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FRESH WATER MANAGEMENT: BANGLADESH PERSPECTIVE

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Abstract: Water is a commodity which has an economic value. So it has a huge impact upon development and for a sustainable development it is the need of the hour to have a "Sustainable Water Management System". In this article the researcher tries to examine the existing fresh water management mechanism by investigating its legal frame work, the activities of various Govt. agencies, NGOs, and the users of water including the public. At least the researcher inserts some recommendations so that a sustainable fresh water management system can be established and ensure.

Introduction

Perhaps nothing is more crucial to life and the environment than water. It is one of the most important natural resources as access to safe water is vital for survival. So all are concern about having their own portion of water throughout the world. The uneven distribution of water resources and the competition between the multiple uses of those resources, combined with the growth of the world's population has given rise to a debate on future æwater wars". While some predict such wars[1] others indicate not.

In today's world, water is not longer taken as plentiful resource that will always be available when we need it. More and more people in more and more countries are experiencing water differently. As a limited resource that must be carefully managed for the benefit of people and the environment, in the present and for a better future. Today, the rest of the world is starting to look at water form a similar perspective, understanding its value[2].

Water management in Bangladesh is a critical issue owing to growing demand and increasing conflict between alternative uses. Demand for water is growing rapidly in agriculture mainly from irrigation for cereal production, the urban and industrial sector, fishery, inland navigation and salinity control. The supply of clean and uncontaminated water has fallen far short of

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demand owing to inadequate flows in the Ganges, pollution caused by the disposal of effluents and chemicals, salinity intrusion in the coastal area and arsenic contamination. Further, the availability of freshwater is highly seasonal depending on the presence and duration of the monsoon. The incidence of both flood and drought in a yearly cycle profoundly affects river morphology. So all these matter should be taken into consideration while preparing policy and guideline for fresh water management.

Objectives

The object of this Article is-

- Firstly, try to determine the necessity of an effective and proper management of fresh water in Bangladesh.
- Secondly, to identify problems for the proper and effective utilization of fresh water of Bangladesh.

Availability and Demand of Fresh Water in Bangladesh

Naturally, Water is the most abundant resource on earth. From space, the Earth appears blue. It is the water planet. But, only a tiny fraction (less than 3%) of Earth's water is fresh. Mostly it is salty Number from the sea. A huge amount of Earth's finite fresh water resource (97%) is locked up, most in the frozen Antarctica or deep underground beyond the easy reach of man. Worse, profligate actions by individuals have polluted much of the finite fresh water accessible to mankind. Thus like Coleridge's Ancient Mariner, the Earth is awash in water with much of it unfit to drink[3].

Presently, about 146.6 million[4] people live on 1,47,570 sq. km of land which makes Bangladesh the most densely populated larger country in the world. The population was 75 million in 1971 and in less than 40 years it has crossed 152 million. The rapid increase in the countries population, from about 72 million at the time of the independence to over 146.6 million in 2010 which will increase to 200 million by 2020 (The Daily Star, July 11, 2010). However in a seminar held on January 12, 2011 at Dhaka University speakers said Bangladesh's population would be 222 million by 2051 and 250 million by 2081, accompanied by growth of agriculture, industrialization, rapid urbanization, economic growth and improved access to basic services has resulted in an increase in the demand for water.

The sources of water in Bangladesh are surface water, groundwater and rainwater. Eventually the gap between supply and demand of water is ever-increasing. In this regard, Chairman of National Disaster Management Advisory Council Dr. MA Quassem said, æWater availability in Bangladesh is around 90 billion cubic metres (BCM) during the dry season against the demand of about 147 BCM, a shortage of nearly 40 percent, resulting in drought- like situation in large parts of the country[5]" The widening gap between demand and supply had led to a substantial increase in the share of

groundwater consumption by the industrial; agricultural and domestic sector. It may also be noted that the quality of water sources is threatened because of inadequate provisions for the treatment of wastewater.

Legal Arena of Fresh Water Management
National Perspective

Before the agricultural and industrial revolutions, less than one billion people competed for available fresh water. Despite occasional site specific droughts, fresh water shortages were the exception rather than the rule. Today, as we approach the 21st century, there are six billion individuals competing for their share of the finite water resource. Projections are for at least eight or possibly more than ten billion by 2050 and in south Asia water scarcity is developing while the member of South Asian countries did not comply with the UN convention on the law of non-Navigational uses of international water courses.

As I have told earlier the demand of water is raising so it's slowly have the attention of the government agencies. Basically Bangladesh started its journey to protect environment from late 19th centuries and before that Bangladesh did not have any water policy. In absence of such a policy all the activities in the water sector by the scores of agencies both Government and NGOs had been highly uncoordinated and grossly isolated based on individual agencies. As a result much damage has been done to the bio-diversity and environment of the country.

Excessive exploitation of ground water for irrigation throughout the country during dry season has created various adverse impacts like alarming lowering of groundwater table, arsenic contamination of groundwater in many parts of the country, intrusion of salinity in the aquifers in coastal zone and so on.

At present the following laws and policy have been prevailing in our legal system[6].

- The Bangladesh Irrigation Water Rate Ordinance, 1983
- The Ground Water Management Ordinance, 1985
- Bangladesh Water Development Bord Act 2000 (In Bangeli)
- Water Supply and Sanitation Authority Act 1996 (In Bangeli)
- Wetland preservation Act 2000
- National Water Policy-2002
- Draft Bangladesh Water Act-2008

International Perspectives

International water resources include surface water such as rivers and lakes and their tributaries, and groundwater such as aquifers and ground basins, which lie within the jurisdiction of two or more states. Management of such

shared water resources must take many factors into account, including current laws, existing legal and institutional frameworks, present and future water resources and uses, climatic conditions and water availability in the basin or region concerned, water cost from different sources, and users' ability to pay[7].

Other non-navigational uses such as irrigation and industrial and recreational exploits also became more and more important. In the course of the twentieth century, economic development and population growth resulted in an increased demand for water. These factors and the concerns about the limited availability of water resources, as well as a growing awareness of the need for protection led to the adoption of the 1966 Rules on the Uses of the Waters of International Rivers, the so-called 'Helsinki Rules', which deal with navigational as well as non-navigational uses of rivers. These rules, which have been drafted by the International Law Association, a non-governmental association of legal experts, have codified principles derived from state practice with the objective of clarifying the rules of the game in terms of the use, sharing and management of international watercourses.

The Finnish delegation to the UN proposed that the Sixth Committee include an item entitled 'Progressive development and codification of the rules of international law relating to international watercourses' in the agenda of the General Assembly (GA) meeting of 1970. The Finnish proposal was endorsed by the representatives of other Member States and the GA adopted resolution 2669, which entrusted the UN International Law Commission (ILC) - a subsidiary body of the GA - with the task of initiating a study on the law of non-navigational uses of international watercourses. The completion of the work of the Commission, which took almost three decades, led to the adoption of a multilateral treaty by the GA on 21 May 1997. This treaty, called the Convention on the Law of the Non-Navigational Uses of International Watercourses, covers all uses other than navigation. The long duration of negotiations within the ILC attests to the difficulty of identifying and specifying principles and norms at the universal level.

In 2003, the ILC again considered the issue of international water law, this time dealing with the law applicable to transboundary groundwater resources. In 2008, it adopted the Draft Articles on the Law of Transboundary Aquifers. The shorter time frame might be explained by the fact that the Draft Articles rely heavily on the principles codified in the 1997 UN Watercourses Convention.

Both instruments codify universal principles such as the principles of equitable utilization and the no-harm rule, and contain provisions establishing a general obligation on riparian states to co-operate. According to these instruments, such co-operation may be achieved through different means[8]:

- Setting up joint mechanisms and Commissions of which riparian are members,
- regularly exchanging information and data[9], and
- Notifying other riparian states about planned measures[10].

The 1997 UN Watercourses Convention affirms the obligation on riparian states to exchange information concerning the conditions of the watercourse, particularly information of a hydrological, meteorological, hydro geological or ecological nature. It also establishes information exchange mechanisms for dealing with planned measures and deals with the obligations of notification and consultation. The 2008 ILC Draft Articles set forth the general obligations on aquifer states to prevent, reduce and control the pollution of their transboundary groundwater's that may cause significant harm to other aquifer states.

Development Priorities and Relevance of the Water Sector

Water is a commodity which has an economic value. So it has a huge impact upon development and development is greatly influenced by water management. Now let me identify few points which is needed to be properly managed through a proper æwater management body".

Food Security & Irrigation

Achieving food security is another major development objective that is heavily dependent on irrigation expansion. The average daily per capita calorie intake hardly exceeds 2,000 kcal, compared to the desired value of 2,400 kcal. The attainment of food production beyond the self-sufficiency level and a higher production of diversified high-valued export foods constitute one significant goal. Rice and wheat production increased from 11.47 million tons in the mid-1970s to 27 million tons in 2002/3 (Government of Bangladesh, 2005). Food security is a temporal as well as a structural issue since floods and droughts disrupt food production and distribution.

Fisheries

The Government of Bangladesh (hereinafter referred as GOB)[11] plans to finalize the National Fisheries Policy to enhance fisheries production to meet the demand for animal protein and boost economic growth by exporting fish and fisheries products. The policy highlights the need to conserve fish habitats particularly in the development of water management infrastructure. It clearly points to a determination to prevent further drainage of standing water bodies for agricultural development and to promote fisheries development in all water bodies.

Improvement of Quality of Life

Only around half of the population has access to basic health care. The major causes of illness are poor sanitation and nutrition. The largest single

disease is diarrhoea, which is responsible for death of many children under one year of age. The government has committed itself to achieve 100% coverage of water and sanitation for all by 2010. At present, safe drinking coverage is 74% while sanitation is only 33%[12] (Government of Bangladesh, 2005). The objective is to improve public health by reducing waterborne diseases and contamination of surface and groundwater. A recent health threat to the population is arsenic poisoning caused by widespread water contamination. The government is undertaking massive programs for the availability of arsenic-free water.

Protection and Preservation of the Environment

Most of the country's environmental resources are linked to the water ecosystem. Successive governments have developed a detailed policy framework. These include the National Environment Policy (1992), the National Environment Action Plan (1992), the National Agriculture Policy (1994), the National Forest Policy (1994), the National Energy Policy (1996), the Forestry Master Plan (1993-2012), the Environment Conservation Act (1995), the National Policy for Safe Water Supply and Sanitation (1998), the National Fisheries Policy (1998), the Draft National Conservation Strategy, the National Water Policy (1999), the Sustainable Environment Management Program (SEMP) and the National Arsenic Mitigation Policy (2004). Further, the National Environment Management Action Plan (NEMAP, 1995) has been prepared with a wide participation of stakeholders. It should be emphasized that realization of most of these objectives is heavily dependent on successful water management practice.

Implications for Policy and Institutions

As water is needed in all areas of society there is a need for effective institutions and a legal framework to take care of the issues described above. The overall management of water resources is shared between state water agencies, users of water including the public, NGOs and other government agencies in agriculture, industry, commerce, water and sewage, public health, municipalities, inland water transport, fisheries, forestry and the environment.

Institutional Network

The Ministry of Water Resources is responsible for flood management, irrigation, drainage control, erosion protection, land reclamation, integrated management of coastal polders, river flow augmentation, water sharing from transboundary rivers and wetland conservation through participation of local people and coordinated programs with all the ministries dependent on water resources. Major public organizations under the Ministry of Water Resources are WARPO, BWDB and River Research Institute (RRI). Organizations in other sectors that have interlinkages with this sector are the Department of Public Health Engineering (DPHE), the Local Government Engineering

Department (LGED), the Water and Sewerage Authority (WASA), the Department of Fisheries (DOF), BIWTA, the Roads and Highways Department (R&H), the Department of Environment (DoE) and respective municipal authorities.

WARPO is a principal agency of the Government of Bangladesh under the Ministry of Water Resources. It has a mandate to ensure coordination of all relevant ministries through the NWRC and to plan all aspects of water development including major and minor irrigation, navigation, fisheries and domestic water supply. It is responsible for three main assignments:

- Preparation of the National Water Management Plan (NWMP) for the period to 2025 according to the National Water Policy formulated in January 1999[13].
- Establishing and updating the National Water Resources Database (NWRD).
- Acting as a clearing-house for all water sector projects undertaken by any agency involved in the water sector.

BWDB carries responsibility for the planning and execution of over 400 projects, ranging from flood control, drainage and irrigation to coastal protection and erosion control. Major investments in the water sector are made by the Ministry of Water through the BWDB and by the Ministry of Local Government and Rural Development through its LGED. As WARPO is responsible for national and regional level plans BWDB is supposed to develop projects fulfilling the requirements of their plans. BWDB is also a major collector of water resources information and as such it is a major partner of WARPO in sustaining the NWRD.

DPHE facilitates rural and urban water supply. DPHE is also responsible for arsenic problems and planning. BIWTA is mainly responsible for maintenance of river channels for waterway navigation during the monsoon and the dry season. Of these the Hydrography and Planning Departments are most relevant to WARPO. The Hydrography Department publishes annual tide tables. The Joint Rivers Commission (JRC) is responsible for 57 identified border rivers and has data on cross-boundary water resources. Many of these are classified according to the ongoing negotiations with the co-riparians.

All water sector projects need to conform to Department of Environment (hereinafter refereed as DoE) rules and guidelines. It endorsed a set of EI A guidelines operated by the Ministry of Water Resources. Most of the Ministry's projects are subject to DoE scrutiny when they are submitted to the Planning Commission. WARPO and DoE share overlapping responsibilities like setting standards, monitoring compliance, data acquisition and storage.

In principle WARPO, NWRC, the Ministry of Environment and Forestry and DoE all have to some extent overlapping roles. Special attention is needed to ensure cooperation between these institutions. At WARPO's level a close link with DoE is of mutual advantage particularly in the area of standards and guidelines development for the water sector[14].

International Dimension of Water Management

Bangladesh shares 57 rivers with India and Myanmar. Since Bangladesh receives the residual flow after upstream utilization, dry season water shortage is always a critical issue in water sharing negotiations with India. Interregional government efforts to tackle the problems of the Ganges began with the signing of the Ganges Water Treaty between India and Bangladesh on December 12, 1996. Under this treaty, India is likely to give Bangladesh a minimum of 991.09 m3 per second, or 50% of the water available at Farakka, if the Ganges' total flow is less than 1,982.18 m3 per second during the dry season. A number of agreements were signed between India and Bangladesh on the Ganges including this treaty. However, these agreements have the limited purpose of sharing the waters during the dry season only from January to May every year. The seasonal variation in the Ganges flow can result in catastrophic floods in the rainy season and acute water scarcity, as well as severe drought conditions during the dry season.

The series of agreements concluded between 1975 and 1996 did not address problems of flood control and environmental degradation. Water sharing is a bilateral issue between Bangladesh and India, while augmentation has to be done through multilateral cooperation of the co-basin countries: Bangladesh, India and Nepal. None of these committees included a neutral third party from outside the region. India has a long-standing policy of adhering to bilateral negotiations because it can best address its own needs vis-a-vis each of its neighbours separately. As a consequence the Ganges-Brahmaputra river system has never been managed to its full potential. Further, the recent Indian plan for a river linking project and Tipaimukhi dam will inflict severe ecological and socioeconomic damage on Bangladesh.

Water Management Issues: Problems and Prospects

Water management is a critical issue owing to the growing demand and increasing conflict between alternative uses. Demand for water is growing rapidly in agriculture, the urban and industrial sectors, fishery, inland navigation and salinity control. The supply of clean uncontaminated water has fallen far short of demand owing to inadequate flows in the Ganges, pollution caused by the disposal of effluents, salinity intrusion in the coastal area and arsenic contamination. On the demand side, irrigation has received higher priority than the supply of safe drinking water. On the supply side, the use of groundwater has received more emphasis than surface water. The

result is mass scale arsenic contamination. These various demand and supply issues affecting water management are taken up here.

Flood and Drainage Congestion

During the monsoon, water is slow to drain and banks overflow. Flood damage from the GBM rivers is catastrophic and after the peak season water congestion continues to impede drainage. Development of FCDI (flood control drainage irrigation) projects in the last 57 years by the Bangladesh Water Development Board (BWDB) is part of water management. Since the floods of 1954 and 1955, flood control and drainage projects have played an important role in water resource management[15].

Most flood control and drainage projects prior to 1988 were justified in terms of increased crop cereal production but undermine the need for water by industry, fisheries, inland navigation and environment. Construction of flood-control embankments impedes natural water flows, threatening wetland and fishery resources. Some intensive irrigation projects have neglected drainage leading to water logging. Bangladesh needs a flood management that combines both structural and non-structural measures. FCDI projects should be multi-purposed and part of an integrated water resource management scheme that takes into account navigation, fisheries and environmental concerns. Embankments must be designed for controlled flooding of major rivers such as the Ganges and Meghna and other small rivers.

Shortage of Water in Dry Season

The issue of balancing water supply and demand during the dry season[16] is a critical one. Water extraction upstream of Bangladesh greatly reduces dry season water flow. This is the season of greatest demand for groundwater for irrigation. Western regions are particularly vulnerable to droughts[17]. From December through to May when rainfall is low droughts occur owing to: (i) a cumulative effect of dry days and (ii) higher temperatures (. 408C in March/May). This drought affects all the winter crops, such as HYV boro, aus, wheat, pulses and potatoes especially where irrigation possibilities are limited. In the Rabi season, 1.2 million ha of cropland faces droughts of various magnitudes. Apart from loss in agriculture, droughts[18] have significant effects on land degradation, livestock population, employment and health.

One can consider the viability of augmenting dry-season flow in the southwest regions (SWR). The 1996 water treaty with India is supposed to give Bangladesh a minimum of 991.09 m3 per second, or 50% of the water available at Farakka, if the Ganges' total flow is less than 1,982.18 m3 per second during the dry season. This should increase the availability of surface water in the dry season and create a new water balance. In order to augment surface water utilization, the BWDB and the Water Resources Planning Organization (WARPO) have already finalized a feasibility study which

includes a detailed engineering design for constructing a Ganges Barrage (Government of Bangladesh, 2005). But India is also exploring the idea of transferring water from surplus to deficit basins. Therefore it is imperative that Bangladesh makes an agreement with India on all other transboundary rivers for mutual benefits.

Availability of Groundwater Availability and Quality

Since the availability of surface water is not uniform seasonally or spatially, use of tube wells to raise shallow groundwater was encouraged to support intensive irrigation and provide safe drinking water in rural and urban areas. Almost 95% of drinking water and 68.5% of irrigation water are derived from groundwater sources[19]. Groundwater abstraction represents 35% of total annual water withdrawal (World Bank, 2006). Overexploitation of groundwater in agriculture together with its massive use by households, municipalities and industries is depleting this resource quickly. It is lowering the water table and increasing saline intrusion. The water table in many areas has fallen below the suction level of the tube wells. In Dhaka the groundwater table has gone down by 20 m in the last decade (World Bank, 1998). The fall in the water table increases the salinity of the shallow aquifers in the coastal region. It also leads to subsidence of land. An additional problem is wide-scale arsenic contamination of shallow groundwater tables.

Arsenic Contamination

High levels of naturally occurring inorganic arsenic are detected in 59 of the 64 districts in Bangladesh. The highest level of contamination is found in the large basins of the Rivers Padma (local name of the Ganges), Atrai, Brahmaputra and Meghna in the northern and the north eastern part. Another area of high concentration of arsenic is in the southern and the south western parts. The World Health Organization has specified 0.01 mg l21 as the maximum permissible level of arsenic concentration in potable water. Bangladesh accepts a higher level of 0.05 mg l21 of water. However, water samples collected from different parts of the country contained arsenic in the range 0.1-0.3mg[20]. It is estimated that 35 million people are affected in both rural and urban areas[21]. The National Institute of Preventive and Social Medicine (NIPSOM) has identified arsenic-related diseases in 37 districts[22]. If farmers continue to depend on shallow tube wells, the rate of groundwater abstraction will increase, leading to increased arsenic abstraction with possible impacts on crops[23].

The solution lies in the treatment of tube wells or in collecting water from alternative sources such as surface or rainwater. Key areas of research are the implications for food safety of irrigating with arsenic-contaminated water, prediction of whether contamination will change over time and cost effective solutions for immediate mitigation and long-term solutions. The extent of

arsenic contamination in water extracted by deep tube wells also needs to be researched further.

Land Erosion and Accretion

Rivers in Bangladesh are morphologically highly dynamic. Rivers erode part of their banks owing to current and wave action during flood and post-flood periods. The GBM, Teesta and Surma-Kusiyara rivers flow within well-defined meander belts on extensive floodplains where erosion is widespread (World Bank, 2000). In lower delta areas, tidal currents and storm surges from the sea cause riverbank erosion. Riverbank erosion is responsible for a huge loss of fertile agricultural land and homestead. Satellite image studies of the GBM rivers show that an area of 106,300 ha was lost owing to erosion between 1982 and 1992, while the accretion amounted to only about 19,300 ha. Most of the net loss of 87,000 ha was agricultural land. A huge population of 728,439 was displaced owing to the erosion.

Riverbank protection and river training works are required in rapidly eroding areas like the banks of the Brahmaputra and Meghna to save valuable land and also to safeguard the existing water management infrastructure. But engineering works on major rivers are expensive and can be subject to high risk. However, in order to control erosion of major rivers and protect large and small towns, the government has undertaken a Jamuna-Meghna Erosion Mitigation Project (Government of Bangladesh, 2005). Because of increasing pressure on land, accretion is an important issue for Bangladesh[24].

Floodplain Fertilization

In recent years the amount of sediment in the Ganges and Brahmaputra has increased with a higher proportion of sand and lower proportion of the organic matter that is important for floodplain fertilization. The probable reason is gully erosion, intensified by the removal of the vegetative cover in the upper catchments in India and China. Sediment load has become a serious quality parameter for this purpose.

Sedimentation

Bangladesh is located on an active sedimentary basin and the intricate network of alluvial rivers carries an average quantity of 0.5-2.8 billion tons.[25] annual discharge and sediment load from the mountains to the Bay of Bengal. Major sources of the sediments are in the upstream areas in India, China, Nepal and Bhutan. Forest clearing in the Himalayan watershed, in the hills of Tripura and Meghalya affects downstream erosion and sedimentation. Part of the load deposited gradually changes topography and seriously reduces the carrying capacity and navigability of drainage channels. In the post-monsoon period, when river discharge decreases rapidly, huge sediment loads are deposited in channels and low-lying areas (Master Plan Organization, 1986). Progressive silting and decrease in channel depth

increase flood vulnerability. The solution lies in selective dredging of channels and selective excavation of silted channels. Dredging and desiltation will be particularly effective when they are combined with measures that reduce maintenance dredging. Dredging is expensive and is often not an option. At the local level, community participation in drain re-excavation should be encouraged.

Navigation

Over the years, water depth in many navigation routes has fallen owing to lack of water in the dry season. Also silting of the delta and the floodplain of the GBM Rivers is seriously curbing surface water supply in many parts and disrupting navigational routes. Many regional rivers such as the river Gorai (a tributary of the Ganges flowing through the SWR) have lost their connection with their perennial water source in the dry season. Dams and diversions for irrigation also affect inland navigation. Navigation has become hazardous owing to inadequate dredging. This is hampering port facilities, Mongla port functioning. The main issues are allocation of stream flows to maintain navigation depths and control of activities restricting or impairing navigation. The government is keen to maintain rivers through comprehensive development and management of the local and main river systems.

Surface Water Quality

This is a serious concern owing to the runoff effects of chemical fertilizers, pesticides, untreated domestic sewage and industrial effluent. The rivers are frequently used as dumps. Certain industries, like tanneries, pulp and paper mills, textile, dyeing, petroleum refineries and other chemical industries, pollute water by discharging untreated effluent. These pollutants are causing serious damage to both freshwater and marine ecosystems including the Sundarban. However, industrial effluent is not a major problem yet because there is very little industrialization in comparison with highly industrialized countries. Pollution of closed water bodies caused by human waste is a major problem. Faecal contamination in urban areas, village ponds and small streams needs immediate attention. Ganges water is heavily polluted. The problem is further aggravated by lean season flows to dilute the pollutants. Poor water quality not only affects country's human population but also its entire aquatic environment. The government is considering a nationwide program to reduce pollution emission and rehabilitate water bodies which consists of various regulatory and non-regulatory measures.

Salinity Intrusion

This occurs through both surface and groundwater aquifers. The effect of saline water intrusion is highly seasonal. Saline intrusion is at its minimum during the monsoon when the GBM Rivers discharge about 80% of the annual fresh water flow (World Bank, 2000). In winter months the saline front begins to penetrate inland and the affected areas rise sharply from 10% in

the monsoon to over 40% (World Bank, 2000)[26]. Environmental degradation caused by the intrusion of saline water is a major problem in the SWR. The reduced flow of the Ganges during the dry season causes intrusion of surface water salinity from the Bay of Bengal since the northward current of water towards land becomes stronger than the southbound river flow owing to lack of water in the river system. The process has been exacerbated by the diversion of the Ganges' water at the Farakka Barrage in India. Since 1975 this reduction has caused the salinity front and tidal limits to move northward, eliminating surface water potential for significant land areas in the southwest, south-central and southeast regions.

The northeast region of the Sundarban is suffering from salinity intrusion. It is affecting fresh groundwater for human and industrial consumption in addition to irrigation of Aus crops. The Khulna Newsprint Mill and Goalpara power station have suffered serious set backs owing to lack of fresh water during the dry season. It necessitates freshwater being imported by barge from further inland for various processing purposes. As a consequence, no new heavy industry has developed in recent years despite increasing infrastructure facilities (sea-ports, etc) in the coastal districts. Thus salinity in surface and groundwater in the SWR has become a serious constraint on industrial growth.

Watershed Management

Upland watersheds in India, Nepal, China and Bhutan are source areas for surface and groundwater recharge in Bangladesh. Downstream agriculture and urban development in Bangladesh are directly dependent on water supply from these countries. Forestry plays an essential role in watershed management. The problem of watershed protection, however, requires a much broader sub-regional plan. When the mighty rivers Ganges, Bramputra, and Meghna roll down in gentle murmur towards the south, they cause stretches of cropland to blossom with the fragrance of alluvium.

The complex **f**actors behind the intensity and long duration of such abnormal water levels are summarized as follows. This includes[27]:

- A huge inflow of water from upstream catchment's area coinciding with heavy monsoon rainfall;
- Major rivers converging in Bangladesh and carrying third of approximately 2 billion tones of rubble and debris into out floodplains, thus reducing the depth of the waterways and spilling over the banks.
- A low flood plain gradient;
- Single-purpose flood control polders that increases the intensity of floodwater flow outside the protected areas.

- Blocked drainage channels and a network of roads and embankments that obstructs the drainage of water whenever they run in east-west direction in opposition to the natural flow of water southwards.

Land degradation and deforestation in the upland and hilly areas of India and Nepal contributes towards increased soil erosion and impacts on the river systems of Bangladesh as sediment loads increase. However it will take considerable effort and time for Bangladesh to enter into agreements with other co-riparian countries in order to realize basin-wide planning in terms of sharing international rivers, watershed management, data exchange, resource planning and long-term water resources management under various circumstances.

Waterborne Diseases

Polluted water is the main cause of many waterborne diseases like diarrhoea, jaundice and typhoid. Water pollution causes four out of five illnesses and 230,000 deaths annually (World Bank, 1998). Water is polluted from arsenic contamination, untreated sewage, runoff effects of chemical fertilizer and pesticides. During floods, inundation of hand pumps and latrines increases the incidence of waterborne diseases. Waterborne diseases caused by the floods of 1988 and 1998 resulted in a large number of casualties. With a rapid growth of population and urbanization it is getting ever more difficult to provide clean water and appropriate sanitation.

Fish Habitat

Availability of water bodies and connectivity of migratory routes are crucial for fisheries. Construction of FCDI projects to prevent or regulate floods in paddy fields has severely restricted the ability of migratory fishes to move across different water bodies. This has heightened tension between farmers and fishermen. A major water management issue is the great damage done to capture fisheries by past interventions. Migration routes are also being affected owing to salinity and therefore fewer habitats during the dry season. These factors have reduced fish (Hilsha) productivity and species diversity in many areas. Fish hatchlings from the Ganges and the Padma (combined Ganges and Brahmaputra rivers) migrate to the southwest region through the Gorai and Arial Khan rivers. Fresh water migratory fish hatchlings[28] face a survival problem in the SWR because of increased salinity. With declining number of hatchlings in the dry season the overall fish production in the floodplains declines significantly.

Biodiversity and Ecosystem Status

The wetland habitats and ecosystems have lost connections with water bodies like rivers and canals owing to silting and land filling for agriculture and homestead use. The northeast region of the Sundarban is suffering from lack of freshwater availability. Wetlands are subject to continuous pressure

from the expansion of the dry season boro rice in the Haor regions of Sylhet and Mymensingh. This degradation has brought about a loss of biodiversity, reduction in fish habitat and an increase in flood proneness of certain floodplains. The country has a tiny island in the south eastern area where coral reefs are located. However existing environmental conditions near the coral island are poor owing to frequent spillage of bulge water from sea going vessels, increasing turbidity of coastal water because of deforestation and land erosion in Chittagong Hill tracts and exploitation of coral by local traders[29]. Without immediate and adequate conservation activities the already endangered coral islands are likely to suffer further degradation.

Brackish water shrimp farming, one of the fastest growing export industries in Bangladesh, has intensified in recent years giving rise to a monoculture with negative environmental consequences. Major shrimp culture activities are located in Satkhira, Khulna and Bagerhat districts in the SWR and in Cox's Bazar[30] in the southeast. Shrimp farming has also created a social conflict in land use with rice farming in the coastal zone. Since it brings substantial foreign exchange, poor rice farmers in shrimp growing areas are forced to move and become landless. As shrimp farming becomes increasingly lucrative, mangroves are cleared to accommodate it. Reduction of forest biodiversity has negatively affected food, fodder, medicine and shelter for poor people. Even though the whole population suffers owing to environmental degradation, the poor are the hardest hit since they are directly dependent on the land and water for a living. Therefore they are most affected by a collapse in the local ecosystem[31].

Trade-off between Agriculture and Fishery

Fish is important for nutrition, poverty alleviation and rural economics1 in Bangladesh. According to a government estimate, 1 million people fish full time and another 11 million rural households are engaged in this activity on a part time basis (World Bank, 2006). Agriculture and fisheries have traditionally been complementary activities in the floodplains, but increasing population and intensification of agriculture have brought these sectors into conflict. Beels have been drained to provide land for dry-season cropping and water for irrigation. River embankments have been built to protect dry- and wet-season crops from flooding. This intervention has damaged natural fish habitats and migration routes. Preservation of natural fisheries must be weighed against irrigation development and flood control and drainage, as the latter has already affected river and open area capture fisheries in many places.

Industry and Agriculture Trade-off

Although at present agriculture consumes the major part of water resources, demand from municipalities and industries are increasing. Currently, municipal water supply is mainly derived from groundwater sources, but

overexploitation has denuded aquifers and there is a critical shortage of groundwater in large metropolitan areas like Dhaka. The country's industrial concentration is also around Dhaka and rising industrial demand for water is likely to become a problem in the near future. It is possible that the constrained water supply for domestic and industrial usage will require a cutback in groundwater irrigation in many areas. The cost of irrigation is bound to rise, requiring a shift away from water-intensive crops such as rice.

Recommendation

So many problems have been underlined in the discussion among this the following recommendation may be drawn:

- In order to establish a sustainable management of fresh water we need to work on Public-Private partnership basis (PPP). Mobilizing the private sector might be an effective initiative. Even in poor urban neighborhoods, safe drinking water can be provided through well-managed community supply points at prices that cover costs and are yet affordable.
- Water is a social good as far as the household needs are concerned, but a scarce resource too. The question of rational pricing of a scarce resource is even more valid when it is an economic good and an input necessary for other produces whether in agriculture or in industry and for that purpose we need to taken into consideration into the overall water scarcity in mind.
- Effective Basin planning provides the most rational basis for development of water resources of the rivers entering the Bangladesh border.
- Except Water Act 2008 (Draft) we don't have any law to regulate fresh water sector. So we need to enact and implement laws regarding fresh water management on an urgent basis.

Conclusion

Un Secretary General Kofi Anan has rightly pointed out that æabout one third of the worlds population already lives in countries considered to be 'water stressed' that is, where consumption exceeds 10 percent of total supply. If present trends continue, two out of every three people on Earth will live in that condition by 2025.[32]" So this is the high time to take immediate steps regarding the management of fresh water.

Finally the crisis that we are witnessing today, whether of scarcity and pollution of water, degradation of the soil, devastation of forests and the rapid diminution of bio-diversity, is essentially a crisis of the human spirit. The crisis is engendered by old-fashioned greed. We need to get out of this greed and for that purpose proper and effective water management is fundamental and need of the hour. Here one thing should be mention that is æproper and effective fresh management" is required successful implementation of

various laws and policy regarding. So for that purpose the think tank of our society and the policy maker needed to be more cautious and patriot. Otherwise by promulgating new laws and policy it cannot be possible to ensure a sustainable management of fresh water.

Notes & References

[1] See, e.g., Mara Tignino, 'Water, International peace, and Security', Volume 92 Number 879 September 2010. p 647.

[2] Sources world water council ,(www.worldwatercouncil.org/)

[3] H. Anenden, Nestlé Bangladesh, World Health Organization, International Institute for Environment and Development.

[4] http://www.dgfp.gov.bd/datasheet.htm

[5] The Daily Star, August 22, 2010.

[6] www:bdlaws.minlaw.gov.bd, visited on 27-12-2011

[7] Freshwater and International Law: The Inter play between Universal, Regional and Basin Perspectives" by Laurence Boisson de Chazournes from UNESCO, 2009

[8] Article 33 of The United Nations Convention on the Law of the Non-Navigational uses of International Watercourses-1997.

[9] Article- 9(1):pursuant to article 8, watercourse States shall on a regular basis exchange readily available data and information on the condition of the watercourse, in particular that of a hydrological, meteorological, hydrogeological and ecological nature and related to the water quality as well as related forecasts.

2. If a watercourse State is requested by another watercourse State to provide data or information that is not readily available, it shall employ its best efforts to comply with the request but may condition its compliance upon payment by the requesting State of the reasonable costs of collecting and, where appropriate, processing such data or information.

3. Watercourse States shall employ their best efforts to collect and, where appropriate, to process data and information in a manner which facilitates its utilization by the other watercourse States to which it is communicated.

[10] Article 11-19 of The United Nations Convention on the Law of the Non-Navigational uses of International Watercourses-1997.

[11] *Ibid*

[12] *Ibid*

[13] The National Water Management Plan (NWMP) has been approved by the government.

[14] The other important organizations are research institutions like RRI, the Surface Water Modeling Centre (SWMC) and the Environment and GIS Support Project for Water Sector Planning (CEGIS). RRI is a research and data generation unit for hydraulic and river studies. SWMC is developed as an excellent centre for water modelling and mapping under the Flood Action Plans (FAP). CEGIS is involved in various environmental, socioeconomic and institutional studies relating to the water resources sector in Bangladesh.

[15] In fact, they account for about half of the funds spent on water development since 1962 (World Bank, 1998). According to an estimate of the BWDB, about US$1732 million were spent on the FCDI projects in the period between 1944 and 1999.

[16] The dry season in Bangladesh, normally lasts from November to April, is characterized by a drastic reduction in the discharge of major rivers, drying of water channels, falling water tables and salinity encroachment, particularly in the southwest.

[17] In the context of Bangladesh, a drought is defined as a period when soil moisture is less than what is required for satisfactory crop growth.

[18] Very severe droughts hit the country in 1951, 1961, 1975, 1979, 1981, 1982, 1984, 1989, 1992, 1994 and 1995.

[19] World Bank Report, 2000

[20] Picture of Bangladesh Arsenic -2001, edited by Kumrul Islam Chowdury, published by World Water Forum of Journalist (WWFJ), on January 2002.

[21] World Bank Report , 2006

[22] http://www.nipsom.org/, visited on 10-02-2012

[23] World Bank Report, 1998

[24] At present this land is owned by the state. Newly accreted land along the coast may take up to 15 years to develop full production potential, whereas land lost to erosion is in most cases valuable agricultural land. Therefore an improvement of land tenure arrangements needs more attention. A coherent land policy with appropriate support services is essential to avoid illegal settlements before the soils have developed their full productive capacity.

[25] http://publications.worldbank.org/, World Bank Report-1998)

26 The coastal areas of Bangladesh face three types of saltwater intrusion in streams, groundwater and soil. Salinity is also experienced severely around the single purpose flood control embankments.

[27] State of world water 2003, Edited by Quamrul Islm Chowdhury with Marjan Radjavi, published by world water Forum of Journalist (WWFJ), Ministry of Environment and Forest (MoEF) Bangladesh, and UNDP, Enayetullah Khan 'Reflections on water' pp105-106

[28] Migratory fresh water fish hatchlings cannot survive even in moderately saline water .

[29] www.banglapedia.org

[30] Salt producing pans and relevant industries are primarily located in Cox's Bazar.

[31] Interested readers are referred to Dasgupta & Maler (1993)

[32] State of world water 2003, Edited by Quamrul Islm Chowdhury with Marjan Radjavi, published by world water Forum of Journalist (WWFJ), Ministry of Environment and Forest (MoEF) Bangladesh, and UNDP, Enayetullah Khan 'Reflections on water' p 5