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Sufia Khanom

TIPAIMUKH DAM: LIKELY ENVIRONMENTAL CONSEQUENCES FOR BANGLADESH

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Abstract

Bangladesh is crisscrossed by rivers. However, the key realities in the water sector of Bangladesh are too much of water during the monsoon season causing floods and too little during the dry season. India, in violation of its commitment made in 36th Joint Rivers Commission meeting in Dhaka, has floated an international tender for the construction of a dam at Tipaimukh on Barak river. It will produce hydro-electricity and support Cachar plain irrigation project. But the dam authority overlooks the experts' warning of dire environmental consequences of such project in the area and that for the lower riparian, Bangladesh. The management of an international river basin is a matter of international concern because it is a trans-boundary environmental resource and environment is basically global. So, regional cooperation on the Tipaimukh dam project will be equitably beneficial for both India and Bangladesh.

I. Introduction

The key realities in the water sector of Bangladesh are too much of water during the monsoon season causing floods and too little or scarcity during the dry season. Being the lowest riparian in the Ganges-Brahmaputra-Meghna (GBM) river systems, this country bears the brunt of flood, discharging over 80 percent of the GBM basins wide runoff within the five months of rainy season and receives residual flows from the trans-boundary rivers during the lean season. Out of 57 rivers in the country, 54 flow from India and 3 from Myanmar. The

Sufia Khanom is Research Officer at the Bangladesh Institute of International and Strategic Studies (BIISS). Her e-mail is: sufia@biiss.org

severe environmental disruptions in both West Bengal in India and Bangladesh set in motion by the Farakka barrage on the Ganges are a bitter testimony to how devastating the consequences are for those whose livelihoods depend on the land and waters of the affected areas. One of the victims of river erosion in north-west Bangladesh has aptly called Farakka 'a devil delivered by Delhi'. The withdrawal of the Ganges water at Farakka has caused serious damage to the ecology and economy of south-western districts of Bangladesh, including the unique mangrove forests along the Bay of Bengal. India unilaterally diverts the flow of water during the dry season, depriving Bangladesh of its proper share, while during the rainy season, the swollen water gets unobstructed thereby abruptly flooding Bangladesh. In such a scenario, its impact on Bangladesh is disastrous and severe, both in immediate and long term.

India, in violation of its commitment made in the 36th Joint Rivers Commission (JRC) meeting in Dhaka, has floated an international tender for construction of a dam at the Tipaimukh on Barak river in the state of Manipur to produce hydro-electricity despite experts' warning of dire consequences of such project in the area and the lower riparian Bangladesh.

The proposed Tipaimukh dam is to be located 500 meters (m) downstream from the confluence of Barak and Tuivai rivers, and lies on the south-western corner of Manipur. It is a huge earth dam (rock-filled with central impervious core) having an altitude of about 180 m above the sea level with a maximum reservoir level of 178m and 136m as the MDDL (minimum draw down level). The dam was originally conceived to contain only the flood water in the Cachar plains of Assam but later on, emphasis has been placed on hydroelectric power generation, having an installation capacity of 1500 mega watt (MW) with only a firm generation of 412MW (less than 30% of installed capacity)[1].

The northeast region of India is one of the six major seismically active zones of the world that includes California, northeast India, Japan, Mexico, Taiwan and Turkey. Again one of the largest river

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[1] Hydro Politics of Tipaimukh Dam, available at *http://www.e-pao.net*, accessed on 15 September 2006.

systems in Bangladesh-Meghna with its distributaries is fully dependent on the waters rolling down from Surma and Kushiara. A massive construction on the Barak river will adversely affect the water flows of the Meghna and its distributaries. India is planning to export the surplus power to Laos, Vietnam, and Cambodia but not to Bangladesh.

Bangladesh's case is strongly anchored on the principles of equity, fairness and no harm to any co-riparian in the context of interventions in common rivers, as enshrined in the 1996, Indo-Bangladesh Ganges (water sharing) Treaty. Regional cooperation on the Tipaimukh dam project will also be beneficial to India. Furthermore, this can lay GBM regional cooperation to flourish in all possible respects. So, this is vital for shaping a better future for all in the region. The paradox of abundant resources including water on one hand, and persisting high levels of ecological disaster in the region must be addressed through regional cooperation, on the other.

With such a perspective, the present paper is an attempt to analyze the likely environmental consequences of Tipaimukh dam on Bangladesh. The paper consists of five sections. The first section reviews the general information about Tipaimukh dam, like its location and main features of dam. The second section deals with the right of lower riparian state in view of international law and Ganges (water sharing) Treaty. The third and main thrust of the paper discusses the plausible environmental impacts/ consequences of Tipaimukh dam. The fourth section attempts to set a vision for integrated water resources management through regional cooperation. Finally, the last section draws conclusion of the paper.

2. An Overview of Tipaimukh Dam

2.1. Location

The proposed Tipaimukh dam will be constructed (24º14' north and 93º13' east approximately) at 500 m downstream from the confluence of the Barak and Tuivai rivers in the southwestern corner of Manipur[2].

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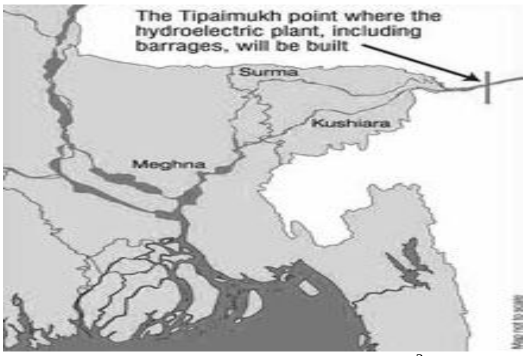
[2] Dr. Benjamin Gangei, "Tipaimukh Dam: A *Cul-De-Sac*", available at *http://www.manipuronline.com,* accessed on 15 September 2006.



Source: http://wanabehuman.blogspot.com[3].

The Barak river is the second largest drainage system in northeast India. It starts from the Lai-Lyai village in the Senapti district of Manipur and meanders through the Senapati, Tamenglong Churachandpur districts and also through the Jiribam subdivision of Manipur. The upper Barak catchments area extends over almost the entire north, northwestern, western and southwestern portion of the state. The middle course lies in the plain areas of Cachar of Assam, while the lower, deltaic courses in Bangladesh.[4]

The Barak enters Bangladesh through Zakigonj in Sylhet and flows in two directions- Surma and Kushiara. The Barak and its main distributaries (Surma and Kushiara) river fall within Meghna basin. Meghna basin is the smallest among the GBM basins but most unpredictable and chaotic in hydrologic means. Barak and then Surma, Kushiara river receive all the surface water originated in Meghna basin[5], carry it down to the upper Meghna river and join with Padma

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[3] Arguha Mahmud, "Politics: Indian Dam Project Threatens Bangladesh, Indigenous and Ecology", available at *http://wanabehuman.blogspot.com*, accessed on 15 September 2006.

[4] Nava Thakuria, "India's Tribals Protest against Tipaimukh Project near Burma Border", available at *http://www.mizzima.com/ar*, accessed on 11 September 2006.

[5] See for details, *Flood Action Plan 6 (FAP 6),* available at *http://bicn/wei/resources/nerp* , accessed on 01 October 2006. Flood Action Plan (FAP) is an initiative to study the causes and nature of flood in Bangladesh and to prepare guidelines for controlling it. FAP was based on several earlier studies by UNDP, a French Engineering consortium, USAID and JICA (Japan International Cooperation Agency). The FAP included 29 different components of which 11 were

river at further downstream. Combined flow of the two rivers then move further southward as Meghna river to Bay of Bengal. The proposed Tipaimukh dam will be constructed on Barak river by controlling the stream flow of it, creating a huge reservoir upstream of the dam to develop one of the largest hydroelectric power plants in eastern India. The dam site is located at around 100 kilometer (km) upstream from the diverging point of Barak river into two rivers[6].

2.2. Main Features of Tipaimukh Dam

A **dam**[7] may be defined as an obstruction or a barrier built across a stream or river. At the back of this barrier, water gets collected, forming a pool of water. The side, on which water gets collected, is called the upstream side, and the other side of the barrier is called the downstream side. The lake of water which is formed upstream is often called reservoir.

It has been stated earlier that the main permanent canal, forming the primary part of a direct irrigation scheme, takes off from a diversion weir or a **barrage**[8]. In general, the above purpose can be accomplished by constructing a barrier across the river, so as to raise the water level on the upstream side of the obstruction, and thus, to feed the main canals taking of from its upstream side, at one or both of its flanks. The ponding of water can be achieved either only by a permanent *pucca* raised crest across the river by or a raised crest supplemented by falling counter balanced gates, or shutters working over the crest. If the major part or entire ponding of water is achieved by a raised crest and smaller part or nil part of it is achieved by the shutters, then this barrier is known as a **weir**. On the other hand, if most of the ponding is done by gates and a small or nil part of it is done by the raised crest then the barrier is known as **barrage** or river

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regional, with some pilot projects, and the rest were supporting studies on issues like Environment, Fisheries, Geographic Information System, Socio-economic studies, Topographic Mapping, River Survey, Flood Modelling, Flood Proofing, Flood Response, etc. The aim of the FAP is to set the foundation of a long-term programme for achieving a permanent and comprehensive solution to the flood problem.

[6] *Ibid*., p.14.

[7] S. K. Barg, *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers, New Delhi, 2005, p. 521.

[8] *Ibid.,* p.521.

regulator[9]. At Tipaimukh, a dam will be built to produce hydroelectricity. A barrage is also proposed to be build in order to support Cachar plain irrigation project.

The Mechanism of Hydropower Generation

The actual process of converting water potential to commercial energy in the form of electricity in a hydropower station is fairly simple. Water is diverted from a river and conveyed to turbines in a power house. Different types of turbines, each designed to make optimum use of the available hydraulic energy for different types of rivers. After entering the turbines, water propells the shafts of the turbines and produce hydraulic energy. This energy is then transferred to the generator which in turn is converted to electricity. Hydropower plants can be placed in two broad categories depending on how water is used.

1. Run-of-river power plants utilize the natural flow in rivers without any storage or regulation. Without regulation, the amount of electricity that can be produced at given time is only as much as the amount of water in the river, and if there is more water than is needed at any moment, it can be stored for later use.
2. Reservoir-type power plants, on the other hand, draw water from large artificial storage lakes created by constructing huge dams across rivers. These reservoirs can store the surplus seasonal water which flows in streams during rainy periods for utilization during dry months.

The Tipaimukh dam is a reservoir type huge earth dam. The purposes of the dam according to Indian authority[10] are:

a. The dam was originally designed to contain flood waters in the lower Barak valley i.e. Cachar plain.
b. Hydropower generation was later incorporated into the project.

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[9] *Ibid*., p.521.

[10] Dr. Debabrata Roy Laifungbam and Dr. Soibam Ibotombi, "Tipaimukh Dam: A Geotechtonic Blunder for International Dimension (part-I)", available at *http://www.kanglaonline.com/index*., accessed on 13 September 2006.

c. The project will have an installation capacity of 6X25 MW and a firm generation of 412 MW.

The total area required for construction including submergence area is 30,860 hectare (ha) of which forest land (20,797 ha), village land (1,195 ha), horticultural land (6,160 ha) and agricultural land (2,525 ha). As per estimates of the authorities themselves, the project will totally affect 311 sq. km and 8 villages, 1461 *Hmar* (tribal) families in Indian territory.

2.3. North Eastern Electric Power Company (NEEPCO) Limited and the History of Dam Proposal

The proposal for the Tipaimukh high dam was first mooted in 1955. It was to be constructed with Japanese aid at a cost of US$[*] 244.198 million (now with NEEPCO at a cost of US$1,234.755 million)[11]. The Central Electricity Authority (CEA) of India had given the final Techno-Economic Clearance (TEC) to NEEPCO to start the construction for the controversial 1500 MW Tipaimukh Hydel Electric Project. The CEA accorded the final TEC for the 1,153.227 million US$ projects to NEEPCO on July 2003 after getting the final clearance and No Objection Certificate from the Mizoram (a state of India) government on July 2003 itself. NEEPCO had started process for floating of international tender to undertake the Tipaimukh project. Contracts had been awarded by March 2004. The six phase project is slated to be completed by 2012. The first unit with capacity of generating 250 MW would be completed within 78 months of awarding the contracts. NEEPCO facilitated a 92 banks meet in Delhi on 11 June 2003 where bankers from France, Germany and India had shown interest in investing in the Tipaimukh project. The dam was designed by the Department of Earthquake Engineering of Rourkee University[12].

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* Note: The Indian Rupee has been converted to US dollar at the rate that prevailed on November 22, 2006.

[11] "Dam Gives Rise to Concern in India and Bangladesh", available at *http:// www.manipuronline.com/Monipur/monipur.htm*, accessed on 26 September 2006.

[12] See for details at *http:// www.lists.resis.ca/pipermail/indegenousyouth/2006*, accessed on 24 September 2006.

Indian government promised Bangladesh to provide with the Detailed Project Report (DPR) of Tipaimukh dam before its implementation at a JRC meeting in September 2005. But the NEEPCO, a public sector enterprise under the Indian ministry of power, had meanwhile completed the DPR and started sale of tender papers for construction of Tipaimukh project. According to NEEPCO's bid announcement, the last date for sale of tender documents was 15 February 2006 and that for submission of those was 3 April 2006. On completion of the tender process, India plans to complete its largest hydropower project by 2012.

3. International Law and Convention

The management of an international river basin is a matter of international concern because it is a trans-boundary environmental resource, and environment is basically global. The treaty practices of riparian states also bear evidence that result from the use of a common river in its territory. There is a large number of such treaties,[13] enumerating an obligation similar in form and substances. The Tipaimukh dam project was entirely developed and approved without informing the government of Bangladesh or involving its people in any meaningful exercise to assess the downstream impacts of dam. Tipaimukh is a multipurpose project and it includes irrigation component, as envisaged earlier. This is clearly a gross violation of co-riparian rights of Bangladesh.

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[13] The Treaty between Russia and Lithuania of 12 July 1920; the Treaty of Riga between Russia and Latvia of 11 August 1920; the Franco-British Convention of 23 December 1920; the Treaty between Russia and Estonia of 2 February 1920; the Convention between Finland and the USSR of 28 October 1922; the Treaty between Hungary and Romania of 14 April 1924; the Treaty between Norway and Finland of 14 February 1925; the Treaty between France and Germany of 4 August 1925; the Protocol between France and the UK of 31 October 1931; the Frontier Agreement and the Exchange of Notes between Afghanistan and the USSR of 13 June 1946; the Treaty between Austria and Yugoslavia of 16 April 1954; for some more treaties with similar provisions, see M. Rafiqul Islam, " The Effects of the Farrakka Barrage on Bangladesh and International Law", *BIISS Journal*, Vol. 5, No. 3, 1984, pp. 249-273.

3.1. Madrid Declaration and Others

Both the 1919 Madrid Declaration and the 1961 Salzburg Resolution adopted by the Institute of International Law prohibit all kinds of utilisation of an international river by riparian state in its territory which strongly affects the possibility of use of the same water by co-riparian states in their territories[14]. Such a principle was considered by the Inter-American Bar Association as a part of existing law applicable in every international river. The International Law Association proscribes any use of international water by a riparian state that adversely affects the equitable utilization of the same water system by co-riparian states[15] . These statement of international lawyers, both inter-governmental and voluntary non-governmental, have contributed significantly to the formulation and systemisation of international legal principles regarding the utilization of waters of international rivers. They are the outcome of long, careful and intensive study and investigation by various committees on the uses of international river consisting of eminent and influential international legal experts. As such, their authority seems to be no less compelling.

The authorities referred to clearly corroborate the notion that it can never be the legal right of a riparian state to deprive another riparian state of its rightful share of the common water and cause injury there in. If it happens, by its location, to be in a position to control the supplies of water they share. On the other hand, it is genuine lawful right of riparian state, which by the reason of its location is placed in a disadvantageous position; to continue to enjoy its right on common water supplies. The land over which to pass first belongs, and is subject, to the territorial control of India. If India can and chooses to do so, it can use up all of the Barak water and leave the rest of the river in Bangladesh only a dry bed. The right of India to do so is unlimited. This means that there is no legal impediment to prevent India from exploiting the Barak water solely to its own benefit. Acknowledgment of such a right tantamount to legitimize the right of India to take away the Barak water in Bangladesh and to inflict serious damage therein.

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[14] Article 1 and 2 of the Madrid Declaration, above note 17, Sevette, p. 261 and Article 4 of the Salzburg Resolution, *American Journal of International Law*, Vol. 56, 1962, pp. 737-38.

[15] The Helsinki Rules, *Report of the 52nd Conference*, 1966, p. 487.

Conceding such a right may turn the situation into a source of international friction. Such a situation is very much likely to be filled with the risk. The frustrated and deprived riparian state may have recourse to unilateral action outside the law, which may endanger peace and security of the region[16]. More importantly, the recognition of such a right indeed implies the disavowal of accepted norms of international law and the establishment of a new precedent contrary to international practice.

3.2. The United Nations (UN) Water Course Convention 1997

The 1997 UN Water Course Convention is the only convention of a universal character on the utilisation of the international watercourses. It was negotiated by almost every member of the international community including Bangladesh and was adopted by a very weighty majority of states. The convention sets forth the general principles and rules governing non-navigational users of international watercourses in the absence of specific agreements among the states concerned and provides guidelines for the negotiation of future agreements. India has even overlooked some major provisions of the 1997 UN Watercourse Convention[17] which are mentioned below:

- ♦ Article 5(1) of the convention requires an international watercourse to be utilized in an 'equitable and reasonable' manner. The objectives are to attain 'optimal and sustainable utilization' as well as to ensure 'adequate protection of the watercourse'. While achieving these objectives, according to article 6(1), conservation, protection, development and economy of use of the water resources have to be taken into account. The incorporation of conservation aspects enjoins the watercourses states with greater responsibility, which the negotiating states consider appropriate in view of the recent development in international environmental law.

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16 Pakistan talked of war when India cut off the Indus water supply for irrigation in Pakistan. The violent Arab-Israel dispute over the sharing of the Jordan river water may also be cited in the same vein.

17 See for details, United Nations Press Release, GA/9248 available at *http://www.law.wits.ac.za/humanarts/index.html*, accessed on 13 November 2006.

- While addressing the obligation of no harm and its relationship with equitable utilization, the 1997 Convention puts significant emphasis on relevant procedural duties. Article 7 of the convention requires a watercourse state to take all appropriate measures to prevent causing of significant harm to other watercourse states. If significant harm, however, is caused, article 7 requires the state causing such harm to give due regard to article 5 and 6 and to consult the affected state in order to eliminate or mitigate such harm and to discuss the question of compensation in appropriate cases.
- Article 9 provides for regular exchange of data and information on the condition of a watercourse. The purpose is to ensure that the watercourse states will have the facts necessary to enable them to comply with their obligation under article 5, 6 and 7.[18]

3.3. The World Bank Environmental Policy

The World Bank is going to approve fund for the Tipaimukh dam projects.[19] According to the World Bank environmental guidelines, the fund it uses in financing projects on international rivers needs to be considered in the form a sort of international protocol with certain guidelines. These guidelines require a country undertaking a project to notify other countries in the basin with the aim of ensuring that the project does not harm them. In the long term, a mechanism has to be evolved to enforce the rules for preventing/mitigating trans- boundary environmental damages in the international river basins, and the UN should have the mandate to perform such functions. The Indian lobby, inside the World Bank, is very strong and they are trying to collect funds for water resources projects in India.[20]

But till now, the people of lower riparian country like Bangladesh have objection regarding Tipaimukh dam.

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[18] *International Law Commission Report (ILC*), 1994, p. 250.

[19] Tipaimukh Dam: A Different Perspective, available at *http://www.e-paonet/ep*, accessed on 20 December 2006.

[20] Reported in *ManabJamin,* Dhaka (a Bengali daily), 27 August, 2003.

3.4. Violation of Ganges Water Sharing Treaty

India has violated the Ganges Water Sharing Treaty that was signed between the two countries, India and Bangladesh, in 1996. Article IX of this Treaty describes….“the principles of equity, fairness and no harm to either party; both the Governments agree to conclude water sharing Treaties/Agreements with regard to other common rivers”. But Tipaimukh dam certainly causes damage to the lower riparian country. If India wanted to cooperate with Bangladesh, it would have shared information on the dam including the barrage. To the contrary, India completed the DPR and floated international tender for Tipaimukh dam.

4. Plausible Environmental Impacts on Bangladesh

Construction of large dams in South Asia has become a subject of debate involving the professionals, donors, potential beneficiaries and affected population, government agencies and other individuals. The idea of construction of dams and reservoirs received popularity in India immediately after the Partition in 1947. The primary objective was to ascertain water supply for the irrigated agriculture to meet the growing food demands. Out of the total 4,291 dams in India, 2,256 were constructed and commissioned during 1971-1990.[21] In the late 1950s, Bangladesh constructed the Kaptai and other dams and barrages for hydropower generation and water supply for irrigation. Nepal has few small dams for the same purposes. Bhutan’s only dam was constructed and financed by India to export hydropower for Indian consumption.

Benefit analyses of most of these dams were carried out with incomplete information and unrealistic assumptions. All non-marketable environmental and social consequences and their costs were simply ignored either for the lack of foresight or because they were unquantifiable. Economic justifications also involved grace repayment periods, high discount rates, low-interest loans, and a transfer of costs to non-dam/reservoir parts of water developments. These dams (barrage) have generated benefits especially for the agriculture in South Asia. However, country specific information is only available for India. Irrigation is either the only or one of primary objectives in 95 percent of the 4,291 dams in India. India’s irrigation

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[21] *The Daily Star*, Bangladesh, 28 April 2000.

potential increased from 22.6 million ha in 1951 to about 89.6 million ha by 1997. In the same period, food grain production in India increased from 51 million tonnes to 200 million tonnes. About 66 percent of the increased grains were contributed by the irrigated agriculture. Hydropower generation from the large dams seems less promising than agriculture. Hydropower received the least priority in India where only 4 percent of the dams have hydropower generation as one of the objectives. In India, hydropower constitutes about 25 percent share of the total installed capacity of 89,000 MW in early 1998. The share of hydropower in the hydrothermal mix drastically declined to 29 percent in 1998 from 50 percent in early 1960s. The ratio of hydropower from the reservoir and run-off river scheme is 2:1.[22]

Furthermore, successes of the dams were not realized without prices. They displaced millions of people, inundated vast forest lands of invaluable ecological importance, wiped out many economically and ecologically valuable species and disrupted cultural values and heritage. Moreover, they introduced certain controlled environment as the cost of natural environment and beauty.

4.1. Tipaimukh Dam: A Geotectonic Blunder

Over a decade and half, the issue of Tipaimukh dam has created a lot of disappointment with regard to scientific, technical, economic and environmental feasibility of the dam. An attempt is, therefore, made here to provide a brief geological, structural and tectonic account of Tipaimukh and its adjoining region in terms of tectonic framework of Indo-Myanmar Ranges (IMR) in general and that of Bangladesh in particular. Such a consideration would reveal the nature and extent of the geotectonic risk being taken by constructing a mega dam at Tipaimukh.

Seismicity of northeast India is one of the highest earthquake potential area in the world due to its tectonic setting i.e. subduction as well as collision plate convergence.[23] Analysis of earthquake epicentres and magnitudes within 100-200 km radii of Tipaimukh dam

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[22] *Ibid.*

[23] Plate convergence means the two lithospheric plates in which one plate descents below the other.

site reveals hundreds of earthquakes having magnitude (M) 5 and above on the Richter scale in the last 100-200 years (See annex 1). It is found that within the 100 km radius of Tipaimukh, 2 earthquakes of +7M have taken place in the last 150 years and the last one having occurred in the year 1957 at an aerial distance of about 75 km from the dam site in the eastern northeast direction.

Beside the frequency of such large earthquakes within 100km radius, it is also further observed that a number of epicentral points align in the form of a linear array parallel to regional strike northern northeast-southern south west or north-south revealing how this Barak-Makru thrust zone is seismically active. Another important aspect of seismic activity is that shallow earthquakes are far more disastrous than the deeper ones even if magnitude is relatively low since destructive surface waves can be quickly and easily propagated from the focus/epicentre. And majority of the earthquakes that takes place on the western side of Manipur are shallow (50 km focal depth or less) which is due to the tectonic setting of the IMR

Under these circumstances, whether it will be a wise policy to construct a huge dam or not need to be thoroughly discussed and investigated. The trend of earthquakes shows that the regions which have experienced earthquakes in the past are more prone to it; the magnitude of future earthquakes may be uniform to the past ones; and the earthquake occurrence, geological data and tectonic history all have close correlation. The Tipaimukh dam site has been chosen at the highest risk seismically hazardous zone.

The dam proponent, NEEPCO claims that seismic hazards are being taken care of through consultations with Rourkee University in India. However, the government of India has requested NEEPCO to also consult with the Geological Survey of India.[24] Here it is pertinent to mention that extreme seismic hazards cannot be addressed adequately or satisfactorily through consultations with seismologists, as the risk inducing and impact factors are mechanical, geophysical, tectonic and socio-economic in nature.

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[24] North Eastern Electric Power Cooperation Limited, available at *http://www.neepco.com/events.html,* accessed on 0 7 November 2006.

4.2. Tipaimukh Dam Failure and the Scenario for Bangladesh

Dam failure risk is, however, a significant issue relating to future environmental management of the northeast region water system of Bangladesh. A dam-break is a catastrophic failure of a dam which results in the sudden draining of the reservoir and a severe flood wave that causes destruction and in many cases death downstream. While such failures are rare and are not planned, they have happened to dams, large and small, from time to time. The scenario and consequences of a Tipaimukh dam-break has not been thoroughly studied. NEEPCO has yet to complete a basic scientifically sound environmental impact assessment even though it is geared up to start construction after having opened international bidding for engineering, procurement and construction[25]. Such a study has to be conducted by international as well as national dam-safety experts as the impacts of a dam-break will have both severe upstream and downstream effects.

However, the downstream effects of a Tipaimukh dam-break have been studied by the government of Bangladesh since 1992-94 under Flood Action Plan (FAP). In Flood Action Plan 6 (FAP 6) as part of the north eastern regional water management plan of Bangladesh, the scenario of a dam failure at Tipaimukh dam project was investigated by international hydraulic and environmental experts in the context of a comprehensive flood action plan for Sylhet district.[26]

The International Commission on Large Dams has identified 164 major dam failures in the period from 1900 to 1965. With respect to the safety of the proposed Tipaimukh dam, hydraulic and environmental specialists opine that well-designed and constructed rock filled dams are, perhaps, the safest type for large heights (Tipaimukh would be among the largest of such dams in the world), but local circumstances may be much more important in this respect than dam type. Two examples illustrate the types of failures that have been reported. The most famous, the Teton dam in the United States

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[25] Dr. Debabrata Roy Laifungbam and Dr. Soibam Ibotombi, "Tipaimukh Dam: A Geotectonic Blunder for International Dimension (part-II)", available at *http://www.kanglaonline.com/index,* accessed on 13 September 2006.

[26] See for details in *www.inwent.org/v-ez/lis/banglade/fap.htm,* accessed on 20 December 2006.

was a 90 m high earth-filled dam which failed in 1.25 hours (hr). The flood wave which was released had a peak discharge of 65,000 m^3/second at the dam and a height of 20 m high in the downstream canyon. The Huaccoto dam in Peru was 170 m high, similar to the Tipaimukh dam; it failed over 48 hr due to a natural landslide in the reservoir[27].

Generally, a flood wave travels downstream at a rate in the order of 10 km/hr although velocities as high as 30 km/hr have been reported near failure sites. From these wave velocities, it would appear that the initial flood wave could travel the 200 km distance from Tipaimukh dam site to the eastern limit of Bangladesh within 24 hr having a height of perhaps 5 m. Peak flooding would occur some 24 to 48 hr later. High inflows would persist for ten days or longer and the flooded area would likely take several weeks to drain. The Tipaimukh reservoir is huge (15,000 million m^3) compared with experience reported in the literature. In the event of a significant unplanned discharge, the river system in Bangladesh would respond (drain) rather slowly, as characterized by the outflow rate relative to the floodplain storage volume, such that most of the water released would remain ponded over the northeast region for some time. Assuming a release volume of 10 million m^3 and a ponded area of 100 km^2, the depth of flooding would be an average of 1.0 m above the normal flood level[28]. There will be first an imperative for Bangladesh and India to cooperate in formulating and implementing risk management measures if the Tipaimukh dam as presently designed should be constructed. A wide range of risk management measures are normally undertaken, including: regular inspections by independent engineering teams, instrumentation and plans for warning downstream populations of deteriorating conditions of a dam, evacuation plans, and so on. As and when India's plans proceed, there will be a clear need for Bangladesh to avail itself of expert technical assistance from dam safety specialists

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[27] The International Commission on Large Dam (ICOLD), *High Dam Failure*, available at *http://www.icold-cigb.org.cn/icold 2000/icold.htm*, accessed on 01 September 2006.

[28] See for details in Flood Action Plan 6, *North Eastern Regional Water Management Plan of Bangladesh*, available at *http://bicn.com/wei/resources /nerp/iee/index.htm*, accessed on 01 October 2006.

experienced with very large dam/reservoir systems and trans-border risk management.

For illustrative purposes only, the Bangladesh study modeled flood waves for a test case of an instantaneous failure, 50 m wide extending to 100 m below the crest of the dam. Discharge and water level hydrographs were presented for three locations: at the exit from the mountain valley (80 km), at Silchar (in the middle of the Cachar plain, 140 km) and at Amalshid (200 km). It was forecast that substantial attenuation of the flood wave would occur upstream of Amalshid and that the flood wave at Amalshid would be a long-duration event. Depending on the breech geometry and peak discharge, the flood peak would occur at Amalshid approximately 2 to 3 days after the dam break had occurred and flooding would continue for ten days or more. The flood levels at Amalshid would rise to approximately 25 m peak water discharge, which is at approximately 8 m above the floodplain level[29]. This flood level depends on the boundary assumptions made and could vary depending on floodplain conveyance.

4.3. Water Resources Projects affected by Tipaimukh Dam

Four projects (upper Surma-Kushiara river project, Surma right bank project, Surma-Kushiara-Baulai basin project and Kushiara-Bijna interbasin project) would be affected by Tipaimukh dam. For phasing purposes, these projects are grouped together for implementation commencing in Year Four, to allow additional time for resolution of the Tipaimukh dam issue. If the Tipaimukh dam/Cachar plain project is delayed beyond this point (i.e. is neither implemented nor definitely dropped), then implementation of the south eastern development projects would be delayed further. This would significantly alter the nature of the impacts produced by several other initiatives. For example, if the upper Surma-Kushiara project and Surma-Kushiara-Baulai basin projects were not implemented, the Kalni-Kushiara river would likely experience a continuation of trends of increasing flood levels and sedimentation rates. Much greater maintenance dredging effort would be required to reverse these trends than is presently envisaged in the Kalni-Kushiara river improvement project.

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[29] *Ibid,* p. 26.

Large magnitude spills (possibly increasing over time due to channel changes) would continue to occur into the central basin from both the Surma river and Kushiara river. This would significantly reduce the effectiveness of initiatives such as the Baulai river improvement project and Kushiara-Bijna interbasin project. In the case of extended delay in resolution of the Tipaimukh dam issue, one approach would be to proceed with key components of the upper Surma-Kushiara project and Surma-Kushiara-Baulai basin project which would be feasible to construct during the extended interim period. Such components of the upper Surma-Kushiara project involve regulation of spill channels and *khals (*canals*)* that divert water from the Surma river into the Kushiara river system. Key components of the Surma-Kushiara-Baulai basin project involve regulation of spill channels from the Surma river into the deeply flooded central basin, and re-excavation of important distributary channels which drain the inter-basin and discharge into the Baulai river. Components that might be postponed until after a final decision on the dam is reached includes raising and upgrading full flood control embankments on the upper Surma-Kushiara rivers and upgrading and construction of new submersible embankments on the lower Surma-Baulai river and Kushiara-Kalni river.

4.4. River Flow Diversion

The use of rivers is of two kinds: non-consumptive and consumptive. Non-consumptive use does not reduce the flow of water of the river, while consumptive use reduces it. For example, dam for hydro-electric power (Kaptai dam) may be called non-consumptive use, while diversion of water through barrage and feeder canal (Farakka barrage) is for consumptive use. Tipaimukh dam will reduce water and certainly change the traditional flow of water.

The change of river flow of water through construction of a dam would have many ramifications on the lower riparian country like Bangladesh. According to Dr. Kholiquzzaman Ahmad, “Bangladesh might get 17,000 cusecs less water than what it gets now after from the Barak river due to building of the dam”.[30] The Surma and the Kushiara

[30] *The Daily Star*, Bangladesh, 31 December, 2005.

pass through the vast *haor*[31] area growing only one rice crop annually. With the recession of monsoon, river level drops and allows drainage of the vast low lying areas, making the land available for *Boro* (one type of rice) cultivation. There is an intricate balance time-bound drainage for the land to be available for *Boro* cultivation. With the Tipaimukh dam being operational, the river level will be higher in the post monsoon period and will obstruct timely drainage of the *haors*. A vast area may thus go out of *Boro* cultivation.

Regulation of the Barak's flow by Tipaimukh dam would provide India with the opportunity to irrigate the Cachar plain i.e. dam with a barrage. So, India is planning for a major Cachar plain irrigation project downstream of the project. This means that the water released from the dam reservoir will be further diverted for the irrigation project planned in Cachar district, contrary to NEEPCO's recent claims. Since the Cachar plain irrigation plan involves the loss of water, it is a matter of great concern to Bangladesh particularly its north-eastern region as no statement is available how much water India intends to take from this scheme. For the purposes of the FAP 6 study it was assumed that the total depth of irrigation water to be applied is 1 m and that the water is diverted on a continuous basis during the six dry months (November through April). As a result, the implementation of the project would cause drastic decline in the flow of the river Meghna and its tributaries resulting in adverse effects on agriculture and its sub-sectors in 12 districts in Bangladesh. The rivers Surma and Kushiara are likely to suffer most, which might lead to desertification process of the whole of Sylhet region like the impacts of Farakka barrage.

4.5. Unexpected Flooding

Schedule of release from dam reservoir is important from another point of view. In order to maximize hydroelectric production, storage reservoirs will keep a certain amount of water. Besides this, additional water will be released from the reservoir for its safety. Late monsoon heavy rain, which is not rare in this area, may cause much more than

[31] *Haor* is a bowl-shaped large tectonic depression. It receives surface water by rivers and *khals*. In monsoon season, *haors* are filled with water and dry up mostly in the post monsoon period. In Bangladesh, *haors* are found mainly in greater Sylhet and Mymensingh region.

normal flood downstream in Bangladesh due to extra release from the reservoir. Bangladesh has experienced such floods a few years back when the districts of Kushtia and Satkhira were flooded due to late monsoon releases from reservoirs on the right bank tributaries of the Hoogly-Bhagirathi system in India. The same case may happen in the Sylhet area.

Average flood height during the monsoon may decrease but operational fault or operation of the dam, without taking downstream flooding into consideration is likely to cause higher flooding at times. Network of existing submersible flood dike in Bangladesh, to protect *Boro* crop from early spring flood, may need redesign and there could be other environmental effect may need some mitigation measure.

4.6. Water Pollution

Increased agricultural activity and development of agro-based industry in the Cachar plains may cause increased water pollution in the downstream flow due to increased use of fertilizer and pesticides and effluent from the industries.

4.7. Sediment-Free River Flow and Loss of Biodiversity

A very substantial part of sediment may be trapped upstream of the dam. Release of comparatively sediment-free flood flow may initiate riverbed and bank scouring as river will try to establish a new regime of reduced sediment discharge. But carried sediment enrich the wet land environment and increase the productivity of the *haor* areas. This sediment free, diverted river flow also affects the biodiversity. Sediments carry lots of nutrients with it and that is very much helpful for flourishing biodiversity. There will be a change in water quality and some of the aquatic life, will probably be eliminated because of the barrier effect of the dam, unless a provision for ladder is made.

4.8. Disruption of Fish Migration and Breeding Place

On large rivers, in late summer season, fish move from downstream to upstream to lay their eggs. These eggs are fertilized by male fish. The old fish may get exhausted and the new born fish again move downstream. They, after two to three years, return to their ancestral spawning place and may be dying after getting exhausted, while the newborns move downstream. The cycle goes on for years.[32] When dam barrier is constructed on a river, these fish can not move upstream to lay their eggs; because it is impossible for these fish to overtop such a barrier.[33]

4.9. Greenhouse Gas Emission from the Dam

Hydropower lobbyists are eager to promote dam as 'environmentally and climate friendly'. But a growing body of scientific evidence shows that hydropower is not as climate friendly as its proponents have assumed. Recent research indicates that dams and their associated reservoirs are globally significant sources of emissions of green house gases like Carbon dioxide (CO_2) and Methane (CH_4).[34] The greenhouse gases cause global warming and ultimately increase the rate of sea level rise. So, as the number of dams in South Asia is increasing, the threat for Bangladesh will eventually be increased.

5. New Vision for Integrated Water Resources Management

Water-related challenges are numerous, diverse and inevitable. Several compelling worldwide statistics compiled from the recent publications of the World Bank and the United Nations[35] illustrate the issues:

- Human water use has increased more than 35-fold over the past three centuries.

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[32] The fish which move to their ancestral spawning place (upstream) are called anadromous fish. Salmon and Hilsa are typical examples of such fish. These are commercially valuable fish and important industries are dependent on them.

[33] Huge money was spent in fish-ladder research. Improvements in design made the fish ladder more attractive to fish. Fish ladders are not always practicable from engineering stand point. In such cases, other steps have to be taken to protect the fish.

[34] For details, see P. McCully, "Flooding the Land, Warming the Earth: Greenhouse Gas Emission from Dams", *International Rivers Network 2002*, available at *http://www.irn.org/programs/greenhouse/pdf/2002ghreport.pdf*, accessed on 15 September 2006.

[35] Dr. Aris P. Georgakakos, "Water Resource Management: Challenges and Opportunities", available at *http://gtresearchnews.gatech.edu/reshor/rh-spr96/rh-spr96-toc.htm*, accessed on 12 September 2006.

- Worldwide, 69 percent of water use is for agricultural purposes, 23 percent for industrial and 8 percent domestic.
- One third of the world's food crops are produced by irrigated agriculture.
- In the past 30 years, 50 percent of food supply growth was attributed to agricultural expansion, a rate which is no longer sustainable.
- Per capita water consumption in North and Central America is twice that of Europe, three times that of Asia, and seven times that of Africa.
- About one billion people in developing countries do not have access to potable water and approximately 1.7 billion have inadequate sanitation facilities.
- Unsafe water is implicated in the deaths of more than 3 million people annually and causes about 2.4 billion episodes of illness each year.
- The world's population, now 5 billion, is expected to increase to at least 8 billion by 2025 and 10 billion by 2050, which would dramatically raise the demand for water and food.
- According to United Nations' projections, by 2050 almost half of the world's population will live in 58 countries experiencing either water scarcity (less than 1,000 cubic meters of renewable water per capita per year) or water stress (between 1,000 and roughly 1,700 cubic meters).
- The financial requirements to meet future demands for irrigation, hydropower, water supply and sanitation investments in developing countries are estimated to be $600 billion to $800 billion over the next decade.

These daunting facts are evidence of a global water resources crisis with the potential for escalating conflicts. Examples can be cited for many river basin and countries such as the Nile basin, Amazon, Rhine, Euphrates, Jordan and almost every other major river system in the world. In the western United States, conflicts and litigations over water allocation have raged for many years. Recently, similar disputes have also emerged in the water-abundant southeast, where the Savannah, Apalachicola-Chattahoochee-Flint, and Alabama-Coosa-Tallapoosa rivers are at the center of a major multistate conflict.

At this point of time, Mekong River Commission (MRC) is an expression of international cooperation for Integrated Water Resources Management. It gives a new vision for international river basin management programme. Water is seen by many countries of the world as "the foreign policy issue of the 21st century". The nations of Southeast Asia like China, Cambodia, Lao PDR, Vietnam and Thailand which conceived and nurtured a Mekong Committee may prove to be a model for the world.

5.1. Mekong River Commission

The Mekong river (known in Tibet as *Dza-chu*, China as *Lancang Jiang* and Thailand as *Mae Nam Khong*), is a major river in southeastern Asia. It is the longest river in the region. From its source in China's Qinghai province near the border with Tibet, the Mekong flows generally southeast to the South China Sea, a distance of 4,200 km (2,610 mi)[36]. The Mekong crosses Yunnan province, China, and forms the border between Myanmar and Laos and most of the border between Laos and Thailand. It then flows across Cambodia and southern Vietnam into a rich delta before emptying into the South China Sea. In the upper course are steep descents and swift rapids, but the river is navigable south of Louangphrabang in Laos. (See Annex 2)

The MRC was established in 1995 by an agreement between the governments of Cambodia, Lao PDR, Thailand and Vietnam[37]. The Agreement on the "Cooperation for the Sustainable Development of the Mekong River Basin" came about as the four countries saw a common interest in jointly managing their shared water resources and developing the economic potential of the river. Signed on 5 April 1995, it set a new mandate for the organisation "to cooperate in all fields of sustainable development, utilisation, management and conservation of

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[36] See for details, "Mekong River Basin", available at *http://www.africanwater.org/rivers_regions.htm,* accessed on 05 November 2006.

[37] "The Story of Mekong Cooperation", available at *http://www.mrcmekong.org/about_mrc.htm*, accessed on 05 November 2006.

the water and related resources of the Mekong River Basin". The agreement brought a change of identity for the organisation previously known as the Mekong Committee, which had been established in 1957 as the Committee for Coordination of Investigations of the Lower Mekong Basin - the Mekong Committee. Since the 1995 Agreement, the MRC has launched a process to ensure "reasonable and equitable use" of the Mekong river system, through a participatory process with "National Mekong Committees" in each country to develop procedures for water utilisation.

The MRC (structure of the MRC: annex 3) is supporting a joint basinwide planning process with the four countries, called the Basin Development Plan, which is the basis of its Integrated Water Resources Development Programme. The MRC is also involved in fisheries management, promotion of safe navigation, irrigated agriculture, watershed management, environment monitoring, flood management and exploring hydropower options.The two upper states of the Mekong river basin, the People's Republic of China and the Union of Myanmar, are dialogue partners to the MRC.

The MRC is funded by contributions from the four member countries and from aid donors. Formal consultation with the donor community is carried out through an annual Donor Consultative Group meeting. The programme focuses specifically on the development of water and related resources, which can be seen as complementary to the Greater Mekong Subregion Economic Cooperation Programme, promoted by the Asian Development Bank. The Mekong Programme is also enhanced by other regional initiatives such as the ASEAN Mekong Basin Development Cooperation, and the United Nations Economic and Social Commission for Asia and the Pacific.

The GBM region is relatively resource poor, but it can boast about its abundant water resources. Snow and glacier melt provides the most significant runoff ranking third in the world.[38] Some of the heaviest rainfalls are experienced in the region which is also endowed with underground water. However, the availability of water is skewed geographically and seasonally.

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[38] Abul Ahsan, *Management of International River Basins and Environmental Challenges*, Academic Publishers, Dhaka, 1994, p.16.

Regional cooperation can provide a unique opportunity to make optimum use of the water resources for the benefit of all concerned nations. Unfortunately, at the present time there is hardly any joint approach in the matter involving all the riparian states. Whatever co-operation is there, it is bilateral in nature between India on the one hand and Bangladesh, Bhutan and Nepal on the other.

6. Concluding Remarks

India raised the concept of Tipaimukh dam project in one of the Bangladesh-India meetings prior to the first agreement on the sharing of Ganges water. The project was introduced as one where both the countries can get the benefits.

India promised Bangladesh to provide the DPR of Tipaimukh before going its implementation to dispel the lower riparian neighbour's concern about possible diversion of water from Barak. But India has finally floated international tender for construction of Tipaimukh dam without the knowledge/consent of Bangladesh.

The construction of Tipaimukh dam cannot be isolated from the broader picture of Indo-Bangladesh relations. Currently, the state of bilateral relations is not at its best. India perceives Bangladesh non-cooperative and inward looking, while Bangladesh thinks India uninterested and obstructive. Pending bilateral issues, such as ensuring peaceful border fencing, illegal movement of people, non-implementation of the 1974 Mujib-Indira Agreement including the non-exchange of enclaves with each other, unresolved sea boundary, dispute over the ownership of South Talpatty island and huge trade deficit with India, cast a shadow on bilateral relations and the proposed dam would, in all likelihood, further complicate the state of bilateral relations between the two countries.

The proposed construction of dam without the input of Bangladesh seems to confirm the perception of India's gross insensitivity to the interests of Bangladesh. Perception of people matters most in bilateral relations. Bangladesh is disappointed with the unilateral construction of the Tipaimukh dam as it appears like twisting the arms of Bangladesh unnecessarily. Trust and mutual respect for each other constitute the structure of long term good relations. The relationship needs constant nurturing and care. The bottom line is while Bangladesh does not compete with India, it does not appreciate being pushed around by a big neighbour.

India should, therefore, sit with Bangladesh to settle these and other related problems and Bangladesh should also show her interest to share the benefits of the project. India is planning to export surplus power to Laos, Vietnam and Cambodia. If India exports electricity to Bangladesh produced from Tipaimukh dam, it would be beneficial for both. India can save huge investment in power transmission cost while Bangladesh can get cheaper power. Through a joint study by India and Bangladesh, the adverse impacts of Tipaimukh dam project can be mitigated to an acceptable limit for Bangladesh. If properly planned, designed, implemented, and operated, the Tipaimukh dam project can bring great benefit to people of the area. India should, therefore, take the people of Bangladesh in confidence.

ANNEX-1

Table I: Major Earthquakes in North-East India in Recent Past

Sl No	Place	Year	Magnitude
1	Cachar	21-Mar-1869	7.8
2	Shillong Plateau	12-Jun-1897	8.7
3	Sibsagar	31-Aug-1906	7.0
4	Myanmar	12-Dec-1908	7.5
5	Srimangal	08-Jul-1918	7.6
6	SW Assam	09-Sep-1923	7.1
7	Dhubri	02-Jul-1930	7.1
8	Assam	27-Jan-1931	7.6
9	Nagaland	1932	7.0
10	NE Assam	23-Oct-1943	7.2
11	Arunachal	07-Jul-1947	7.5
12	Upper Assam	Upper Assam	7.6
13	Upper Assam	15-Aug-1950	8.7
14	Arunachal	1950	7.0
15	Manipur-Burma	1954	7.4
16	Darjeeling	1959	7.5
17	Indo-Cachar	11-Nov-1984	5.8
18	Indo-Myanmar	06-Aug-1988	7.5

Source: Dr Md Ali Akbar Mollick, "Status of Seismicity in North-East India: The Home of Tipaimukh Barrage" *International Tipaimukh Dam Conference 2005*, Dhaka Bangladesh.

ANNEX-2

Table II: Approximate Distribution of Mekong River Basin Water Resources by Country and Province.

	Yunnan Province, PRC	Myanmar	Lao PDR	Thailand	Cambodia	Viet Nam	Mekong River Basin
Catchment area as % of MRB	22	3	25	223	19	8	100
Average flow (m3/sec) from area	2410	300	5270	2560	2860	1660	15,060
Average flow as % of total	16	2	35	18	18	11	100

Source: http://www.mrcmekong.org/programmes/bdp.htm, accessed on 05 November 2006.

ANNEX-3

Figure: Structure of the Mekong River Commission (MRC)