from the drier parts of the basin to the parts with abundant rainfall. This adds to the high flows and the annual inundations.

In 1947, as India was partitioned into two independent countries, India and Pakistan, the present area of Bangladesh was known as East Pakistan. Thereafter the "international trans-boundary" characteristic of the GBM basin emerged with several new dimensions. In the accepted conceptual framework, Bangladesh-India trans-boundary waters relations have been diplomatically focused on the sharing of the flows, like of the Ganges and the Teesta. Hydrologically, the flows in 54 rivers and streams that cross the boundary between the two countries are

counted as the trans-boundary rivers. However, during the monsoon high flows, these numbers become much higher and it is not possible to limit trans-boundary flows within these 54 streams or rivers alone.

4. Anthropogenic Interventions over Trans-boundary Waters and Environmental Security

The 1960s witnessed rapid expansion of human interventions in the water systems in India primarily motivated by concerns about food security. In the last few decades, such interventions in the GBM basin have been made largely in the context of energy security, as hydro-power projects. The more subtle but political role of large storage projects in the redistribution of river waters should, however, not be underestimated. The rivers emerging from the Himalaya, in particular, those providing snow- and glacier-melt flows, became increasingly important in meeting the growing demands in the plains for irrigation in the early summer months.The traditional reductionist approach to river engineering, as initiated by the British, continued to guide the interventions in post-colonial India. Hence, such interventions were frequently based on old ideas and site selections were made several decades back (MoWR, 1989). Many of these were prone to creating trans-boundary disputes in the GBM basin. This resistance to change has been explained as hydrological obscurantism (Bandyopadhyay, 2012). The resistance to change may also be linked with the advantages that the politically powerful gain from such projects as many important negative externalities are conveniently kept out of project assessment as 'market failures' (Menon et al., 2009).

4.1 Reductionist Engineering, Hydro-political Tensions and Environmental Security

In the context of India's relation with Bangladesh in respect of water, there is a common perception, right or wrong, that a smaller

country receives an iniquitous and poor share of the benefits of the trans-boundary waters. The Bangladesh-India water relations became centralized on the issue of the Farakka barrage and had actually led to a crisis of trust between the two co-riparian countries (Abbas, 1982). More recently, however, developments based on the MoU reached between the two countries and signed on September 6, 2011, on the cooperative management of the Sundarbans, and the growing cooperation in trans-boundary navigation provides an example of regaining of trust between the two countries. The Sundarbans is shared between Bangladesh and India and located at the southern end of the GBM delta. The Sundarbans depends on supply of freshwater from upstream areas in the GBM delta. The push for this cooperation on the Sundarbans came from more interdisciplinary ecosystem perspective. In presenting the interventions in trans-boundary rivers, the three issues, namely, the Farakka barrage, the proposed transfer of water from the Brahmaputra and tributaries in India's project on Interlinking of Rivers, and the prospects of cooperative management of the Sundarbans will be analyzed.

4.1.1. The Farakka Barrage

The construction of a barrage at Farakka across the Ganges has been historically the most crucial factor affecting the Bangladesh-India hydro-political relations and the perceptions of trans-boundary environmental security issues. Farakka is located just upstream of the point where the main branch of the river Ganges enters Bangladesh and a smaller branch, Bhagirathi- Hooghly, reaches the Bay of Bengal flowing within the Indian state of West Bengal. The barrage was planned to enhance the flow of Bhagirathi- Hooghly branch so as to resuscitate the port at Calcutta, located downstream. The port was rapidly getting silted up and losing navigability. The Government of Pakistan and, after 1971, with the birth of Bangladesh, the Government of Bangladesh were critical of the project as it was apprehended by them that by enhancing the flow into Bhagirathi-Hooghly, the barrage would

reduce the dry season flow of the Ganges / Padma into Bangladesh. This would have serious implications for environmental security including food security in that country (Abbas, 1982).

Islam and Gnauck (2008) attribute the salinity ingression in the Bangladesh Sundarbans delta to the construction of the Farakka barrage in 1975. They find evidence of saline water penetrating the upstream area, with river water salinity increasing significantly in 1976 as compared to the year 1968.

The Bangladesh-India treaty of 1996 on the sharing of the dry season flows at Farakka turned out to be merely an arithmetical exercise. It is not based on a broader and interdisciplinary ecological perspective on river flows. In Bangladesh, the Barrage is blamed for water scarcity and salinization in the lower parts of the GBM delta. Even in India, the drying up of the Indian Sundarbans Delta (ISD) and the consequent saline water ingression in the delta region have been attributed to the streamflow depletion due to sedimentation in the Farakka, as also the rise in sea levels (Ghosh et al 2016). The absence of ecosystem perspective in the case of the Farakka barrage is also exemplified by the recent statement (21 Aug 2016) by the Chief Minister of Bihar, linking the sediment problems caused by the barrage with the floods in Bihar.

Moreover, many unsubstantiated claims fog the hydro-political relations, thereby causing further confusions over the impacts of the barrage on environmental security in the GBM delta region. As recognized by Richards and Singh (2000:1915), "… In Bangladesh, the Farakka Barrage has been widely portrayed in political and media discussions as a symbol of India's evil intent toward Bangladesh. Technical controversy about the 'flushing' process through which the barrage was expected to save the port of Calcutta and its industrial hinterland, as well as India's failure to consider the downstream consequences of the project, left space for the assertion that the barrage was built *because of* its deleterious effects on Bangladesh (then East Pakistan). A second myth of Indian malice has also been widely repeated. This is the assertion that India can cause flooding in Bangladesh through the release of

water stored behind the Farakka Barrage. A brief description of the barrage indicates that it is unequipped for storing more than trivial quantities of water, far too little to have a significant effect on floods in Bangladesh".

Such issues have caused harm to both sides of the border over decades. The progress in the evolution of new ideas has also been hindered by the lack of availability of detailed hydrological data in the public domain. This has obstructed the generation of crucial and new interdisciplinary knowledge on the complex ecology of the GBM basin, especially the delta. Further, professional criticisms from within water technocracy were ignored, as has been the case with Bhattacharya (1954) whose views on river engineering for the Farakka barrage were not in tune with the official position. It is in this background that ecologically informed hydro-diplomacy and holistic engineering had been strongly suggested for the GBM basin by Bandyopadhyay and Ghosh (2009). The impact of the reductionist understanding of rivers is clear from the fact that the decline in the navigability of the port at Kolkata (Calcutta) has not been reversed by the Farakka barrage. The plus side of the barrage, nevertheless, for West Bengal is the flow in the Bhagirathi-Hooghly, especially during the lean season. This has substantially reduced the water problem in the downstream in the densely populated areas of West Bengal.

4.1.2 Interlinking of Rivers in India

While on the one hand, Bangladesh feels that the lack of flow in the dry season months poses a threat to environmental security, a proposal for taking part of the flow of the Brahmaputra to other parts of India was planned. This can be seen as a part of the larger project of interlinking of river in India (ILR) (Fig. 3). Further, linking of its tributaries Manas, Sankosh and Teesta with the Ganges (MSTG Link) is also on the cards. On many platforms, NGOs and civil society groups in Bangladesh have expressed opposition to the river interlinking project. If official negotiations

are not completed prior to the completion of the links, it may become a possible trigger for further disputes over environmental security in Bangladesh (Mirza et al., 2007). This project has also drawn criticism from the perspective of ecological and economic impacts (Bandyopadhyay, 2009:147-183; Alagh et al., 2006). From these publications, it is apparent that an old and ecologically uninformed approach has been used to conceptualize this massive project intervening into several Himalayan rivers. Environmental security in the downstream areas will surely be impacted by such a project but environmental impact studies are very limited in their scope and knowledge base used. While some groups in both Bangladesh and India have been advocating a basin-level strategy to address trans-boundary waters, realization of such ideas has not progressed very much. Again, it is only an ecologically informed hydro-diplomacy and holistic engineering that will be needed to make an amicable progress.

4.1.3 The preparatory steps for cooperative management of the Sundarbans

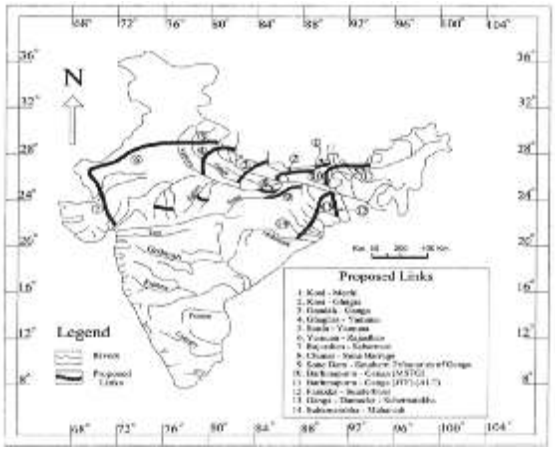

Fig. 3: The Proposed Himalayan Links in the ILR Project

Source: http://wreforum.org/khaleq/blog/4971

The other critical trans-boundary issue related to water is of the Sundarbans ecosystem. The Sundarbans ecosystem extends from southern Bangladesh to the southern part of the Indian state of West Bengal. It is the largest single block of tidal halophytic mangrove forest in the world and became a trans-boundary mangrove after the division and independence of India in 1947.. The forest area of the Sundarbans covers approximately 10,000 square kilometers (3,900 sq mi) about 65 percent of which is in Bangladesh with the remainder being in India. The Sundarbans is declared as a UNESCO World Heritage Site. The ecosystem is dominated by mangrove forests (one of the three largest single tracts of mangrove forests in the world), spreads over an area of 26000 square kilometers, with 9630 sq kilometers in India. The Sundarbans is located at the southern end of the GBM delta and freshwater flows from the Ganges, Jamuna and Meghna are very much needed for its ecological stability.

With a population of about 8 million (in both Bangladesh and Indian parts), the Sundarbans presents itself as one of the most poverty-stricken regions of the world. The deep-rooted ecosystems-livelihoods linkage can be witnessed from the heavy reliance of the population for livelihoods on the ecosystem services. Therefore, fishery, honey collection, gathering of wood, shrimp larva farming, crab collection, and agriculture are the major forms of occupation.

While "development deficit" in terms of health, education, and high poverty levels work against environmental security, it has been stated for long that the Farakka barrage has been responsible for reduced freshwater flows into the GBM Delta (Richards and Singh, 2000; Danda et al, 2011; Ghosh et al 2016). Even the expansion of irrigated agriculture has been stated as a reason. The reduction in freshwater flow has been resulting in salinity ingression in the Sundarbans delta regions of both the countries. In the Indian part, saline water ingression has proved detrimental for agriculture, and there are already talks on reviving the salt-tolerant variety of paddy that was discarded during the

Green Revolution of the 1960s. The other critical threat has been posed by global warming and climate change. These changes are in the form of increase in sea surface temperature, sea level rise, changes in the precipitation pattern and more frequent occurrence of storm events (Danda et al., 2011; Hazra et al., 2002; Singh 2007; Pethick and Orford 2013). Further, the proportion of higher intensity events appears to be increasing, possibly as a result of rising sea surface temperatures (Hazra et al., 2002). Analyses of cyclonic events over the last 120 years indicate a 26 percent rise in the frequency of high to very high intensity cyclones over this time period (Singh, 2007).

The importance of the Sundarbans, however, has been recognized by the Governments of both the countries. Interestingly, despite the fragmented nature of water management regimes, both the governments have recognized the Sundarbans as two parts of the same ecosystem. This is particularly of significance from the point of wildlife management. The acknowledgements that the Sundarbans have a broader role to play by the continuation of diverse ecosystem services led the two governments to design and sign the Memorandum of Understanding (MoU) on Conservation of the Sundarbans on September 6, 2011. This is a non-binding agreement on the part of both countries, with an initial tenure of 5 years, and with the provision of automatic renewal, unless terminated by mutual consent by either party by serving written notice 90 days prior to the date of termination.

There is no doubt that such a form of cooperation with an ecological perspective to protect and restore ecosystem processes involving trans-boundary forests and water differ from the agreements on water sharing. However, the inherent problem with this agreement is that it essentially concentrates on the conservation component without any reference to the issues of economic development policy. Though the agreement recognizes the importance of ecosystem services to human communities, there is a need for a holistic statement describing the complex

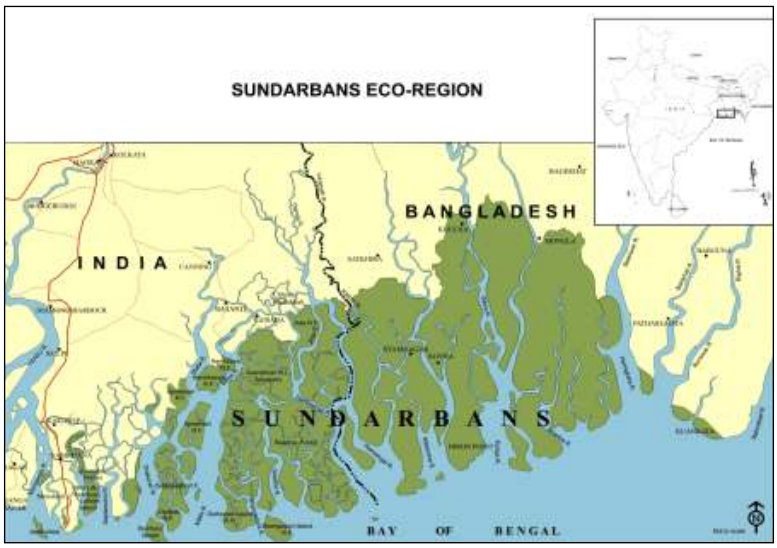

Fig. 4: Sundarbans Eco-region

Source: Danda et al (2011)

relations between regeneration of the ecosystem and the human economic activities. A very innovative concept in this regard has been put forward by Danda et al (2011). They have conceptualized a framework vision for the Indian Sundarbans Delta (ISD) for 2050 by highlighting the need for a planned retreat of humans from areas with high vulnerability to extreme natural events which can lead to ecosystem regeneration in that zone free from human interference. Ghosh et al (2016) have justified how such an option for adaptation and development is economically more beneficial than the business-as-usual scenario of non-adaptation. This vision presents a holistic statement of sustainable development in the ISD region. However, such types of vision statements are also needed for the Bangladesh Sundarbans region, and could be made as a component of the cooperative framework. Nevertheless, the shift of the basis for cooperation to ecosystem regeneration indicates

that a holistic perspective of rivers could also promote and advance cooperation between Bangladesh and India.

4.2 Environmental Security as a two-level game

As observed by Richards and Singh (1997), usually national governments get engaged in a "two-level game" (Putnam, 1988) when dealing with trans-boundary waters. They have to deal with their domestic water regimes, and almost simultaneously get into international trans-boundary water negotiations, keeping in view their domestic compulsions. On the other hand, international agreements also affect domestic hydro-political conditions. A move in one game will typically have implications for the outcome of the other. The ongoing impasse on the proposed Bangladesh-India agreement on the flows of Teesta is a case in point. The Bangladesh-India engagement over the trans-boundary waters complies well with this contention. There is no doubt that the domestic economic interests have been the prime drivers of international negotiations as far as the India-Bangladesh trans-boundary water relations are concerned.

On the one hand, domestic policies based on the traditional engineering paradigm have led to domestic problems over the basin. The absence of a robust sediment management strategy makes it difficult to understand and address the changing course of the Ganges in the upstream and the downstream of the Farakka barrage. The changing course has resulted in extensive land-erosion and flooding generating dispute between the federal states of Jharkhand and West Bengal, creating neo-refugees. Bandyopadhyay and Perveen (2008) have expressed their apprehensions on the interlinking of rivers project and feel that the project may further aggravate interstate water disputes, apart from aggravating the Bangladesh-India hydro-political relations. They identify avenues through which new inter-state conflicts may emerge with the project. It is a fact that the federal states in India have always enjoyed right over water for apportionment and allocation. Already a few states in India have revealed their dissent

against the ILR project. On the other hand, a recent report the Institute of Defence Studies and Analyses, (IDSA) New Delhi, expressed the strong role of the civil society in Bangladesh in the context of the international dialogues over water sharing with India (IDSA 2010). Bangladesh is also concerned with India's ILR project that would divert water from tributaries to Brahmaputra.

The above examples not only hint at a possibility of interstate conflict, but also at inter-sectoral conflict (irrigation needs versus domestic supplies issues, and also of ecosystem processes, navigation, etc.) whose environmental implications will widely be felt in South Asian hydro-politics.

5. Knowledge Gaps on Trans-boundary Water Regime: A concern for Environmental Security

The ineffectiveness of traditional water engineering to contribute to promoting environmental security in the context of population pressure and continuing poverty in the GBM delta can be largely linked to the absence of an ecological perspective, and use of a framework of economics that cannot recognize the ecosystem processes and services in their totality. By not engaging with critical opinions worldwide, the existing view of governmental water engineering has exposed its inability to evolve with the flow of global knowledge. The result has been an exclusive mode of hydro-diplomacy that has essentially resulted in bilateral negotiations between Bangladesh and India on the downstream flows in the basin (Richards and Singh 2000). Whereas worldwide there has been a call for taking an "ecosystemic" approach for integrated river basin management, the bilateral approach to water resource development moves away from considering the entire river basin as the unit for water resource management. More recently, Bandyopadhyay (2016) has made a strong plea for introduction of river basin organizations in managing rivers in India. Bridging the "disconnect" between the emerging paradigm and the traditional perceptions still dominating water policy and management in South Asia is going to be critical for water

management and environmental security in the context of the transboundary water relations. With global climate change seriously affecting the hydrology of the Himalayan rivers, water endowment of the rivers and future flows would become more uncertain (Shrestha et al., 2015).

6. Way Forward for Research and Water Diplomacy

In addressing the state of dispute over shared waters in the Bangladesh-India context, the perception of stock, divert and use needs to be replaced by a form of collaborative water diplomacy informed by ecological characteristics of the GBM river system. The most important remedy to address such knowledge gaps and eventually impact diplomatic thinking is to undertake research in some of the areas that are of utmost relevance in terms of affecting environmental security in the region. The proposed research issues need to be addressed from three perspectives in a holistic and inclusive framework combining various disciplines. These perspectives have otherwise been suggested by Bandyopadhyay and Ghosh (2009).

a. *The ecological perspective: Ecosystem service–Livelihood linkage:* The river basin needs to be looked at as a collection of productive ecosystems that greatly affects livelihoods further downstream. The growing recognition of the importance of the ecosystems services has been highlighted in the report of the Millennium Ecosystem Assessment (2005). While upstream diversions help agriculture, there is a consequent decline in the downstream fishing economy all along the river as also enhanced salinity ingress affecting downstream economies, leading to partisan and suboptimal decisions. Based on recent research on the economic role of ecosystem services, the satisfaction of the needs of natural ecosystems has become a genuine contender for allocation of water in many countries (Aylward et al., 2005; Dyson et al., 2003). Further, the importance of sediment needs to be

understood in a holistic framework of fluvial geomorphology and biodiversity. This element has somehow eluded policy documents so far. Even floods in the Brahmaputra-Jamuna floodplains need to be understood through a holistic ecological engineering knowledge, so as to manage floodwaters and also sediments.

b. *The Perspective of Economic Valuation:* To complement the ecological perspective, a fundamental re-think has been going on with the internalization of important perspectives of ecological economics, which, more importantly entails identification of economic values with ecosystem processes (Ghosh and Bandyopadhyay, 2009). Such valuation exercises are often conducted with offering a range of values (which, by themselves, are approximations). The important aspect of such valuation exercises is their usefulness in providing means to internalize factors that remained to be considered in the traditional assessment of river projects. A very comprehensive process of valuation has evolved from the Water Allocation Systems (WAS) developed by a project at Massachusetts Institute of Technology (MIT) on water management and conflict resolution in west Asia (Fisher et al 2005). It is models like these and the ones by Hitzhusen (2007) that need to be developed for comprehensive evaluation at the river basin scale, in the context of GBM. For India, Desai (undated) and Bandyopadhyay and Ghosh (2009) have suggested expansions of the valuation framework in the assessment of projects, though, in reality, little has been done to expand the framework.

c. *The Institutional Perspective:* There has not been much work on the institutional aspects of water management at the basin scale over the Ganges-Brahmaputra-Meghna basin barring those by Crow and Singh (2000). Crow and Singh

(2000) have highlighted the need for extending bilateral exchange to multilateral exchange, and the second is expanding negotiations from conventional diplomacy to incorporate private economic actors. This implies the consideration of inter-sectoral modes of water distribution, and considering the ecosystem as an important sector that plays an important role in human civilization. On the other hand, there needs to be a redefinition in the ways the property rights over water are being looked at. In western US, property rights over water had been defined in terms of three doctrines: History, Harmon and Hobbes. While the doctrines of History (right belongs to the one who has appropriated the resource first), and Harmon (right belongs to the one who has the water falling on his roof), were leading to conflicts, as different actors in the basin at various levels and sectors defined property rights as per their own convenience, it is therefore better to have peaceful modes of negotiations for defining property rights as defined by the Hobbesian doctrine (Richards and Singh 2001). This might even lead to the development of water markets for defining property rights.

The perspectives, however, should not be treated as independent modes of looking at the challenges of environmental security in the context of the India-Bangladesh transboundary water relations. There is a need to combine the three perspectives in order to conduct research in a holistic framework.

7. Concluding Remarks

The above discussion highlights that the concerns of environmental security in the context of trans-boundary water relations between Bangladesh and India should be viewed through the lens of the ecosystem processes and services and livelihoods linkages, rather than from the perspective of traditional engineering. Such perspectives and interests have so far

led to conflicts at international, national and sectoral levels between stakeholders, and have posed threats to environmental security.

The movement from a state of distrust and suspicion to a state of trust and cooperation can be facilitated with an ecosystem-based approach to basin-level management of rivers. This implies that on the one hand, the relevant stakeholder nations in the Ganges-Brahmaputra-Meghna basin have to be involved in a dialogue. On the other hand, since the environmental security concerns boil down to the most micro-level stratum of the society, there is a need to involve sub-national actors in the deliberation processes, as also to involve them realistically in the decision-making process.

However, research and knowledge creation has to precede policy dialogue to bridge some critical knowledge gaps. While this paper has talked of inclusiveness of diverse stakeholders, it further stresses inclusiveness of diverse disciplines for conducting research. The new research framework needs to be based on a new trans-disciplinary knowledge base created by the emerging science of eco-hydrology, economics, and new institutional theories. There is a need to specially consider the important economic issues of the delta region. The Indian Sundarbans Delta specifically presents a critical challenge of vulnerability of humans and other life forms in the wake of global warming and climate change. On the other hand, there is a need to reconsider the ways floods are being looked at further upstream, and consider their ecosystem contributions and services. On the whole, there needs to be an economic assessment of the demand for water based on scarcity value framework on an immediate basis, with the results being disseminated at a broader policy scale, with clear recognitions of the ecosystem based delineations of a hydro-diplomacy that concerns itself with human well-being, food security, and environmental security.

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