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Inside the issue ...

Himalayan Water Resources - Transboundary Challenges and Opportunities	Page 1
Transboundary Rivers Converting Challenges into Opportunities.....	Page 3
Transboundary Water Cooperation Brahmaputra River.....	Page 4
Cooperation in the Brahmaputra River Managing Perceptions and Prospects.....	Page 5
Towards Collaborative Transboundary River Governance Brahmaputra Dialogue Initiative.....	Page 6
India-China Transboundary Water Cooperation Challenges and Opportunities.....	Page 7
Understanding China's Transboundary Water Policies Major Gaps	Page 8
Lessons from Civil Society Engagement on Water South Asia.....	Page 9
Bridging knowledge for Transboundary Water Cooperation Informing Exchange in the Indus Basin.....	Page 10
Innovations/Discoveries in Science	Page 11
Books on Water Resources..... Forthcoming Events.....	Page 12

Himalayan Water Resources- Transboundary Challenges and Opportunities



Photo : Swapnali Bora

There are 276 international transboundary rivers basins in the world, which is shared by 148 sovereign states and over 2.7 billion of the world's population depend on these river basins. While the availability of freshwater in the world have roughly remained the same, but the demand for water is growing annually, putting a pressure on these transboundary international river basins. As such, allocation, access to and control over resource seems to be the most important cause of conflict, in the case of transboundary waters. Further, transboundary water interaction is an inherently political process, as these river basins are shared by two or more sovereign state, with diverse value and interest in water resources management. The interactions are mostly determined by the broader political context of the riparian countries. The interactions are also effected by the differences between the riparian countries – in terms of socio – economic development, capacity to manage water resources, infrastructure, political, institutional as well as legal contexts. These differences or power asymmetry between the riparian countries often becomes a challenge towards effective and coordinated management of the river basin.

Despite the potential for dispute in international basins, there are many more instances of cooperation over shared water resources. There is also a huge and growing body of literature that highlights, in transboundary waters, conflict and cooperation can co-exist. The evidences from different transboundary river basin across the world (e.g. Nile, Jordan, Mekong) also

shows that water, by its very nature, tends to induce even hostile co-riparians to cooperate, even as disputes rage over other issues.

However, there are a number of challenges to transboundary cooperation, such as lack of political will, poor understanding of cost of noncooperation, lack of basin level information, hydro hegemony, power asymmetry, lack/poor capacity of basin institution for co-management of the river. Further, countries sharing the basin are usually positioned differently in terms of geography, socio-economic development, political orientation and infrastructural capacity; therefore they understand the usage, access and control of transboundary resources differently. The resultant power asymmetry between the nations influences their bargaining position as well as the outcome of the negotiation. Therefore, arriving at transboundary cooperation through formal or informal understanding is not an easy task, particularly when the transboundary rivers flows through multiple riparian countries. Any transboundary cooperation without recognizing and analyzing the power asymmetry will be skewed and in most cases will benefit the hegemon. The weaker side signs the treaty although they are skewed and asymmetric in order to remain in the game, than resign and not participate. Such cooperation through asymmetric treaties has become source of conflicts rather than source of cooperation and often brings new source of tensions between the riparian countries. Thus, all cooperation is not necessarily good as in many instances they look like domination dressed up as cooperation.



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Editors' Note

Dear Readers,

Water is a fundamental resource to support all life-forms on this planet earth. It covers over 70% of the earth's surface. In spite of its abundance, only about 0.3% freshwater is available in the form of river flows and lakes. More so, the spatial and temporal dynamics of water, particularly in the Himalayan mountains makes it a precious resource. It is often said that in this "Water Tower of Asia" the inhabitants face water scarcity of various magnitude almost year-round leading to loss of livelihood, water related hazards, unrest over water use issues and out migration. Therefore, understanding water resource dynamics at a basin scale (that involves transboundary cooperation) is a pre-requisite to manage it for the flow of ecosystem services and human-wellbeing, and also for flood management. Articles in this newsletter dwelt on socio-political and legal issues at basin scale that become detrimental for the water resource management.

We hope the current issue of ENVIS Newsletter would improve the understanding of various stakeholders on the various ongoing efforts for the judicious use of water resources between the neighbouring countries sharing some of the important river basins of the Himalayan mountains.

Editors

International water law serves as a platform for facilitating transboundary cooperation through establishing transparent and predictable rules of engagement. It provides a normative and institutional framework within which various aspects and drivers that affect the potential for cooperation can be properly accommodated – issues of geography, resource availability and variability, governance, inter-State relations and power asymmetries, trade, colonial heritages, and diverse political regimes. Among the most important global instruments are the 1997 UN International Watercourses Convention (UNWC) and two recent resolutions adopted by the UN General Assembly, one on the Right to Water and Sanitation and another related to transboundary aquifers. At the regional level, the two most relevant legal documents contributions are the UNECE Water Convention and the 2000 SADC Revised Protocol on Shared Watercourses (SADC Revised Protocol) greatly influenced by the UNWC. International water treaties that utilizes formal institutions often helps to prevent riparian conflicts and resolve disagreements over sharing of water between riparian countries. However, when the basin is shared by multiple sovereign states, the biggest challenge is to design and sustain institutions, which will enable the sovereign states to share the water resources equitably and judiciously. Moreover, there is no one-size-fits-all approach to transboundary basin management, as riparian countries are driven by different political, social, economic and ecological drivers. These drivers can influence the nature and the characteristics of the institution.

South Asian Trans-boundary rivers are inextricably linked to regional geopolitics since it involves countries that are unequal in both size and power. These River basins are but important engines of economic development, livelihood security and are also biodiversity hot spots. However, the last fifty years of transnational water governance in South Asia as assessed by scholars has been the story of an unfolding disaster based on scarcity, ill faith and bad governance. While studies have concluded that transboundary cooperation can bring socio-economic and political benefits, eradicate poverty, reduce disasters, and livelihood security in the region but lack of political will as well as poor institutional capacity (none of the South Asian countries have ratified the UN convention) continues to be a major challenge. The region also lacks scientific evidences which can highlight the upstream-downstream interdependencies along with the cost of non-cooperation. This newsletter brings in diverse perspectives on opportunities and challenges to transboundary cooperation in South Asia, particularly for the three major river systems of South Asia – the Indus, the Brahmaputra and the Ganges. This issue of newsletter also highlights the initiatives taken by different institutions in developing a common knowledge base as well as facilitating dialogues between the riparian countries to enhance cooperation for better management of the South Asian transboundary rivers.

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Transboundary Rivers

Converting Challenges into Opportunities.....

From Afghanistan in the west to Bangladesh in the east, the South Asian countries are criss-crossed by numerous transboundary rivers that originate in the Himalayas. The dominant narrative on transboundary rivers has been one of sharing, evocative of division of the spoils (or scarce and dwindling resources), based until now on the premise of zero-sum games. There are very few examples of agreements reached to date. Notably, treaties were arrived at only on two of these rivers to date: the Treaty between India and Pakistan on the Indus River and the Treaty arrived at bilaterally on the Ganges River between Bangladesh and India in December 1996. None of the other Himalayan rivers are governed by any agreed-upon framework between the countries through which these rivers mender.

My personal involvement in the finalization of the Ganges Treaty led me to certain conclusions about pathways to arriving at solutions. Prior to its resolution, the dispute over the sharing of the Ganges River waters between Bangladesh and India had come to be viewed as the defining function of bilateral relations between these two countries. Once the treaty was signed, it opened the doors to progress in other sectors that had become dormant.

How was the Ganges conundrum solved? For me, parsing the dynamics of the negotiations there were eight factors that had to come together before arriving at the point of resolution. First, it was absolutely necessary that the political will existed at the highest level possible made the critical difference. Second, both sides realized that the political dynamics had to take precedence over technical-mechanical drivers. The negotiations were now led by the Foreign Ministries of the two countries, and not the Water Resources Ministry, since both acknowledged that resolution mechanism had to be political, not technical. Third, in a federal configuration, the state/provincial governments had to be co-opted as primary stakeholders and made active participants in the negotiating process. Without West Bengal become an active partner in seeking a solution, the final resolution would not have been reached. Fourth, the web of diplomacy had to be expanded beyond engaging primarily (and only) with the ruling establishment of the other side. The Bangladesh side engaged in intense diplomatic contacts at senior levels that extended beyond merely the senior officials and cabinet members of India and also reached out to leaders in opposition at national and state levels, and also enlisting media and think-tanks' sympathy and support. Fifth, breaking down embedded myths that generate suspicion helps the process immensely. The engineers on the Bangladesh side had a deep-rooted suspicion, which had over time been transformed into deep-seated conviction as without visiting the Farakka site, that India was siphoning off water through additional measures at the Jangipur Barrage that they had built downstream of the site of the original Farakka Barrage. When the same engineers were taken to the site, that myth was shattered and the suspicions laid to rest. Sixth, enlisting personal/emotive ties of provincial leaders/officials on other side also helps immensely. Seventh, setting a firm time frame for completing negotiations rather than keeping it open-ended can be of critical importance. Open-ended negotiations had become self-perpetuating, without any compulsion for arriving to a mutually satisfactory solution. Eighth, de-linking solution of different issues from each other, and pursuing negotiations on different issues on separate but simultaneous tracks, facilitates arriving at practicable solutions. The linkage of augmentation of waters at Farakka had tied up both sides from reaching any solution on the issue of water sharing, because the approaches of the two sides on augmentation were diametrically and radically opposed to each other conceptually – building dams in Nepal (that required a third party being involved), or upper reaches of India as favoured by Bangladesh, vs. linking the waters of the Brahmaputra with the Ganges by constructing a canal within Bangladesh, as favoured by India. In the face of this, the Bangladesh side, for a change, took a pragmatic

approach – as certaining that even without augmentation, there was sufficient water at Farakka that could be shared, and then arriving at an arrangement for sharing that. Thereby, both sides could get on with their lives and with their other plans for development.

The Ganges Treaty enabled both sides to break out of a hostage situation and move on with their lives. It is another matter that many subsequent opportunities for resolving other contentious issues, or even moving forward on areas where cooperation was feasible, were frittered and lost. However, the region is now confronted by enormous ecological challenges, that would be well beyond the capacities or capabilities of anyone country to address alone, on its own. However, if all the countries who belong to the realm of these trans-boundary waters were to finally get together to collaborating on managing these vast basins, I do believe the situation would change dramatically, and we could transform the challenges into vast opportunities.

The eastern Himalayan rivers affect the lives of hundreds of millions of people who inhabit the most densely populated geographic region of the Indian sub-continent comprising Bangladesh, Bhutan, Nepal, northeast India, Sikkim and West Bengal. Taking account of recent welcome developments on basin management of rivers in this region, I believe this sub-region now needs to consider a scheme for holistic management of river basins. Collaborating on holistic basin management in Bhutan, Bangladesh, India and Nepal (BBIN) of associated shared commons – water resources and forestry – would transform what appears to be a daunting challenge into an opportunity with vast consequences for the countries and their inhabitants. It must necessarily engage proactively with the people who inhabit the countless villages, towns and cities, and restore to them a sense of ownership and pride in their shared commons. If we wish to restore navigability of these rivers, sorely neglected over the last sixty years, we would need to undertake:

- Dredging, for sustaining navigability (and in the process, even perhaps regain some land for human habitation and agriculture)
- Expansion of existing irrigation channels (that would also serve as overflow drainage channels during high season floods),
- Shoring up the embankments
- Creating water conservation reservoirs / pond age generation of hydro-electricity

Opening the rivers to better and more optimized use of river transportation, in turn will open new service sectors and industries. Dying rivers would be revived, progressive siltation of river-beds would be reduced, and the ecology resuscitated. The generation of hydro-electricity would also serve the purpose of rendering surplus hydrocarbon resources for intra-regional use or export abroad. They would also dramatically reduce the current rate of deforestation (for fuel as well as for illegal logging). The regeneration of forestry and increasing forest coverage would create new, and enhance existing, carbon-sequestration zones.

We are at the cusp of transforming these mighty rivers, that nurture and sustain our eco-system, from continuing to be the rivers of confrontation and conflict that they have become over the last over seven decades, into rivers of cooperation nurturing comfort and our well-being. Let us seize the moment, not lose or squander it.

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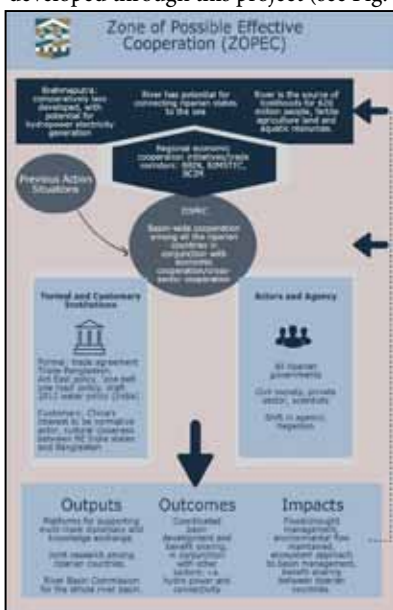
Transboundary Water Cooperation

Brahmaputra River

Water is an essential resource for life, health and development. In many parts of the world, water, particularly freshwater, has been source of both conflict and cooperation. As a way to manage conflict and enhance cooperation, it is critical to identify factors that affect water cooperation. The Water Diplomacy project, initiated by The Hague Institute for Global Justice along with seven global partners, aims to identify key factors that affect water cooperation, taking a combined approach of research and stakeholder dialogues. In doing so, we identified a zone of possible effective cooperation (ZOPEC), where the potential for mutual gains between countries is significant. Over the past decade, a handful of such projects have shown a promising potential for cooperation in the South Asia region. However, the overall progress in cooperation still has a long way to go in the region and a greater effort and commitment is needed.

The project conducted an in-depth analysis of factors that affect cooperation over the Brahmaputra basin, one of the largest in South Asia. The Brahmaputra river (and many of its tributaries) emerges from the eastern Himalaya and traverses across a varied and complex landscape before falling into the Bay of Bengal. The whole river basin has a large hydropower potential, fertile agricultural lands and plenty of aquatic resources that supports riparian populations and their livelihood. The Brahmaputra traverses through four countries including China, India, Bhutan and Bangladesh that claim sovereignty over various parts of the basin. Resource management of the whole basin is now at an important juncture, with increased trade-offs evident between different visions of how the basin should be utilised in the future.

Within the Brahmaputra river basin, most cooperation in the past has typically been between governments (Track I) taking a bilateral approach. Our in-depth analysis of these bilateral cooperation processes identified various factors that influences the way cooperation takes place. In the Brahmaputra basin context, geography, political relationships including power relationships, even within nation states, economics and cultural histories showed complex dependencies influencing the policies and ultimately the overall status/progress of effective cooperation. Thus, the analysis identified the importance of formal institutions such as laws and policies in shaping each basin state's positions vis-à-vis its resource use, as well as customary institutions such as culture and history that shape the way cooperation takes place. These factors are reflected into the multi-track water diplomacy framework, an analytical framework developed through this project (see Fig. 1).



As part of the research approach, our project also analysed processes of dialogues and cooperation facilitated by civil society groups, academia, think tanks and international organizations within the Brahmaputra basin (Track II and III cooperation). These types of cooperation can play different roles to those of Track I cooperation, as they often facilitate dialogue among different stakeholders representing different users of the river, and often result in joint actions such as joint research, capacity building, media campaigns and dialogues. The non-official

nature of these dialogues provided advantages in facilitating informal conversations, fostering long-term relationships and trust among different stakeholders within the basin.

Based on the analysis of existing cooperation and factors affecting cooperation, the project also conducted analysis of the ZOPEC that could bring effective cooperation and provide benefits to all the riparian countries. The analysis was validated during the Brahmaputra basin multi-stakeholder workshop, where further inputs on the ZOPEC were proposed by participants. The workshop was conducted in November 2016 as part of the Water Diplomacy project, and twenty seven participants from four riparian countries participated in active discussions on the ZOPEC.

The key feature of the proposed ZOPEC is to have basin-wide cooperation among all the riparian countries in conjunction with economic cooperation, allowing cross-sectoral cooperation and benefit-sharing. Such cooperation integrates all sectors involving water, ecology and economy in its scope and can potentially create win-wins for all the riparian countries. Taking a cross-sectoral approach in water cooperation can open space for sharing benefits from different sectors. For example, downstream countries can benefit from upstream hydropower generation by offering its trade routes (navigation, road and rail) and access to port facilities in return for energy supply by the hydropower generating country. Arrangements for benefit-sharing may include benefits to the river (e.g., improved water quality, environmental protection, etc.), benefits from the river (e.g., hydropower, irrigation, etc.), benefits because of the river (e.g., reduced risk of conflict, increased food and security, etc.), and benefits beyond the river (e.g., integration of markets, benefits of regional trade, etc.). Adequate management of the basin, based on an ecosystem approach, can also promote tourism as the river is a home to endangered species such as river dolphins.

The circle in the centre of Fig. 1 indicates this ZOPEC, followed by potential output, outcome and impact from such cooperation. The analysis of current contextual factors, formal and informal institutions, and actors support the ZOPEC. Existing economic cooperation within the region is one of the key contextual factors that can positively affect the ZOPEC.

Taking a cross-sectoral approach to water cooperation can also create shifts in power relationship where traditionally, large and upper riparian countries tend to dominate and have advantage in use of resources.

While the region is politically fragmented, historically and culturally it is closely inter-linked; harnessing these links can facilitate cross-border cooperation, whilst acknowledging customary institutions can be an important factor that supports cooperation. Our experience of the Water Diplomacy Project in the Brahmaputra basin suggests that building upon these pre-existing ties and augmenting them with multi-track dialogue processes provides a possible route for enhanced cooperation between the countries of eastern South Asia.

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Fig. 1: Analysis of ZOPEC using multi-track water diplomacy framework

Cooperation in the Brahmaputra River

Managing Perceptions and Prospects.....

China and India are upper and middle riparians, respectively of the Brahmaputra River. Presently, however, there are few robust mechanisms for riparian cooperation between China and India. Cooperation consists primarily of a series of memoranda of understanding (MOUs) on hydrological data-sharing and an expert-level mechanism established in 2006 (Table 1) which provide information about water level, discharge and rainfall. But these MOUs are non-binding and there is no oversight body that can ensure implementation. The low level of institutionalized riparian cooperation between China and India is a challenge for the management of Brahmaputra River. Without any water-sharing agreement, a joint river commission and dispute settlement mechanisms, there are limited avenues to prevent and resolve water conflicts.

Table 1.: Existing Sino-Indian Cooperation on Transboundary River

Date	Frameworks	Details
2002, renewed in 2008 and 2013	MOU on Hydrological Data Sharing on the Brahmaputra River Brahmaputra/Yalu Zangbu	China agreed in a MOU signed in 2002 to provide hydrological information, namely water level, discharge, and rainfall, from 1 June to 15 October every year. The 2002 MOU expired in 2007 and was renewed in 2008 for another five years. In 2013, the MOU was further extended till 2018. In October 2013, a new MOU on Strengthening Cooperation on Transboundary Rivers was signed. China agreed to share data from 1 May instead of 1 June. Under the MOU, China and India also agreed to "exchange views on other areas of mutual interest."
2005, renewed in 2010	MOU on Hydrological Data Sharing on River Sutlej/LangquinZangbu	China agreed to provide hydrological information during flood season. An Implementation Plan was additionally signed in 2011 for China to provide hydrological information, data transmission method, and cost settlement.
2006	Expert-level Mechanism	The expert group made up of representatives from both sides discusses interaction and cooperation on provision of flood season by hydrological data, emergency management, and other issues on an annual basis. The first meeting was held in 2007, and meetings were held every year subsequently.

Water politics between China and India are conflated with larger historical, political, and territorial issues. Two misperceptions, a lack of trust, and security dilemmas between the two sides prevented the emergence of robust institutions to manage their transboundary water relations. However, despite these tensions difficulties in building institutional capacity for managing their transboundary waters, both the governments have managed to keep their differences on managing the Brahmaputra from breaking into open conflict. The chief strategy they have relied on is to desecuritize water as an issue between them by relying on inclusive rhetoric to minimize hot issues and control the escalation of misperceptions. The narrative both sides have employed is to focus on reassurances to safeguard interest of each other.

By sharing hydrological data with India, China seeks to assuage Indian concerns about the floods in northeast India. When news of the construction of the Zangmu Dam broke in India in 2010, Chinese

officials and hydropower companies assured the Indian side that the dam will not stop the flow of the river downstream, that it is not a project to divert the waters of the Brahmaputra, and that it will not affect the welfare of populations in the downstream areas.

On its part, the Indian government has tried to manage domestic perceptions of Chinese upstream activities. Top Indian leaders consistently and repeatedly raised transborder rivers as an issue of concern to Chinese leaders. They have repeated assurances from the China that they have no intention of diverting the waters of the Brahmaputra and any act that would adversely impact India's interest. Such official discourses are aimed at desecuritizing water as an issue with China so as to prevent relations from being derailed by water issues.



These efforts on the part of the both the governments have helped prevent tensions on the Brahmaputra river, however, more can be done to enhance cooperation between the two sides. While water-sharing agreements and joint development are difficult at this stage, both sides could nevertheless upgrade their current MOU-based cooperation to a higher level of institutionalization. A greater level of institutionalized cooperation will provide forums for negotiations and lower transaction costs, thus ensuring greater stability in their relations. Both sides could enhance mutual exchanges in disaster management. For instance, it was reported in June 2016 that flood-prone Assam has set up a team of experts tasked with going to China to study its Yellow River flood management techniques. Apart from hydrological information-sharing for flood control, both sides could move on to the next stage to exchange information on water pollution control and environmental protection. Such exchanges will enhance cooperation and help build confidence on both sides. In addition, both India and China are interested in sustainable economic development, which could serve as a platform for engendering cooperation. They could collaborate on research into the impact of climate change on the Himalayan glaciers. This can be built on top of the MOU to cooperate on climate change issues that was signed between the two sides in 2009. Such cooperation could be further extended and given greater substance by bringing in expertise from both sides.

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Towards Collaborative Transboundary River Governance

Brahmaputra Dialogue Initiative.....

Transboundary rivers are those which crosses political or geographical boundaries, within a nation or internationally, and act as a source of potential growth and development by creating hydrological, social and economic dependency among the basin communities. Trans-boundary waters (TBW) are a critical, non-substitutable resource, which figures prominently in all continents and supports more than 70% of the world's population (Wolf et al., 1998). Managing such profound cross-state resource can pose as a potential security challenge in the current times. Therefore cooperation and collaboration among the riparian nations is a necessity, despite the existing political contention, for effective TBW governance.

Among South Asian rivers, the Brahmaputra is the principal arm of the Ganges-Brahmaputra-Meghna systems. The Yarlung Zangbo/Brahmaputra/Jamuna (hereafter referred as Brahmaputra River Basin) is one of the critical trans-boundary river systems, including four riparian countries —India, China, Bhutan and Bangladesh. This basin constitutes a populace of 130 million, where in more than 40% reside under poverty. The basin is unique, considering its size, annual drainage, sediment load, hydropower capacity, endemic biodiversity and wildlife. Although it is riddled with physical and cross-boundary governance challenges, there are many signs of on-going cooperation: flood season data sharing between India and China; cooperation on navigation between India and Bangladesh; hydropower development collaboration between India and Bhutan.

Brahmaputra dialogues process since 2013

Dialogues are considered a best practice to enable co-management of the river resources, jointly mitigate disasters, address development and livelihood issues. An inclusive dialogue process can help to build capacity of multiple stakeholders through sharing of knowledge and information related to the various aspects of TBW management. For dialogues to be effective, it has to be multi stakeholder, multilateral and gender sensitive so that voices of all the concerned stakeholders are represented (Brouwer et al., 2016).

Addressing the complexity of transboundary governance, SaciWATERS initiated a dialogue process in 2013 for the River Brahmaputra through the project titled 'Transnational Policy Dialogue for Improved Water Governance of Brahmaputra River'. This was a first of its kind in the basin. The objective was to understand the issues of the region, its challenges, and means for fostering cooperation across the boundaries for better governance. SaciWATERS along with IIT-Guwahati (IIT-G), Bangladesh University of Engineering and Technology (BUET) and The Asia Foundation initiated a bilateral dialogue between India and Bangladesh in 2013.

Since then, the dialogue has progressed to Phase II and now currently in Phase III, expanding to eight partner organisations, across four riparian countries of the Basin – in a multilateral dialogue on river basin co-management. The objective now has expanded to include multilateral and multi-stakeholder dialogue process among the riparian states and nations. Through various country and regional level dialogues, the process has grown from track 3 to track 1.5 stakeholders participating in these deliberations. In the current phase (Phase-3), efforts are exerted to build a two-way capacity building process engaging community representatives and bureaucrats. It also seeks to enhance gender balance by empowering women to contribute to dialogues and bring out local women's narratives to better inform decision-making process regarding TBW issues.

Achievements since 2013

Brahmaputra Dialogue has been successful in bringing together track 3, 2 and 1.5 diplomats from India, Bangladesh, and Bhutan; and influential academicians from China on one platform. The dialogue has provided a space for multi-level actors and stakeholders to interact and share

views, which would have not been possible otherwise. One of the major achievements of the project has been the recognition of the importance of a dialogue in the Brahmaputra Basin. Further, this initiative has generated a demand from the stakeholders for the continuation of the dialogue so as to create a pathway for the formulation of a forum on Brahmaputra Basin management. It has built relationship between departments and CSO's across borders that pave way for cooperation. It has shaped consensus on the key challenges being faced at local, state and national levels. Three years of dialogue helped in realising that it is imperative to understand and acknowledge the existing cooperation within the basin. The project has attempted to place a greater focus on the identification of avenues of cooperation. Brahmaputra Dialogue initiative is steadily contributing towards building collaboration among the riparian nations of China, India, Bhutan and Bangladesh for effective TBW governance.

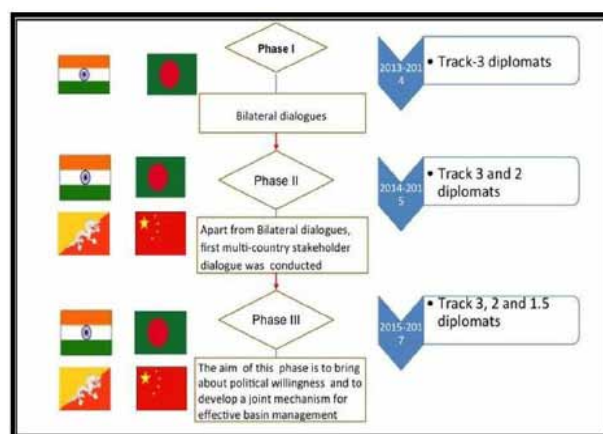


Fig. 1. Transnational Policy Dialogue for Improved Water Governance of Brahmaputra River- Phase progression

Way forward

Addressing the concerns of inclusion and capacity, the way forward looks to involve and build capacity of the stakeholders, both women and men, both CSO's and bureaucrats for decision making process to become more gender sensitive. Although it is difficult to remove power asymmetries, the project through such dialogue initiatives is attempting to encourage the basin hegemon to work towards a holistic and sustainable management of the river basin. River basin management is an intricate issue, requiring effective two-way communication and dialogues. Dialogues, however are a slow and deliberate process. The process requires time for building consensus towards inclusion and optimal agreements. This effort while slow is steadily building foundations for long-term relationships and paving the pathways for cooperation towards effective management of Brahmaputra River.

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India-China Transboundary Water Cooperation

Challenges and Opportunities.....

The mighty Himalayas are the home 10 major rivers of the region. The Brahmaputra river has a total length of 2,880 kilometres and is the 22nd longest river in the world, its total drainage area is 5,73,394 square kilometres, and is shared by China, India, Bhutan and Bangladesh as co-riparian basin countries. The Brahmaputra is the lifeline for communities living along its banks.

The Brahmaputra is truly a frontier and trans-border river which has seen little conversation or dialogue among its co-riparian countries. Riparian communities have learnt to live in harmony and move along the meanders of the mighty river over centuries. One of the popular composition, asks the mighty Brahmaputra the reason for its quiet and unbounded flow, amidst the suffering and pain of the people living by its banks. This song can be re-contextualized in the backdrop of the great uncertainty and fears among the communities living in the Brahmaputra river basin. The fears about possible conflict over the trans-border waters of the Brahmaputra in the future stems from the lack of conversation between the riparian countries and sub-national stakeholders, and this feeds into the hype and hysteria of unilateral interventions on the river.

The way forward is to bring about a larger understanding of rivers in this frontier space through joint research and monitoring, and generate a trans-Himalayan consensus on utilizing shared rivers in the region, and this will require a riparian leadership role by both China and India. Lower riparian anxieties can only be allayed through a framework of engagement and cooperation and India must push for more that the current Expert Level Mechanism with China.

At a time when rivers are likened to mere 'taps' by nation states, which they imply can be turned on and turned off, across borders to fulfil strategic objectives, we need to think about the larger ecology of the source of such trans-border rivers. The ability to negotiate successful trans-border arrangements for mutual benefit depends on how we integrate our core national development interests with a measure of ecological sense. China and India need to engage in sustained dialogue, and the Trans-Himalayan Development Forum can be a good platform for multilateral engagement of nations sharing Himalayan rivers.

The increased understanding of the Brahmaputra through a mix of modern research methods and traditional community-based knowledge systems is central to any dialogue being meaningful between and within the riparian countries. An emphasis on dialogue, multilateralism and cooperation will dispel the prevailing notions of conflict. The layers of understandings of the Himalayan ecosphere in a time of development rush by nations has to be nuanced in a combination of strategic foresight and ecological caution.

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The Brahmaputra River, termed as a moving ocean, is an antecedent snow fed river which flows across the rising young Himalayan range. Geologically, the Brahmaputra is the youngest of the major rivers in the world. The Brahmaputra river basin is the principal drainage of the North East India which flows across unique geo environmental and bio-physical settings with numbers of tributaries and sub-tributaries having local, regional and international ramifications. The basin is thickly populated and disaster prone and does not have any control throughout its journey. Management of such an unique river basin is not only complex but also a gigantic task. With advances in the scientific understanding of river eco-systems and long term river basins scale process, new river management approaches need to be developed that allow for integration of flood-erosion management and water resources development objectives with protection and conservation of the riparian and flood plain ecosystems.

Brahmaputra is the one among the mightiest rivers of Asia. It is a transboundary river. River Brahmaputra is called Yarlung Tsangpo in Tibet. It emerges from Angsi Glacier, on the northern side of the Himalayas in Burang County in southwestern part of Tibet Autonomous Region (TAR) at an altitude of 4877m. It flows, through southern Tibet in easterly direction for a longer length, at an average height of 4000m at its easternmost point, the river bends around Mount Namcha Barwa and forms the Yarlung Tsangpo Canyon. The total length of Brahmaputra River is 2906 km and the river drains an area of 5,80,000 sq km.

Brahmaputra is most challenging Transboundary river which has not been managed in its truest perspective for sustainable development in the riparian countries. It is highly essential to have a pragmatic approach with international consensus for co-management of this river basin for mutual benefit among the shared countries. Various National and International countries are working to create a dialogue /consultation process to evolve a rational and acceptable approach for solving the common problems of Brahmaputra river basin and to achieve the goal.

In order to design sustainable solutions for flood management and water resources development for a complex river system like Brahmaputra it is imperative to ensure that management approaches and technical decision making are grounded in a good understanding of the nature to balance the developmental process particularly to ensure water security for the future.

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Understanding China's Transboundary Water Policies

Major Gaps.....

While the developed countries have largely been able to successfully manage their shared waters, transboundary water management is still very problematic in the developing world, especially in Asia, which is home to over 60% of the global population and many of the most water-stressed countries. As far as transboundary water management in Asia is concerned, China's role is vital. Sharing 112 international rivers and lakes along its southwest, northwest, and northeast borders and being home to most of Asia's great rivers that flow into 18 downstream countries. China is the most important upstream country for transboundary water and ecological security in Asia. This geographic reality makes the transboundary water resources and corresponding environmental issues key components of China's international and regional relations.

Despite the critical importance of China in managing transboundary water conflicts in Asia, China's policy and practices towards issues related to the shared waters has been inadequately researched and thus understood. Most of the academic papers and journalist articles tend to most of the academic follow the realist approach to examine China's practices towards the Transboundary Rivers, and unanimously argued describe China as a malevolent hydro-hegemon. While the existing research has significantly enriched our understanding of the transboundary water issues both in general and the Chinese context, there are still several significant research gaps which deserve further studies.

First, the most common problem in the limited studies which conceptualize China's approaches to transboundary water issues tends to neglect the uniqueness of each river basin or river. Without fully comprehending the key differences of each river basin, cross-comparison of China's behaviors at each river basin could easily generate faulty conclusions. In the Chinese context, transboundary rivers can broadly be divided into two groups. One group includes cross-border rivers with China at the upstream. Nujiang-Salween River, Yarlung Zangbo-Brahmaputra River, Yuanjiang-Red River Ganges River, Indus River, Lancangjiang-Mekong River and Irtys River belong to this group. The other group consists of border rivers, cross-border rivers with China at downstream and mixed rivers. Most of the transboundary rivers in the Northeast region are either border rivers or mixed rivers, including most notably Amur, Yalu, Tumen River. Although in most cases, China is located at the upstream, there are a few rivers where China is at the downstream. For instance, China is at the downstream of the Kherlen River, which is originated from Mongolia. The Ili River is a much more complicated case. The biggest source of Ili river-Tekesi River is originated from Kazakhstan and another important tributary of Ili River is Khorgos river which serves as the 150 km border between China and Kazakhstan. These groupings will be helpful in analyzing the degree of vulnerability from China's more vulnerable when it is located at the downstream of a particular transboundary river and over a border. This does not only due to water-related issues but also because changes in the river course will affect national sovereignty. And the likelihood of conflicts between China and neighboring countries will be affected by four key factors, including the degree of water scarcity (including other importance aspects of water), the extent to which water supply is shared by more than one region or state, the relative power of the basin states, the ease of access to alternative fresh water resources.

Second, another major problem in the majority of the transboundary water management studies has been the often implicit assumption that the state is the sole or primary actor in international relations. Earlier studies of transboundary water governance have focused on inter-state relationships, taking state actors as the key players in international waters affairs. While the critical role of the state in defining formal governance structures and even informal interaction in transboundary

water issues should not be overlooked, the emphasis of the state's role is nonetheless inefficient. Similarly, in the case of China, scholars and security analysts who have taken notice of the critical role of China in transboundary water management issues in Asia often treat China as a unitary actor and describe everything that China has undertaken in its relations with the region as part of China's strategic calculation. However, transboundary water governance should not be monopolized by state actors, but rather include aspirations and opinions of non-state actors living in the basin.



Photo : Swapnali Bora

At national level, the transboundary water management is highly fragmented, hence, there is not a single lead agency responsible for all the issues relating to China's transboundary water. Sub-national governments could be of equal importance to central government bureaucracies, particularly in the field of water resource management and overall interactions with neighboring countries. Apart from state actors, the role of other players, such as dam builders, NGOs, and scholars should not be neglected as well. The subnational actors, such as the local government, NGOs, state-owned enterprises, can influence the country's practices at the transboundary water management from three major aspects: 1) the degree of utilization of transboundary rivers, 2) China's overall relationship with neighbouring countries, and 3) the implementation of central government's policy.

Third, previous studies on China's approach towards the transboundary water issues has been framed within the conflict-cooperation spectrum, focusing mainly on the central government's willingness and practices in formulation of an international agreements or treaties. The separation of conflicts on the one end of the spectrum and cooperation on the other end means that "the less ugly faces of conflict and less pretty faces of cooperation are overlooked". In addition, the existence of an international water agreement is also a poor indicator of the status of cooperation between two countries over shared water resources. Even when international water agreements are signed, it does not mean contracting states are actually cooperating and the lack of agreement does not mean riparian states are fighting. In other words, the presence of a treaty does not automatically translate into behavioral altering cooperation. Therefore, a more robust and nuanced understanding is required for analysis and for policy making to reflect the multifaceted reality of transboundary water conflict and cooperation in China. Even more importantly, it is necessary to highlight that cooperation in and of itself is not the desired end for third-world riparian governments, as for China and its neighbours; rather, cooperation need to be perceived as the basis for proceeding with the development of water resources encompassed by basins. Accordingly, the mere existence or depth of water agreements is a poor indicator of the degree of water interactions between two China and neighboring countries which, instead, needs to be measured against the larger economic ties between countries at a particular river basin.

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Lessons from Civil Society Engagement on Water

South Asia.....



Photo : Subrat Sharma

South Asia's transboundary river systems i.e. Indus, Ganges and Brahmaputra - collectively support over 700 million people across the sub-continent. Despite a number of formal bilateral mechanisms that mediate water allocation and use, the management of these rivers has for the most part been abysmal. Given the complexity of transboundary water management, this is perhaps not surprising. However, the approach to water management in South Asia is also a large part of the problem. Governments and state agencies at a national level continue to play a dominant role in decision-making processes associated with transboundary water management (TWM). From a disciplinary perspective, the approach to TWM is overwhelmingly technical focused largely on designing engineering solutions to manage what are very large, complex and inter-dependent eco-systems. Basin level or regional planning of river systems, while recognized in theory, in principle has yet to be actualized either at a national or transboundary level. In this closed environment, there is limited scope for alternative perspectives to percolate into the system.

Greater civil society engagement on transboundary water governance issues is vital to ensure a more comprehensive and nuanced approach to policy making and planning on water, particularly to effectively address its social and ecological dimensions. Given the fact that there are often multiple and diverse actors with differing interests and stakes in the use and management of a water resource, civil society organizations (CSOs) have the capacity to navigate these differences and bring different actors and perspectives together to the negotiating table. This in turn can help in informing and providing legitimacy to policy and planning processes and reduce conflicts. As mediators, CSOs also serve to bridge the gap between state and non-state actors; highlighting key issues and concerns from a grassroots and community perspective and at the same time playing a constructive role to build local support for government policies and programs. Last, but not least, civil society engagement is critical to bringing in the voices of the excluded and marginalized in particular women, girls and indigenous communities that are not only the most vulnerable but also at the frontlines of climate change linked disasters and impacts.

Engaging with civil society on regional water governance issues is however no easy task. Despite many efforts, the space for engagement and representation of civil society voices at key national and international forums remains limited. At a regional level, civil society engagement and collaboration on transboundary water in South Asia has been equally challenging. The lack of regional integration; weak land, sea and air connectivity, not to mention the absence of integrated mobile and banking services has made it very difficult for CSOs to work collaboratively across borders to share experiences and exchange best practices. However, there are signs of increasing openness and

willingness both within and outside government for engaging with civil society on an issue as complex as transboundary water.

Since 2011, The Asia Foundation has supported civil society organizations in South Asia to work collaboratively to address the region's complex water resource challenges. Through support to CSOs working in India, Nepal and Bangladesh, the Foundation has been working to broaden discussions on water beyond the state, and create multi-stakeholder platforms for dialogue on water in the region. The Foundation's programming has focused on convening and supporting multi-stakeholder and multi-country dialogues and platforms on water; supporting media training and exchange programs for more informed reporting on transboundary water issues; and initiatives to enhance the availability of data and information on water in the region. Some of the key lessons learned from engaging with civil society on water issues in South Asia have been first of all to recognize the importance of engaging with governments at different levels. Any effort at bringing about reform will only succeed where there are concerted efforts to engage with bureaucrats, technocrats and water professionals at different levels i.e., district, state and national. Second; access to credible data and information is critical to inform not only government interventions but also to enable civil society to develop credible counter-narratives. Third, engaging with the media is critical to busting many of the myths that surround the transboundary water discourse in the region. The Asia Foundation along with the Third Pole Project has supported a number of media fellowships and study tours with environmental journalists in India, Nepal and Bangladesh in order to encourage balanced and informed reporting of transboundary water issues. Fourth, moving beyond dialogue and policy level engagement; where civil society engagement on cross-border issues is perhaps of most value, is where it serves to highlight the interests and needs of communities that are dependent on and most impacted by changes in transboundary river regimes. Today, across South Asia, many organizations are at the forefront of researching, analysing and reporting on the diverse impacts that climate change for example, is having on the livelihoods of people dependent on rivers. Ensuring that the lessons from their work is appropriately channelled into the policy and planning process at a national and regional level is critical to reforming the TWM regime in South Asia.

To conclude, much of the debate on transboundary water issues in countries in the region, has been led by governments with limited space for civil society engagement. However, there is sufficient evidence to suggest that civil society engagement is crucial to a more productive, collaborative and constructive discussion on the issue of water security. Specifically, at a national level, civil society organizations can serve as important conduits for fostering dialogue, highlighting critical issues around environment, biodiversity, livelihoods and gender, and linking grassroots issues to national policy making processes. At a transboundary level, through their ability to engage, network and convene across borders, civil society organizations can engage with a range of stakeholders, and foster dialogue processes that support and bolster formal negotiations. In this way, civil society can serve to highlight critical issues on water security, foster collaborative relationships and partnerships that transcend borders and in so doing deescalate tensions around regional cooperation on water.

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Bridging knowledge for Transboundary Water Cooperation

Informing Exchange in the Indus Basin.....

The Indus, one of the largest transboundary rivers in the world, is a complex system ranging from high-altitude glaciers in the Himalayas to vast agricultural plains reaching down to the Arabian Sea. It also supplies water to the largest contiguous irrigation system in the world. Encompassing parts of Afghanistan, China, India and Pakistan, the entire Indus River Basin supports a population of some 300 million people, the vast majority of which live in Pakistan. From recent interviews conducted by the International Water Management Institute (IWMI) with stakeholders across the basin, it emerged that there was a lack of wider understating of changes taking place in the basin, including challenges related to climate change and other 'multiplier' issues such as environmental variability and vulnerability, and the impacts of rapid demographic change.

A basin which has complex geopolitics, these challenges continue to hinder development potential for the basin population, exacerbating social vulnerabilities and risks from natural and man-made hazards. A prevailing 'trust deficit' exists between riparian countries, in part fueled by a fragmented knowledge environment and lack of a 'common core' of accessible scientific information, which can form the basis for rational public debate and sound decision making.

To address this identified gap, IWMI developed an Indus Basin Knowledge Platform (IBKP) in late 2016. Forming a one-stop knowledge portal to support public access to scattered but key information on the Indus River Basin, our fundamental concern (and conviction) is that easier access to high quality knowledge is a necessary – though admittedly not a sufficient – condition to improving the capacity of those tasked with understanding, responding to (and reporting on) the key development challenges in the basin, be they agricultural development, managing resource scarcity (and over-abundance in relation to flooding) and assessing how best to respond rationally and equitably to the impacts of future climate change on the 'third pole' in the Himalayas to sea level rise on the Indus Delta, and the huge surface water and groundwater resources in between. Our premise is that informed decision making is a key starting point for more successful cooperation at all levels, from intra-national to international transboundary and wider regional levels.

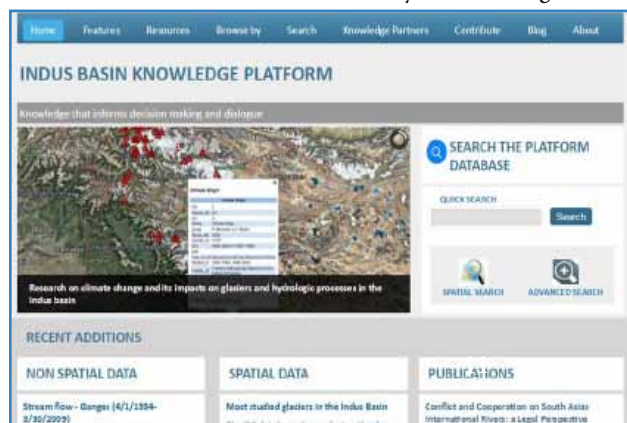


Fig. 1: The Indus Basin Knowledge Platform Homepage

Hosted by IWMI (www.iwmi.org), IBKP (www.indusbasin.org) is explicitly designed for policy makers, development practitioners, academics, civil society organizations, the media and others. A key feature of IBKP is the broad range of data and other forms of information that is made available, allowing users to establish more multi-dimensional understandings of key development challenges in the basin, including, for instance, the relationship between climate change and potential for impacting future flows, on population growth and demand for the resource, and on environmental impacts of growing use on water quality issues. To do this, IBKP brings together material

from multiple disciplines, including spatial and time series biophysical datasets and maps, social science data, academic publications and policies, strategies and legal instruments from local analyses to regional scale datasets. Also included, where relevant, access to different types of media from blogposts to video, whilst continuing all the time to strive for neutrality and impartiality given the acknowledged challenge of avoiding any form of political or geographic bias. IBKP also provides a dedicated space for partners and others to showcase past or ongoing initiatives, and/or to inform others of planned activities.

Visitors to IBKP can access information through different search options from broad searches to more specific information needs on key topics and/or geographic locations within the basin. Search results are broken down by tab into a range of information types, from datasets to publications and multi-media. Biophysical and socioeconomic data are directly downloadable where intellectual property rights allow for this. Where restrictions to direct access apply, the user is directed to the source site or other location.



Fig. 2: The categorized display of search results

More information on IWMI's work on the Indus

IBKP is part of a program titled 'Informing change in the Indus Basin' funded by the Department for International Development (DFID). Led by IWMI, the program supports cooperation and improved decision making in the Indus Basin. It does this through improving the way knowledge is managed and shared in the basin, supporting new forms of analysis and enhancing dialogue at different levels and through different channels across the basin.

For further information on IBKP and to become part of this exciting initiative, email Indus.IWMI@cgiar.org or visit the website (www.indusbasin.org).

Read more on IBKP: <http://scroll.in/article/822729/can-a-new-knowledge-platform-save-the-indus-basin>.

IBKP was launched for feedback and comment during World Water Week in Stockholm and at the International Rivers Symposium in Delhi, both in September 2016. The IBKP management team is continuously looking to add other interested knowledge partners to the growing constituency of individuals and institutions interested in the goals and objectives of providing accessible, impartial access to key knowledge on this critical and unique river system.

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Innovations/Discoveries in Science (October- December, 2016)



News Section.....

• DNA analysis of seawater detects 80% of fish species in just one day.

Japanese research group has used a new technology that identifies multiple fish species populating local areas by analyzing DNA samples from seawater, and proved that this method is accurate and more effective than visual observation. Until recently, marine surveys of fish species relied on diving or capturing methods that classified fish based on appearance. A new solution to the survey issue has recently drawn attention: environmental DNA metabarcoding, a method which can simultaneously detect multiple species fish in multiple areas during a short time period. This method identifies the fish species through collection and analysis of DNA released by fish in seawater (environmental DNA, or eDNA).



• Sticky gels turn insect-sized drones into artificial pollinators

As bees slip onto the endangered species list in USA, researchers in Japan are pollinating lilies with insect-sized drones. The undersides of these artificial pollinators are coated with horse hairs and an ionic gel just sticky enough to pick up pollen from one flower and deposit it onto another. Far from replacing bees, the drones' designers are hopeful that their invention could someday help carry the burden that modern agricultural demand has put on colonies and in turn benefit farmers.



• New species of catfish discovered in Myanmar

The new catfish, scientifically named *Oreoglanis hponkanensis*, has a moderately broad and strongly depressed head and body, and small eyes. The species is predominantly brown in colour, with light yellow belly and several yellowish patches across the body. Noticeable are also two round, bright orange patches in the middle of the fin.



• Evolution of a functional head joint in deep-sea fishes (Stomiidae)

Barbled dragonfishes, deep-sea fishes in the Stomiidae family, have a flexible connection between their first vertebra and the back of their head, a characteristic that is unique among deep-sea fish. The researchers found that, when the fish is in resting position and not elevating its head, this flexible rod has an additional ventral sheath that embraces the back of the head like a socket, but that when these fish open their mouths, the extra sheath gets stretched out and the bottom part of this rod is exposed, potentially allowing the fish to open its mouth up to 120 degrees.



• Scientists confirm dorado catfish as all-time distance champion of freshwater migrations

An international team of scientists has confirmed that the dorado catfish (*Brachyplatystoma rousseauxii*) of the Amazon River basin holds the record for the world's longest exclusively freshwater fish migration, an epic life-cycle journey of approximately 11,600 kilometers (more than 7,200 miles).



• New species of Pika discovered in Sikkim Himalayas

Scientists have discovered a new species of Pika (a mammal belonging to the rabbit and hare family in the Himalayas in Sikkim). It has been identified as '*Ochotona sikimaria*'. It is quite distinct from all other Pika species based on the faecal pellets and tissue samples. *Ochotona sikimaria* Pika species looks similar to the Moupin Pika, however genetically it is completely different.



• Scientists studying dolphins find Bay of Bengal a realm of evolutionary change

Marine scientists have discovered that two species (*Sousa chinensis* and *Tursiops aduncus*) of dolphin in the waters off Bangladesh are genetically distinct from those in other regions of the Indian and western Pacific Oceans, a finding that supports a growing body of evidence that the Bay of Bengal harbors conditions that drive the evolution of new life forms, according to a new study. The findings indicate that there is a connection between the presence of these distinct populations of dolphins and the unique oceanic habitat that is found in the Bay of Bengal. The combination of a biologically rich yet isolated seascape could be driving speciation, or the emergence of new species.



• Multi drug resistant bacterium isolated from chicken

Researchers from Hyderabad have isolated *Helicobacter pullorum* bacterium in chicken that may be source of transmission of the multidrug resistance pathogen to humans. This is the first evidence on prevalence and isolation of *H. pullorum* multidrug resistance bacterium from broilers and free-range chicken sold in Indian markets.

• IGKV develops a high protein enriched rice variety

A protein-enriched rice variety has been developed by the researchers of Indira Gandhi Krishi Vishwavidyalaya (IGKV). The new developed rice variety has over 10 per cent protein content, which is three per cent more than what is found in any popular variety and has 30 PPM zinc content.

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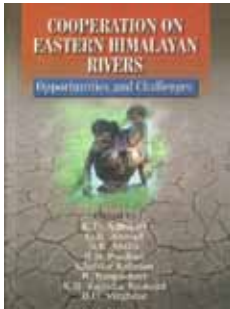
<http://www.careerride.com>

<http://novatata.blogspot.in>

<http://www.lsu.edu>

<http://www.sci-news.com>

Books on Water Resources



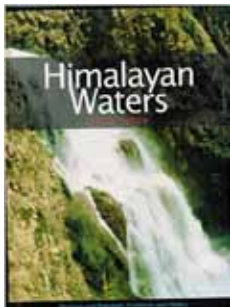
Cooperation on Eastern Himalayan Rivers: Opportunities and Challenges

This Book Presents The Nine Studies Conducted Jointly by Bangladesh Unnayan Parishad (Bup), Dhaka, Centre For Policy Research, New Delhi And Institute For Integrated Development Studies (Iids), Kathmandu As A Part Of Phase Ii Of The Initiative Launched By The Three Institutions In 1990 Focusing On Regional Cooperation In The Harnessing Of The Eastern Himalayan Rivers.

Authored by: K.D. Adhikari, Q.K. Ahmad, S.K. Malla, B.B. Pradhan, K. Rahman, R. Rangachari, K.B. Sajjadur Rasheed & B.G. Verghese

Published by: Konark Publishers | Year: 2000

ISBN-10: 8122005713; ISBN -13: 978-8122005714



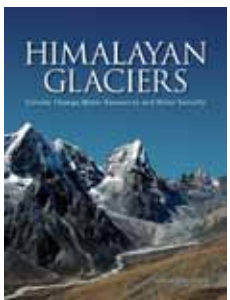
Himalayan Waters: Promise and Potential Problems and Politics

This is an excellent and beautifully illustrated handbook on everything anyone may want to know about Himalayan waters but is afraid to ask. Karakoram waters are also appropriately included for good measure. Both the author, Bhim Subba, and the publisher, Panos South Asia, Kathmandu, deserve much credit for bringing out this handsomely produced volume written for the lay person with graphs and charts that provide telling international and regional comparisons.

Authored by: Bhim Subba

Published by: Panos South Asia | Year: 2001

ISBN-10: 9993330477; ISBN-13: 978-9993330479



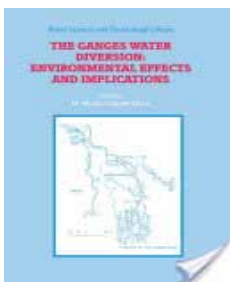
Himalayan Glaciers: Climate Change, Water Resources, and Water Security

This report emphasizes that social changes, such as changing patterns of water use and water management decisions, are likely to have at least as much of an impact on water demand as environmental factors do on water supply.

Authored by: Hydrology, Climate Change, and Implications for Water Security Committee on Himalayan Glaciers, Board on Atmospheric Studies and Climate, Division on Earth and Life Studies, National Research Council

Published by: National Academies Press | Year: 2012

ISBN-10: 0309260981; ISBN-13: 978-0309260985



The Ganges Water Diversion: Environmental Effects and Implications

This book deals with environmental effects on both sides of the border between Bangladesh and India caused by the Ganges water diversion. This issue came to my attention in early 1976 when news media in Bangladesh and overseas, began publications of articles on the unilateral withdrawal of a huge quantity of water from the Ganges River through the commissioning of the Farakka Barrage in India.

Authored by: M. Monirul Qader Mirza

Published by: Springer Science & Business Media | Year: 2006

ISBN-10: 1402027923; ISBN-13: 978-1402027925

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Coverage & Indexing



Forthcoming events

National

5-7 JANUARY 2017

“Rural Habitat, Institutions and Development: Changing Nature and Challenges”

Venue: Jaipur, Rajasthan, India

24 JANUARY 2017

“International Conference on Computational Mathematics and Statistics”

Venue: Jaipur, Rajasthan, India

15-17 FEBRUARY 2017

“Transforming India 2030: Strategies for Sustainable Development Goals”

Venue: Lavale, Pune, Maharashtra, India

International

21-23 JANUARY 2017

“3rd International Conference on Environment and Bio-Engineering (ICEBE 2017)”

Venue: Bangkok, Thailand

8-10 FEBRUARY 2017

“8th International Conference on Environmental Science and Development (ICESD 2017)”

Venue: Frankfurt, Germany