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Upstream-downstream linkages in Ganges-Brahmaputra-Meghna basin: the hydro-social imperatives

Avash Pandey[a,*], Anjal Prakash[a,b], Anamika Barua[c], Md. Abu Syed[d] and Santosh Nepal[a]

[a]*International Centre for Integrated Mountain Development (ICIMOD), Lalitpur, Nepal*
**Corresponding author. E-mail: avash.pandey@icimod.org*
[b]*Indian School of Business, Hyderabad, India*
[c]*Indian Institute of Technology (IIT), Guwahati, India*
[d]*Bangladesh Centre for Advanced Studies (BCAS), Dhaka, Bangladesh*

Abstract

To manage the transboundary water resources of the Ganges-Brahmaputra-Meghna (GBM) River Basin, it is important to identify and understand the complex upstream-downstream linkages in the basin. This paper provides a comprehensive overview of social, economic and cultural processes of the GBM Basin and examines existing mechanisms for governing the shared water resources. It draws attention to the uneven power relations between countries that share the basin and how it affects transboundary water governance. The review concludes that the countries need to strengthen cooperation and harness benefits arising from economic, social, and cultural aspects and proposes multilateral cooperation over the existing bilateral cooperation approach in the region.

Keywords: Cooperation; Multilateralism; River basin management; Transboundary rivers; Upstream-downstream linkages

Highlights

- The review paper analyses hydro-social dynamics of the upstream-downstream reaches of Ganges-Brahmaputra and Meghna River Basin.
- The paper points out the multitude of benefits that can be harnessed through cooperation in the river basin nations.
- For an equitable transboundary water management, multilateral governance mechanisms are proposed over the current bilateral mechanisms.

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Introduction

From ancient times to the modern era, rivers have played an integral role in ensuring the development and well-being of human societies. Entire civilisations have emerged and flourished around rivers such as the Indus and the Ganges. A river connects upstream and downstream areas across different spatial scales, thus creating hydrological, social and institutional territories (Boelens *et al*., 2016) linking physical, socioeconomic, cultural, and institutional spaces. The territories are socially constructed and historically produced through an interface of society and technology, often ignoring nature. This paper looks at the hydro-social interlinkages between water and society in the Ganges, Brahmaputra and Meghna (GBM) Transboundary Rivers that are shared by Bangladesh, Bhutan, China, India, and Nepal (see Figure 1). The GBM river system is home to 670 million people (Whitehead *et al*., 2015) and is the third largest river basin in the world after the Amazon and the Congo in terms of freshwater flow (Immerzeel *et al*., 2010; Rasul, 2015a). The water towers of these river basins are among the most vulnerable and important in the high mountain region of Asia (Immerzeel *et al*., 2019). These rivers flow from upstream to downstream and their water resources connect societies, economies and cultures, providing a basis for strong upstream-downstream linkages and interdependence.

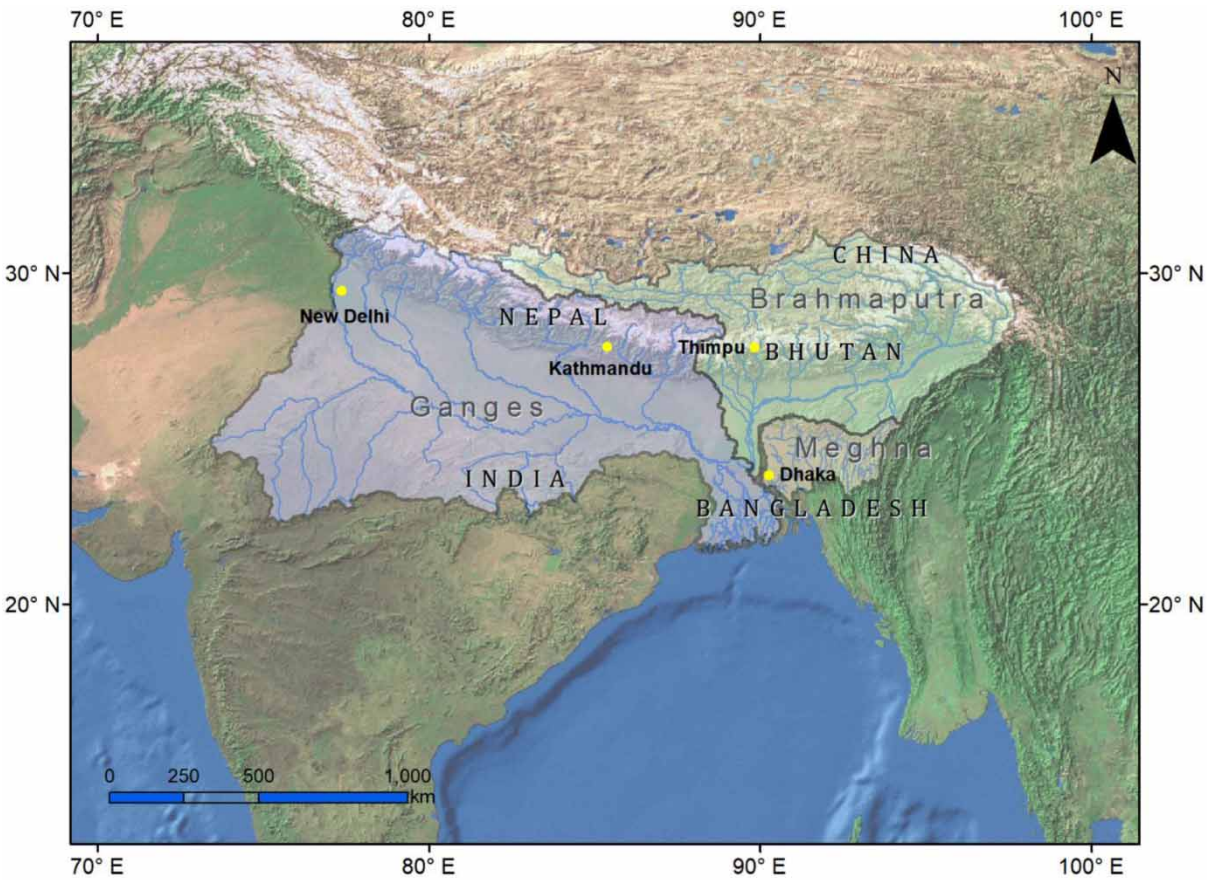

Fig. 1. The Ganges, Brahmaputra and Meghna River Basin (prepared by Santosh Nepal, ICIMOD).

River basin studies conducted in the GBM River Basin region generally overlook the socioeconomic (Chowdhury, 2005; Rasul, 2014), biophysical (Mirza *et al*., 2003; Chowdhury & Ward, 2004; Nepal *et al*., 2014) and institutional (Ahmad & Uddin Ahmed, 2003; Bandyopadhyay & Ghosh, 2009) aspects. Out of these, the biophysical aspects of upstream-downstream linkages of the river basins are relatively well-known and studied (Bruijnzeel & Bremmer, 1989; Nepal, S. *et al*., 2018) but hydro-social aspects for proper management of land and water resources, with respect to upstream and downstream linkages, have not been well documented. There have been studies on hydro-social issues in other parts of the world (Carey *et al*., 2014; Palomino-Schalscha *et al*., 2016); these studies mainly examine water use and water availability from the infrastructural development, economic and political perspectives. There is, however, limited literature on the role of upstream-downstream dynamics in the management of Transboundary Rivers in the Hindu Kush Himalaya (HKH). For this reason, we look at the hydro-social interlinkages and use the definition offered by Boelens *et al*. (2016) of the hydro-social cycle. They define hydro-social territories as '*spatial configurations of people, institutions, water flows, hydraulic technology and the biophysical environment that revolve around the control of water*'. We also discuss the role of water in developing and defining the socioeconomic, political and cultural aspects, influencing territorial politics. We follow this definition in understanding the flow of water from upstream to downstream nations in the GBM Basin, discuss its socioeconomic utilization and reveal different modalities of water governance. We also discuss existing bilateral agreements that could potentially spark conflict and propose ways to improve hydro-social cooperation for greater socio-economic benefits.

Understanding the multiscale interlinkages at the regional, national and sub-national level is imperative for harnessing the benefits. This paper tries to understand two important aspects of upstream-downstream linkages of the GBM River Basin: the existing hydro-political and socioeconomic linkages in the GBM Basin and the type of institutional arrangement that can help maximise the potential to harness hydro-economic opportunities. In the literature review, our starting point is 1989, the year when Ives and Messerli published a book on the Theory of Himalayan Environmental Degradation (THED) highlighting the highland-lowland interactive systems of the Himalayan region (Ives & Messerli, 1989). The theory, which blamed highland land-use change for various disasters in the lowlands, was challenged by multiple scholars in the following years (Nepal, S. *et al*., 2018). However, the study created a basis for continued research on upstream-downstream linkages in river basins. For the review we used literature search engines like Google Scholar, Scopus and HimalDoc. For a comparative perspective on upstream-downstream linkages, we also explored the socioeconomic, political and institutional aspects of river basins in other parts of the world.

The paper includes an introduction and a section on the importance of understanding of upstream-downstream linkages in the GBM Basin. Subsequent sections discuss current economic, social, cultural and institutional linkages in the GBM Basin and how these linkages could be strengthened by applying hydro-social concepts. We conclude this paper by underscoring the need for a transdisciplinary approach for understanding the interface between social and hydrological phenomena of a river basin.

Hydro-social significance of upstream-downstream linkages in the GBM Basin

Large river basins face complex problems related to climate change, sedimentation and erosion, land-use/land-cover change and infrastructural development, and these have implications for water

availability in downstream areas of the basin (Nepal, S. *et al*., 2018). These phenomena profoundly affect the socioeconomic condition of people who live in the river basin. As we look at the river basin beyond political boundaries, it is necessary to understand elements that exist within such boundaries. Differences in the availability and use of natural resources provide a fundamental basis for upstream-downstream linkages. Upstream and downstream communities share social and cultural features but have uneven access to natural resources, resulting in economic differences. For instance, upstream areas have niche products and services like herbs, hydropower and tourism but are unable to benefit from such resources due to inaccessibility and lack of knowledge. As a result, communities in upstream areas are economically marginalised compared to communities in lower elevations (Jodha, 1997, 2002). Similarly, downstream areas have access to water but suffer the impacts of development activities in upstream areas, such as changes in water availability and quality, and water-related hazards (Middleton *et al*., 2009; Jeuland *et al*., 2014).

We live in a time of rapid industrialisation when water resources are being extracted at an ever increasing rate. It is therefore necessary to understand the socioeconomic and institutional dimensions of upstream-downstream linkages. This would help us design and implement fair and equitable strategies to manage transboundary basins such as the GBM Basin. A huge amount of water in the basin is withdrawn for agriculture as the majority of the population of the GBM Basin is still dependent on agriculture. There is also an increasing trend in withdrawal for industrial and municipal uses (Table 1). Withdrawal of water by the upstream countries for industrial and agricultural purposes affects the water dynamics of the downstream countries. For instance, water diversion at the Farakka Barrage has caused downstream effects such as reduced water availability in the dry months and increased discharge in the monsoon season, increased water salinity, agricultural loss, and negative impacts on ecosystems and ecosystem services and health (Mirza, 1998, 2006; Giupponi & Gain, 2017). Similarly, the growth of urban areas in the GBM Basin has increased the demand for water and given rise to uncontrolled urbanisation, lack of infrastructural investments or funds, inefficient resource allocation and management, and weak institutions (Varis *et al*., 2006).

The rising demand for water has put pressure on water reserves in the basin and posed challenges for institutions responsible for managing water. Although previous research shows no direct correlation between water scarcity and conflicts or cooperation, rather they happen through interplay of a variety of factors where upstream-induced water stress could be one (Munia *et al*., 2016). A bilateral approach has the potential of one entity or country overpowering the other, creating a sense of unilateral control over the river basin (Barua *et al*., 2018). Global databases on international treaties and talks show that a

Table 1. Water withdrawal in GBM Basin countries.

Country	Year	Total water withdrawal (km^3/year)	Agricultural water withdrawal (km^3/year)	Municipal water withdrawal (km^3/year)	Industrial water withdrawal (km^3/year)
Bangladesh	2008	35.87	31.5	3.6	0.77
Bhutan	2008	0.338	0.318	0.017	0.003
China	2005	554.1	358.02	67.53	128.55
India	2010	761	688	56	17
Nepal	2006	9.497	9.32	0.147	0.0295

Source: Modified from Scott *et al*. (2019).

bilateral approach often prevails over a multilateral approach (TFDD database). This suggests the need for a multilateral approach.

Current economic, social, and institutional linkages

We have to properly review the existing situation before proposing a mechanism for improving upstream-downstream collaboration around the use and management of water resources. In this section, we examine current upstream-downstream linkages in the GBM Basin from socioeconomic and institutional aspects and then propose a mechanism for managing transboundary river basins more effectively.

Resource and socioeconomic linkages

The mountainous upstream countries in the basin have prioritised hydropower (Table 2) as a means to improve their economic status. They seek to import and export hydropower to meet their industrial energy needs. Bhutan and India have signed multiple agreements for hydropower generation (e.g. Chhukha, 1980; Chhuka II and III, Sunkosh 1993; Punatsangchu Hydroelectric Power Project, 2003; Tala Hydroelectric Project Authority, 2007) whereby after satisfying its internal energy needs, Bhutan exports excess energy to India. This has accelerated Bhutan's economic and social development, with the energy sector contributing to around a quarter of Bhutan's Gross Domestic Product (GDP) and it is expected to contribute half of the GDP by the end of the Eleventh Five-Year Plan (FAO, 2011). Similarly, on a smaller scale in Nepal, the government has introduced benefit-sharing mechanisms whereby a portion of royalties collected from a hydropower project is distributed to the local community through local government bodies. Other benefit-sharing mechanisms such as equity investment, support for local livelihood, investment in infrastructure and environment enhancement activities have also been incorporated in hydropower projects in Nepal (Shrestha *et al*., 2016).

Further, Nepal has developed a National Water Plan with a focus on achieving economic growth and food, energy, and health security (Karmacharya, 2007). Currently, the country's total generating capacity is 1,073 MW and an additional 11 hydropower plants are under construction and nine major plants have been proposed (Alam *et al*., 2017; MoEWRI, 2018). Given the steady increase in energy production, there is a high potential for transboundary energy trade in the region and for the countries

Table 2. Hydropower potential of GBM nations.

	Hydropower potential (million kW)		
Country	Brahmaputra	Ganges	Meghna
China (TAR)	110	–	–
India	66	13	–
Bhutan	30	–	–
Nepal	–	83	–
Bangladesh	Negligible	–	Negligible
Total	206	96	Negligible

Source: Modified from Rasul (2015b).

to uplift their economic status. The cost-benefit ratio of energy trade in the GBM Basin countries is encouraging; for six ongoing and planned power trade projects, the total approximate cost of USD 85 million is estimated to yield benefits worth USD 2549 million (Wijayatunga *et al.*, 2015).

Modern irrigation systems in the GBM River Basin started developing around the mid-19th century, on the foundation of traditional irrigation structures. Barrages and dams constructed along the rivers provide irrigation for 35.1 million ha of land and simultaneously mitigate the effects of flooding (FAO, 2011; Chintan, 2012). In the Upper Meghna River Basin, for example, 60% of the working population is involved in producing boro rice, contributing to 14% of Bangladesh's total production. Similarly, on the Indian side of the basin, around 80% of the population is dependent on agriculture, which shows the economic importance of the water of the GBM River Basin (Sinha *et al.*, 2018).

Countries that share the GBM Basin have a rich social and cultural heritage. The basin not only has abundant natural resources but also serves as a cultural repository for people of diverse faiths, ethnicities and nationalities (IUCN BRIDGE, 2018). As a result the basin has immense potential for tourism, in particular religious tourism. Because of the large number of pilgrimage sites across the basin, people from upstream areas frequently travel to downstream areas and vice-versa (Nepal, M. *et al.*, 2018; Soni *et al.*, 2019). In 2018, for instance, Indian tourists accounted for more than 17% of tourists in Nepal. The number of Indian visitors to Lumbini, a Buddhist pilgrimage in western Nepal, has increased from 60,000 per year to almost 200,000 in the past eight years (MoCTCA, 2019).

Water geopolitics

International water policies mainly revolve around four features: scarcity, maldistribution, sharing, and over-utilisation and misuse (Kliot *et al.*, 2001). In terms of sharing water resources and water management, countries engage in bilateral negotiations with the primary goal of serving their respective national interest. The politics and institutional aspects of the GBM Basin are shaped by water policies of the individual countries. For example, Indian Water Policy (MoWR, 2012) focuses on the bilateral agreement to share hydrological data. Bangladesh Water Policy (MoWR, 1999) stresses co-riparian involvement in sharing information on water resources to mitigate the effects of floods and droughts. The policy further states that international and regional cooperation is required in education, training and research in water management. Similarly, in Nepal, the national water plan and strategy (2005) emphasises cost-effective utilisation of hydropower potential for domestic use and export. The plan further stresses bilateral and regional cooperation for sharing of water-related information for gaining mutual benefits across the region. The Bhutan water policy (NEC, 2007) also states that transboundary water issues will be dealt according to international laws and conventions to promote cooperation among regional countries in water resource development and management.

The policies of large and powerful countries with high stakes in the basin's water resources have made the region susceptible to hydro hegemony. Further, lack of integrated planning and difficult natural terrain and political situation have pushed the region towards water scarcity (Hanasz, 2017). To address this scarcity, upstream-downstream countries play power games where upstream uses water to get power and downstream uses power to get water, thus showing hydro-arrogant and hydro-egoist behaviours (Zeitoun & Warner, 2006; Sinha, 2012). Trading blame is quite common in transboundary rivers in the region and beyond. For instance, during the 2001 flood in the Indian north-eastern states, India accused China of not informing them about the breach of temporary lakes and thus causing huge economic and human loss. China, on the other hand, has denied this accusation (Blaikie & Muldavin,

2004). To mitigate transboundary water conflict issues, cooperation in the form of treaties and agreement are designed based upon: '*parties to the agreement (bilateral/multilateral); subject matter (data collection, allocation, planning, construction, etc.); territorial extent (the whole basin or parts of it) and intensity of cooperation (from the duty to inform to implementation of joint programs)*' (Kliot *et al*., 2001, p. 234). However, in reality transboundary disputes over the GBM Basin have been difficult to resolve. Powerful countries are in favour of bilateral agreements whereas smaller countries prefer multilateral or regional agreements (Samaranayake *et al*., 2016). Cooperation and agreements are largely absent in large infrastructure projects; upstream countries often build infrastructure without considering water availability in the downstream countries. Such acts are carried out by powerful countries like China and India that have significant technical and financial capacity vis-a-vis their neighbours and are blamed for water resource exploitation (Chellaney, 2013; Hanasz, 2014). Negotiations that have happened so far are essentially bilateral and confidential with no public participation. This has led to distrust, conflict and uncertainty at all levels, as seen during the vote for the ratification of the UN Watercourses Convention, where only Bangladesh and Nepal voted in favour of the convention, Bhutan was absent, India abstained from the vote and China voted against it (Rieu-Clarke *et al*., 2012).

Strengthening upstream-downstream linkages: application of the hydro-social concept

The above section discussed upstream-downstream linkages in the economic, social and institutional spheres of the GBM. Understanding these linkages is important to develop effective and sustainable ways to manage the basin's water resources. In this section, we look at benefits derived from economic, cultural and institutional linkages and argue that multilateralism is a better approach for resource management in the GBM Basin.

Linkages for harnessing socioeconomic benefits

The GBM Basin region has huge potential for hydropower generation, which can be used for industrialisation, economic growth, and poverty alleviation (Rasul, 2015b). It offers the possibility of power-hungry countries like India and Bangladesh relying on surplus power generated from Bhutan and Nepal. Rich economies like India have provided grants and loans to low-income countries to share the cost and risks of economic development projects (Biswas, 2011). Hydropower has several economic and environmental advantages such as low cost of generation and sustainable energy production; however, much still needs to be done in hydropower research and policy (Biswas, 2008; ICIMOD, 2016). Despite its tremendous potential for hydropower generation (see Table 2), the GBM Basin region is considered one of the least developed in the world because of difficult geopolitical, financial and environmental conditions (Nanda *et al*., 2015). However, cross-border energy cooperation such as Bhutan's and Nepal's trade transactions with India has generated economic benefits from the perspective of upstream-downstream linkages (Biswas, 2011; FAO, 2011). The cooperation is so far limited to bilateral agreements (see Table 3). Multilateral involvement of all the countries will increase the cost-benefit ratio in both economic and environmental terms (Wijayatunga *et al*., 2015).

Most people in the GBM Basin depend on agriculture for their livelihood and food security, which makes the region highly water-dependent. Agricultural use accounts for almost 89% of the total water withdrawn from the basin (Babel & Wahid, 2011). This withdrawal has now led to a situation where

Table 3. Agreements and treaties in the GBM Basin.

Name of agreement/treaty	Signatories	Basin	Date	Remarks
Chukkha Hydroelectric Project	India, Bhutan	GBM	1905-05-27	Development for hydropower
Kosi Project	India, Nepal	Kosi	1954-04-25	Hydropower/Hydroelectricity
Gandak Irrigation and Power Project	India, Nepal	Gandak	1959-12-04	Water quantity
Amended agreement concerning the Kosi Project	India, Nepal	Kosi	1966-12-19	Hydropower/Hydroelectricity
Statute of the Indo-Bangladesh Joint Rivers Commission	Bangladesh, India	Ganges-Brahmaputra	1972-11-24	Flood control/relief
Sharing of the Ganges' waters at Farakka and on augmenting its flows	Bangladesh, India	Ganges	1977-11-05	Water quantity
Chandra Canal, Pumped Canal, and distribution of the Western Kosi Canal	India, Nepal	Kosi	1978-04-07	Water quantity
Memorandum of Understanding on the sharing of Ganga waters at Farakka	Bangladesh, India	Ganges	1982-10-07	Water quantity
Ad-hoc sharing of the Teesta's waters	Bangladesh, India	Teesta	1983-07-20	Water quantity
Integrated development of the Mahakali River	India, Nepal	Mahakali	1996-02-12	Flood control/relief, Hydropower/Hydroelectricity, Water quantity
Sharing of the Ganga/Ganges' waters at Farakka	Bangladesh, India	Ganges	1996-12-12	Water quantity

Source: TFDD (n.d.).

there is either too much water in the monsoon season or too little water in the dry season. For example, 80% of the total precipitation in Nepal falls during the four months of the monsoon season, and sometimes the sudden bursts make surface runoff exceed infiltration, increasing water stress in the dry season (ICIMOD, 2009). To overcome issues of drought and water stress, countries have focused on building dams and reservoirs. However, such infrastructure projects have always attracted unwanted attention from the downstream countries. For example, China's ambitious plans to divert water to its drier northern region from the Brahmaputra is increasing the country's tension with India since the Brahmaputra accounts for almost 29% of all surface water and has around 44% of India's total hydropower potential (Pak, 2016). Better catchment management practices in the upstream would create opportunities for downstream communities; poor catchment management practices may not only degrade environmental conditions but will also limit the opportunities downstream (Flügel & Bartosch, 2011). Hence, users in downstream areas often have serious concerns about upstream land use and water management practices. There is a consensus in the scientific community that coordinated development and management of water, land and related resources may address the complex basin-level management issues (Calder, 2005; Nepal, S. *et al*. 2017, 2018).

Another revolutionary idea for involving upstream-downstream communities in improving their economy is inland navigation. In the past, inland waterways were used in the Ganges and Brahmaputra rivers (CUTS International, 2016). They are no longer in use owing to vested political interests, but such waterways could pave the path for new economic cooperation and development. For example, 4% of India's trade and 47% of China's trade relies on inland navigation, which also proves how important

inland navigation is (Gyawali, 2016). Improving inland navigation is extremely important for the economic development of landlocked countries like Bhutan and Nepal. There is a need for a multilateral strategy to improve economic and cultural linkages in the GBM Basin. A few initiatives that incorporate inland navigation have adopted a multilateral approach, such as BBIN and BIMSTEC; however, their full potential has not been realised (Mohan, 2016; Rasul *et al*., 2018).

Inland connectivity will not only improve trading facilities but also increase the flow of tourists between countries. The rivers along the GBM Basin possess aesthetic beauty and offer opportunities for different types of tourism including spiritual, adventure and aesthetic tourism. Tourists from all over the world come to the rivers for white-water river rafting and other sports. In the Koshi River Basin of the upper Ganges, the number of tourists has increased from 69,000 in 2009 to 97,000 in 2011. Tourists mainly come for rafting, bungee jumping and other water-related adventure sports (Vaidya & Sharma, 2014). Opportunities for spiritual tourism can be harnessed by developing spiritual tourism circuits in India (Medhekar & Haq, 2012), marketing the Great Himalayan Trail in Nepal where multiple spiritual locations exist (Pradhan, 2014) and promoting sacred natural sites in China as tourist destinations (Zhang *et al*., 2007). Thus the rivers create not only upstream to downstream linkages but also downstream to upstream linkages through the means of religious, cultural and touristic activities.

Fostering institutional linkages: shift from bilateralism to multilateralism

About 67% of the world's 263 international rivers are bilateral (shared by two states) (Wolf, 1998). For multilateral river basins (shared by more than two states), negotiations may take place at a multilateral level (involving all the riparian states), but states prefer bilateral treaties, which are easier to achieve and maintain than multilateral treaties (Axelrod & Keohane, 1985; Oye K, 1985; Song & Whittington, 2004). In addition, multilateral treaties have higher transaction costs (Williamson, 1985; Martin, 1992) and are difficult to achieve and maintain (Powell, 2006; Tanner *et al*., 2009). Power asymmetry between states can also play a significant role in the kind of treaty that is signed between riparian states. According to Crow & Singh (2000), powerful riparian states prefer bilateral treaties in multilateral basins because bilateral agreements allow them to impose a 'divide and conquer' policy and secure substantial relative gains. Hence, while power parity can lead to a multilateral treaty, power asymmetry in a multilateral basin usually leads to a bilateral treaty.

Conflicts in the GBM Basin represent this stereotypical conflict of interest between upstream-downstream riparian countries. In hydro-politics, both China and India have traditionally been fixated on bilateralism, which allows space for national priorities and policies to gain prominence over regional aspirations (Wouters, 2013; Ho, 2014). Conversely, other nations are proposing a multilateral framework for agreements (Crow & Singh, 2000). The failure of GBM Basin countries to coordinate their river development efforts through a multilateral approach has minimised the gains from cooperation, contributed to inefficient resource use, and resulted in environmental degradation of the basin (Hossain & Katiyar, 2006). Conflicts over shared rivers between riparian countries are a result of the countries' hydro-political behaviour, which is well-grounded in bilateralism, and their tentative attitude towards multilateral institutions and mechanisms.

Despite these challenges, there are shreds of evidence where states have managed to arrive at multilateral agreements by overcoming these obstacles (Keohane, 1990). River basin commissions such as the Mekong River Commission, Nile River Basin Initiative and International Commission for the Protection of the Danube River are good examples of multilateral cooperation for large river basins (see Table 4). A

Table 4. Examples of multilateral river basin treaties across the globe.

	River basins and agreement points		
Features of water policies (after Kliot *et al*., 2001)	Mekong River Council (MRC, 1995)	Nile River Basin Cooperative Framework (NBI, 2010)	International Commission for the Protection of the Danube River (ICPDR, 2016)
General	Identify areas of cooperation	Cooperation and sustainable development	Protection and sustainable use
Sharing	Reasonable and equitable utilisation (wet and dry season), freedom of navigation and emergency situations	Equitable and reasonable share of water resources, data and information sharing (chargeable)	Flood risk management plans
Overutilisation and maldistribution	Responsibility for damages	Environmental impact assessment for planned measures	Hydromorphological alterations
Misuse	Prevention and cessation of harmful effects	Obligation not to cause significant harm and provide compensation for, mitigate or eliminate harm	Organic and inorganic pollutants discharge

similar commission for the GBM involving all countries that share the basin could lead towards a sustainable and equitable mechanism for dealing with issues highlighted by Kliot *et al*. (2001) – sharing, scarcity, maldistribution, and over-utilisation and misuse.

Institutions play an important role in mitigating conflict and promoting cooperation around water. However, when river basins encompass multiple sovereign states, a paramount concern is how to design and sustain institutions to equitably share and protect water resources (Sneddon & Fox, 2006; Stinnett & Tir, 2009). Contrary to the predominant trend toward multilateral cooperation in other issue areas (Denemark & Hoffmann, 2008), in case of transboundary waters, riparian states have typically opted for bilateral agreements instead of multilateral agreements (Zawahri & Mitchell, 2011). International governmental organisations (IGOs) and international non-governmental organisations (INGOs) can also play an important role in bringing about a multilateral agreement between riparian states. This is because joint membership in IGOs and INGOs can decrease the transaction costs of negotiating a treaty and assist in its enforcement (Zawahri & Mitchell, 2011). Such organisations provide a platform where direct and indirect communication between states can take place (Keohane, 1990). IGOs or INGOs can act as third parties for mediating disputes between states; they can facilitate treaty negotiations, help address fears of non-compliance and help resolve disputes (Mitchell & Hensel, 2007; Dorussen & Ward, 2008), thus reducing the transaction costs of negotiating and making multilateral treaties sustainable (Zawahri & Mitchell, 2011).

Discussion: towards understanding hydro-social linkages in GBM River Basin

The transboundary GBM Rivers are interdependent in many ways – socially, culturally, economically, biophysically and institutionally. For centuries these river basins have fostered human civilisation, supported cultural evolution and accelerated economic transformation. Understanding upstream-downstream

linkages is necessary for ensuring the sustainability of the river basin and its population. Based on a review of available literature, we define upstream-downstream linkages as biophysical, socioeconomic, cultural and institutional interdependencies that shape the integrated management of water resources. Countries can reap huge economic benefits if they cooperate in harnessing their hydropower potential as a source of clean energy to meet the rising demand of the industrial sector. Similarly, equitable allocation of water resources for irrigation will not only secure economic benefits but also ensure food and nutrition security of this poor and densely populated region. Inland waterways geared towards the economic development of landlocked countries would generate many benefits. The rich cultural and religious heritage of the GBM Basin and the easy movement of people within the region offer huge opportunities for boosting tourism and creating local jobs and markets.

Institutions play a major role in strengthening the water-energy-food nexus in the GBM Basin. However, we found that existing institutional mechanisms are very traditional and based on unilateralism (e.g. China in the Brahmaputra) and bilateralism (e.g. Indo-Bhutan, Indo-Nepal, Indo-Bangla) rather than a more equitable multilateral approach. It seems quite natural and obvious that powerful nations have used transboundary water resources in their favour through tactics and strategies. Rectifying these tactics and strategies to achieve equity is not a priority for these nations (Zeitoun & Warner, 2006; Hanasz, 2017). Further, geographical remoteness and regional disputes have increased distances between upstream and downstream communities within and across borders. To address this, institutions can act as a catalyst to foster cooperation and achieve equity between upstream and downstream areas of the GBM rivers. Through well-designed and far-sighted initiatives, institutions can enhance awareness and promote cooperation among riparian countries. For instance, in a multilateral initiative of Hydrological Cycle Observation System (HYCOS), real-time hydrological data is shared with member countries – Bangladesh, Bhutan, Nepal, and Pakistan – helping prepare them against floods by providing hydrological information beforehand (ICIMOD, 2012). Institutions can lobby for maximising benefits and promoting a variety of elements such as free trade, education, scientific and technological development (Biswas & Tortajada, 2010). Countries need to shift their thinking and planning from bilateralism to multilateralism. This is necessary in the region, where some countries seem to overpower others in order to over-utilise water resources. Institutions and multilateral mechanisms can help address the problem of hydro-hegemony in the region for better cooperation. Available literature discusses the importance of regional cooperation in the GBM Basin but does not emphasise multilateral agreements and treaties.

The growth of economic, social and cultural opportunities in the GBM River Basin has increased the risk of mismanagement of water resources in the basin. Pollution, environmental degradation, and climate change can undermine ongoing development efforts in the GBM River Basin. As repositories of ancient civilisations, these rivers have immense historical, cultural and spiritual significance. Lessons about transboundary river management can be learned from the Mekong River Commission in the HKH region and similar commissions for governing the Danube and Nile river basins. There is huge opportunity and scope for further research on specific aspects of upstream-downstream linkages in river basin management.

Conclusion

This review paper looked at the socioeconomic and hydro-political linkages of the GBM River Basin and the existing mechanisms for governing the water resources of the basin. The aim was to propose a suitable

governance mechanism that would benefit all countries that share the basin. From ancient times, socioeconomic activities in the GBM River Basin have benefitted people in both the upstream and downstream regions. However, modern day geo-politics has altered traditional practices and introduced strategic manoeuvring in the governance of these rivers. For instance, existing bilateral agreements allow the more powerful countries to control the shared water resources of the basin and dominate other countries economically, physically and psychologically. We found that multilateral agreements are better for governing shared water resources. Multilateral agreements would allow for equitable allocation and use of water resources and generate benefits (e.g. tourism and inland waterways) for both upstream and downstream countries.

The review has a few limitations. As there are no multilateral agreements on the governance of the GBM Basin, we cited examples of multilateral agreements from neighbouring regions and beyond. We also realised there is limited documentation of socioeconomic activities that thrive in the basin, especially in countries like India and Nepal that share an open border.

We believe that the densely populated countries that share the basin should move beyond purely domestic priorities and focus on integrated development of the entire river basin. To improve policies and strategies, it is necessary to understand flows of water and people at the basin scale. Regional level institutions could play a significant role in expanding people's understanding of upstream-downstream linkages. Literature on the river basin is dominated by physical sciences and lacks a much-needed hydro-social perspective that would shed light on integrated river basin management. A transdisciplinary approach is crucial for understanding the interface between the socioeconomic and hydrological phenomena of the river basin.

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Data availability statement

All relevant data are included in the paper or its Supplementary Information.

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