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ORIGINAL PAPER

Pursuits of adaptiveness in the shared rivers of Monsoon Asia

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Abstract How water should be managed in Monsoon Asia is emerging as one of the core earth system governance challenges. In this article, we explore the politics around pursuits of adaptiveness in water management, emphasizing the major transboundary river basins draining the south and eastern Himalayas. We look at two main functions: storing, diverting and sharing water for periods of scarcity; protecting people and places from destructive floods. We find that the pursuit of adaptiveness will take place partly outside the range of human experience in a context of large differences in exposure and vulnerabilities, disparate interests and unequal power. Anticipatory policies and actions to adapt and improve adaptive capacity to the transboundary impacts of changes in water-use, land-use and climate on water resources and services are still in their infancy; but several problem-framing discourses are emerging that have longer-term implications for water governance. It is not yet clear how these competing policy-frames will evolve in Asia. Much will depend on how systems of water governance develop. Public scrutiny of how governments in Asia plan to adapt to climate change in the water sector—on how risks of not enough and too much water are dealt with—will need to continue to help sort out those projects and strategies which are driven primarily by political benefits from those which actually contribute to building adaptive capacities and maintaining social-ecological resilience.

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Keywords Climate change · Water governance · Monsoon Asia · Transboundary rivers

Abbreviations

BDP Basin Development Plan
GWT Ganges Water Treaty
IWT Indus Water Treaty
MRC Mekong River Commission
NRLP National River Linking Project

1 Introduction

How water should be managed is emerging as one of the core earth system governance challenges (Biermann 2007; Pahl-Wostl 2007; Biermann et al. 2010). Nowhere are the drivers so critically poised as in the Himalayas, a major influence on the Asian Monsoon (Bohner 2006), home of Asia's water tower (Xu et al. 2008) and source of major rivers that support more than 1.3 billion people (Fig. 1). Water demand has grown alongside population and the intensification of agriculture. Dams and water diversions have multiplied to service new irrigation areas and hydropower cascades. As agriculture has expanded and intensified in some areas, in others tree cover is now re-expanding in part because of efforts to restore watershed services or for expansion of industrial tree crops (Xu et al. 2007; Ziegler et al. 2009). Adapting to the profound changes in hydrology already underway and anticipated is going to be a major challenge at several levels.

First, the pursuit of adaptiveness[1] will take place partly outside the range of human experience: we have entered the anthropocene era (Crutzen and Stoermer 2000). Climate change is already affecting snowfall, precipitation and glaciation. The highlands of Asia are getting much warmer than the global average (IPCC 2007). Scientific studies suggest that glacier-fed rivers will swell for a few decades as glaciers and snow packs melt, but eventually many of those flows will slow to a trickle (Barnett et al. 2005; Rees and Collins 2006). Significant uncertainties and spatial heterogeneity in glaciation processes add to the complexity of forecasting future changes on water resources (Bagla 2009). Large-scale changes to land-use, through their impacts on soils and land cover, will also impact on hydrology and interact with climate-related changes (Costa-Cabral et al. 2007; Ma et al. 2009; Västilä et al. 2010). Future patterns of precipitation across most basins remains highly uncertain. Uncertainties about social responses to policies are even greater with prospects of water being a trigger for both more conflict and more cooperation (Miller 2008; Zeitoun and Mirumachi 2008). These uncertainties are compounded by differences in norms and values with respect to what are acceptable risks. New and uncertain risks abound and have become the normal context in which decisions about water are made.

Second, the pursuit of adaptiveness must launch from a context of heterogeneous exposure and vulnerabilities, disparate interests and unequal power. Geographically, latitude, continentality and topographic features affect climate and local weather patterns, rendering some locations almost permanently wet, others dry, and yet others highly

[1] Adaptiveness describes how well the activities undertaken by (or on behalf of) a social group in response to actual or anticipated environmental changes have, or are likely to, benefit that group in a changed environment.

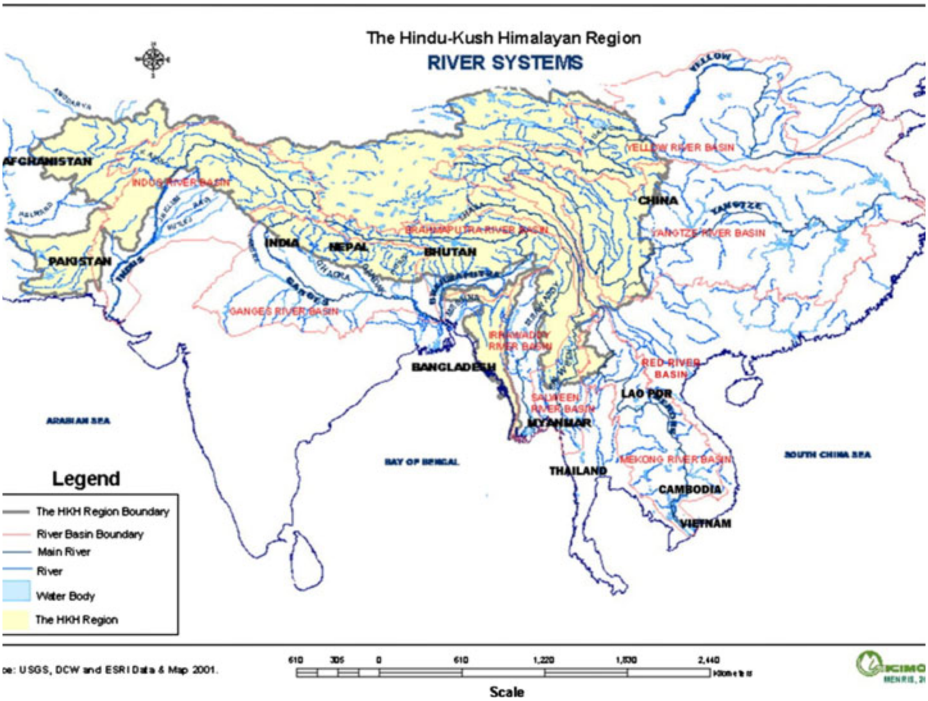

Fig. 1 Major river basins and the water tower in Monsoon Asia

seasonal, which further determines the ways of life, land uses and livelihood activities of local people (Xu et al. 2009). Differences in access to critical social processes (Gupta and Lebel 2010) often underline existing water insecurities—whether services like water supply for health, ecosystems and production or hazards like flash floods, pollution and droughts (Grey and Sadoff 2007). Climate change will make the pursuit of water security harder. If the rights, needs, burdens and risks of marginalized and vulnerable groups are excluded from decision-making about adaptation policies, insecurities could be exacerbated by not only the original threat, but also the 'solutions' (Lebel 2007; Paavola and Adger 2006).

Third, the pursuit of adaptiveness is likely to produce side effects and redistribute risks (Lebel 2007). Large storage dams and diversions to secure falling dry season supplies of water for one country or group may have major implications for local communities that need to be resettled or find alternative livelihoods and other water users downstream including fishers (Molle et al. 2009). Diversions and storage to secure supplies for irrigation or hydropower may build adaptive capacities of one location but undermine it at other locations. Water sharing agreements, therefore, may have to be revised (Draper and Kundell 2007). Diversions of high flows in the wet season to protect built infrastructure and human settlements may increase risks for other rural livelihoods and settlements without sufficient compensation (Lebel and Sinh 2009). The pursuit of adaptiveness can create winners and losers, shift risks and burdens and reinforce existing inequalities (Thomas and Twyman 2005).

The processes involved in, and outcomes of, pursuits of adaptiveness can be conceptualized as a chain of reactions to risks (Fig. 2). Water management responses—policies,

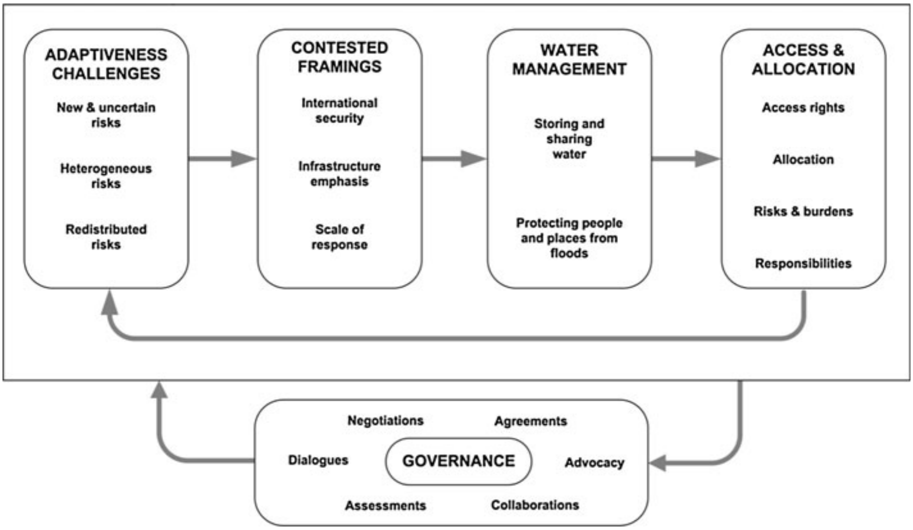

Fig. 2 Conceptual framework for exploring, understanding and explaining policies to build adaptiveness in transboundary river basins

projects and practices to store and share water and protect places and people from floods—are the outcome of contested framings about how to respond to risks, for example, involving different emphasis on ecological sources of resilience or needs for certainty prior to taking actions. The outcomes of water management actions include rights of access and the allocation of benefits, risks, burdens and responsibilities, which, in turn, have consequences for future risks (Fig. 2).

Diverse governance processes influence actual and perceived risks, framings of the adaptation problem, water management actions and outcomes. Assessments, for example, can be important for identifying new risks. Dialogue can help stakeholders learn about each other's risks. Advocacy on behalf of vulnerable and disadvantaged groups may help reduce unfair redistribution of risks.

In this article, we explore the politics of adaptiveness emerging around water management in the larger, transboundary, river basins draining the south and eastern Himalayas (Fig. 1). Our core research question is: *How have the way that risks are framed influenced water management in transboundary river basins?*

The set of transboundary rivers draining the south and east Himalayas provide a diverse range of biophysical and socio-political contexts. We focus our attention here on three basins: The Indus, Ganges–Brahmaputra-Meghna and the Mekong (Table 1). Glacial inputs, for instance, are particularly important for the Indus but less so for the other rivers. Histories of land-use conversion with their consequences for hydrology also vary with some locations having millennia of human modification and others more limited or relatively recent landscape transformations. The socio-political context for collaboration also varies among basins, for example, by numbers of countries involved and their geographical positions relative to each other. Although upstream–downstream relationships are invariably the main emphasis in transboundary discussions, there are other geometries as well. Lao PDR and Thailand share a long Mekong border. Several major river basins converge and link in the complex flood-prone delta of Bangladesh. Inter-basin transfers create other even more complex spatial relationships with respect to flows. The negotiation and content

Table 1 Major river basins discussed in this article

River basin	Basin area ('000 km^2)	Glacial melt in river flow (%)	Mainstream major dam infrastructure	Countries	Major international agreements (Countries)
Indus	1082	45	Y	China, Pakistan, India, Afghanistan	1960 Indus Water Treaty (I,P)
Ganges	1016	9	Y	Nepal, India, Bangladesh	1996 Ganges Water Treaty (I,B) 1996 Mahakali Treaty (I,N) 1996 Power Trade Agreement (I,N) 1966 Kosi Treaty (I,N)
Brahmaputra (known as Yarlungtsampo in Tibet, Jamuna in Bangladesh)	651	12	N	China, India, Bhutan, Bangladesh	Bilateral agreement for hydropower (I, Bh) Flood forecasting data sharing agreements (I,C) (I,B)
Mekong (known as Lancang in China)	806	7	Y	China, Myanmar/Burma, Vietnam, Thailand, Lao PDR, Cambodia	1995 Mekong Agreement (T, V, L, Ca)

I India, *P* Pakistan, *B* Bangladesh, *C* China, *Bh* Bhutan, *T* Thailand, *V* Vietnam, *L* Lao PDR, *Ca* Cambodia

of major international agreements often reflects these socio-political and biophysical flow contexts.

2 Storing and sharing water

Climate change could affect transboundary water sharing agreements (Miller 2008). In the past, historical flow records for a specific period could be used; in the future, this will get harder to justify as climate change affects flow regimes and capacities to project futures remain subject to significant uncertainties. Agreements will, therefore, need to be made adaptable—to changing climatic and maybe also other conditions. It should be easier to introduce such provision into new agreements than to modify those already in place and working (Draper and Kundell 2007). Among existing agreements those which respect 'grandfathered uses' may be particularly hard to adjust, whereas those based on percentage of flow may be easier, provided critical thresholds are not exceeded as partition remains even between parties (Draper and Kundell 2007). More problematic are agreements that are ambiguous about allocation and enforcement or negotiation procedures: these may unravel if climate change led to conflicts or loss of perceived benefits of cooperation (Miller 2008). In many cases, comprehensive agreements among riparian states and detailed allocation agreements are still far away. Here, more modest alternatives to strengthening cooperation are needed, that focus more on benefit sharing rather than just physical allocations and flows of water, for example, considering, power generation benefits, flood control, international trade and food security (Michel 2009; Sadoff and Grey 2005).

2.1 Ganges

The 1996 Ganges Water Treaty (GWT) between India and Bangladesh, like the Mahakali Treaty between Nepal and India, incorporates on paper widely recognized principles—like equitable and reasonable utilization, the obligation not to cause significant harm, communication and notification (Rahaman 2009). GWT came into force to address conflicts over water shortages after construction of the Farakka Barrage in 1975. What constitutes no harm in the treaty was left ambiguous. The basis for sharing is based on 40-year records (1949–88) for 10-day period averages (Rahaman 2009). The details of water sharing agreements (Tanzeema and Faisal 2001) between India and Bangladesh may need to be adjusted to take into account climate change. Snowmelt does not match when water demand is highest downstream suggesting a high sensitivity to climate variability (Subedi 1999).

As glacial melting proceeds, water flows in the Ganges river would increase in the short-term but in the long-term could drop by two-thirds (Sharma and Sharma 2008). Current withdrawals are already creating huge problems. Barrages in the Ganges River already divert as much as 60% of flows for large-scale irrigation. The Farakka Barrage built in 1975 just 18 km from the Bangladesh border greatly reduces average monthly discharges in some seasons. Glacier flows are most critical at the end of dry season (Sharma and Sharma 2008). The 1996 Ganges River Treaty includes provisions for releases to Bangladesh, which remains highly vulnerable to these diversions. With insufficient water to meet demand in both India and Bangladesh in the future, more serious conflicts could emerge. One solution being explored is for transfers from Nepal to Bangladesh through India (Bhaduri and Barbier 2008; Faisal 2002). Another is for building a barrage within Bangladesh. An assessment of water supply and demand impacts on flows to the Ganges Delta in Bangladesh suggests that the proposed Ganges Barrage could meet internal water demands to 2050 under likely climatic changes, but would be at risk if additional upstream diversions in India took place or climate change was more extreme in which case 'the consequences may be devastating' (Mondal and Wasimi 2007).

The politics between Indian states also compound the challenges and interact with international issues on the Ganges River. Within India, Bihar has already a strong sense of grievance that its interests in respect of the waters of the Ganges system have not been given due consideration (Iyer 2003). West Bengal only reluctantly agreed to the large allocations to Bangladesh under the Ganges Treaty. Neither state would look kindly upon any diversion of Ganges waters southwards (Iyer 2003). The century-old row over sharing of the river Cauvery's[2] waters, for instance, among the riparian states of south India—Karnataka, Tamil Nadu, Kerala and Puducherry, has not yet been fully resolved, despite a water sharing agreement finally brokered in 2007. Whenever conflicts become acute, proposals for a Ganges–Cauvery Link reappear in popular discourse despite likely high ecological risks and economic costs. Diversion of water from the Ganges would also have international implications. Bangladesh is likely to view such schemes with apprehension and raise objections. Under the India–Bangladesh Treaty of December 1996 on the sharing

[2] The Cauvery is one of the most important rivers of south India. It originates in the Kodagu district of the Western Ghats in the state of Karnataka and flows generally south and east through Karnataka and Tamil Nadu and across the southern Deccan plateau before emptying into the Bay of Bengal.

of Ganges waters, India has undertaken to protect the flows arriving at Farakka, West Bangal, 10 km from the Bangladesh border. Bangladesh would likely contend that a diversion of waters from the Ganges to the southern Indian rivers will not be consistent with that undertaking and that any stored water should be used for the augmentation of the lean season flows of the Ganges itself for being shared at Farakka, and not be diverted to other basins (Iyer 2003).

India has an even larger proposal on the table: the National River Linking Project (NRLP) which proposes a total 30 river linkages and 3000 storage structures and 14,900 km of canals to shift water to western and southern India including water from the Ganges and Brahmaputra to the Mahanadi basin (Amarasinghe et al. 2008; Mirza et al. 2008). The National River Linking Project was conceived in 1982 by the late Prime Minister Indira Gandhi. It is based on a questionable policy narrative that repeatedly paints the Ganges–Brahmaputra basin as having too much water and rivers in the south not enough. The plans lay dormant until 2002 when the Supreme Court of India in response to a public interest petition ordered the project be revived. The huge project raises many issues—displacement of people and environmental impacts and transboundary impacts with Nepal and Bangladesh (Amarasinghe et al. 2008). Key parts of the scheme, for example, depend on inundating areas in Nepal to store water with little clear local benefits. Reduced dry season flows to the Farraka dam and Bangladesh would increase threats of salinity intrusions (Mirza et al. 2008).

The proposed river links, despite the rhetoric, are not going to help with water scarcity problem in many drought-prone areas. Many dry areas are distant from major rivers and at higher elevations hard to serve with interlinkages. In these locations, adaptation to scarcity and climate change will have to be local, for example, through rainwater harvesting or watershed management. The contributions to flood mitigation are also likely to be small (Alagh et al. 2006; Singh 2003). Dr. Manmohan Singh, the present Prime Minister of India has sought to adopt a cautious approach to the interlinking of rivers project. The Congress General Secretary, Rahul Gandhi and Union Minister for Environment, Jairam Ramesh recently called the project an 'environmental disaster' (The Hindu 2009). The current opposition party (the Bharatiya Janata Party), however, continues to strongly support the project. Political factors play an important role in large water infrastructure schemes throughout Asia.

In April 2010, China officially revealed plans to build hydropower dams on the upper reaches of the Brahmaputra but claimed it would not have significant effects on flows downstream in India (The Economic Times 2010). The project itself has been speculated on and criticized for many years, in particular, out of concerns that it would lead to other major projects to divert water to arid areas in the southwest (Crow and Singh 2009). China and India do not yet have a water sharing agreement, and only recently began formal discussions on exchanging hydrological data.

Informal cooperation among experts in the Himalayan region has often preceded more formal intergovernmental discussions. A group of experts that met in January 2010 in Dhaka, for instance, issued the Dhaka Declaration on Water Security calling for a more transparent exchange of information on flows in the low flow season (BIPSS and SFG 2010). Concerns with potential impacts of climate change on water security were an important backdrop. Individuals that span expert and policy-making communities often play a crucial role in opening and maintaining these alternative channels of dialogue and cooperation building.

2.2 Indus

The 1947 Partition of the Indian subcontinent cut the Indus River system into two disrupting irrigation development. An understanding on water sharing between the two new countries was clearly necessary. The 1960 Indus Waters Treaty (IWT) brokered by the World Bank split six shared rivers three a-piece between the two countries rather than water flows in individual tributaries (Wirsing 2008; Zawahri 2009). The three western rivers (the Jhelum, the Chenab and the Indus itself) were allocated to Pakistan, and the three eastern rivers (the Ravi, the Beas and the Sutlej) were allocated to India. Restrictions were placed on India as the upper riparian (Iyer 2003). On the rivers allocated to Pakistan, India was not allowed to build major storage and run-of-the-river hydroelectric projects had to conform to particular technical stipulations (Iyer 2007). Restrictions were also imposed on irrigation development. There were also some restrictions placed on Pakistan, the lower riparian. There were also provisions regarding the exchange of data on project operation, extent of irrigated agriculture and so on. The treaty further mandated certain institutional arrangements: there was to be a permanent Indus Commission consisting of a commissioner each for India and for Pakistan, and there were to be periodical meetings and exchanges of visits between the two sides. Provisions were included for conflict-resolution: differences, if any rose, were to be resolved within the commission; if agreement could not be reached at the commission level, the dispute was to be referred to the two governments; if they too failed to reach agreement, the treaty provided an arbitration mechanism (Iyer 2003).

The treaty had acquired a reputation internationally as a successful instance of conflict-resolution and is often hailed as such in the literature. It has been widely noted that it has been working reasonably well despite the difficult political relationship between India and Pakistan, and that it was not abrogated even during periods of war between the two countries. However, there is also a measure of dissatisfaction with the treaty in both countries. Quite apart from the fairness of the sharing of waters in terms of percentages, the real difficulty from the Indian point of view is that certain projects that India has planned on the western rivers are stalled because of Pakistan's objections. One such project, the Salal Hydroelectric Project on the Chenab, was under prolonged discussion at the commission level and later between the two governments and was eventually accepted by Pakistan (with some agreed changes) in the 1970s. However, differences over other projects—Tulbul or Wullar, Baglihar and Kishenganga—remain unresolved (Iyer 2007).

Pakistan objected to the Tulbul Navigation Project (or the Wullar Barrage Project) on the Jhelum River on the ground that it involves the creation of storage on a river allocated to Pakistan and that it is therefore a violation of the treaty. India argues that no creation of storage is involved; that the proposed barrage will merely head up the waters temporarily, retarding the rapid depletion of floodwaters, with a view to extending the period during which navigation is possible; and that the regulation involved will also benefit Pakistan (Iyer 2003). On Baglihar, a 'run-of-the-river' hydropower project on the Chenab, Pakistan invoked the arbitration clause of the treaty for the first time (Iyer 2007). It contends that the design and certain features of the project are not in conformity with the provisions of the treaty, and therefore constitute a violation of the treaty. However, India claims otherwise. The invited 'Neutral Expert', Professor Raymond Lafitte gave his determinations on the points of difference referred to him in 2007. On the whole, India has reason to be somewhat more satisfied than Pakistan with these findings, as the Project per se stands vindicated, and the changes suggested are relatively minor (Iyer 2007).

There is much unhappiness in the state of Jammu and Kashmir where these projects are located at the fact that the restrictions placed on India in relation to the western rivers make it virtually impossible for that state to derive any benefits by way of irrigation, hydro-electric power, navigation, or other from the waters of rivers Jhelum and Chenab that flow through the state (Iyer 2007). This has prompted thinking on the lines of abrogating the treaty altogether.

The density of technical detail in the Indus Treaty, the nature of division of waters between the two countries, the political dimension with regard to Pakistan being the lower riparian that makes it look with anxious eyes at any attempts by India to build structures on the western rivers and the fact that the unresolved projects are located in a disputed territory—Jammu and Kashmir, all pave the way for the intractable differences on the working of the treaty. Moreover, the waters of the Indus are being badly mismanaged on both sides of the border, as evidenced (for instance) by the serious incidence of water logging and salinity and the intensity of internal water-related conflicts in both countries (Iyer 2007).

Short-term political gains that have dominated decision-making on irrigation severely constrain risk management (Alam et al. 2007). Climate change will add more challenges. Technical cooperation on water issues, it should be noted, has not ended the military conflict, although it has sometimes helped de-escalate tensions (Ali 2008; Zawahri 2009). Uncertainties about climate change impact make information exchange very important; but sharing of hydrology data is seen as a national security risk by many governments in Asia (Michel 2009).

2.3 Mekong

The Mekong River Agreement of 1995 is a relatively well-studied component of the water regime in the Mekong region (Browder 2000; Jacobs 2002). The basin as it is currently institutionalized under the Mekong Agreement is a superficial, truncated and lopped vision of a 'basin': Key provisions of the Mekong Agreement apply to the main-stem of the river and not to tributaries and only to the four downstream riparian countries. The four countries adopted the principle of reasonable and equitable utilization among states and agreed to maintain minimum flows. Rules for water use or allocation and a coordinated basin development plan (BDP) were left to be worked out later. There is still substantial flexibility remaining in the framework agreement; a bigger problem is that the Mekong River Commission has often struggled to keep up with, or constructively influence, current events (Dore and Lazarus 2009) despite encouraging signs of broadening stakeholder engagement (Sneddon and Fox 2007).

In the Mekong River, cascades of dams and diversions in the mainstream as well as in key tributaries are in operation, being built or planned (Magee 2006). Many actors are concerned about the aggregate implications of mainstream and tributary dams in all of the countries on the natural flood regimes important to productivity and proper functioning of wetlands especially Tonle Sap Lake in Cambodia, but also in the Mekong Delta of Vietnam (IUCN et al. 2007; Molle et al. 2009; Sokhem and Sunada 2006). Opposition within countries and political security issues among countries have so far kept some of the grander schemes in the Lower Mekong basin from being pursued (Molle et al. 2009). The 'Thai' water grid, for example, was another in a long succession of grand schemes to 'green' the seasonally dry northeast of Thailand. It included inter-basin transfers from other countries in the Mekong region and made many dubious assumptions about water balances, labour availability and socio-economic impacts (Molle and Floch 2008).

The proposal got as far as it did because of its populist appeal; it may have gone further if the former Prime Minister Thaksin's government was not toppled by a military coup in 2006 (Molle and Floch 2008). Visions for major infrastructure remain in place with signals that adaptation to climate change may become another rationale for large-scale infrastructure development (e.g. Thapun 2009).

Projections for the Mekong River basin to 2030 suggest that overall annual precipitation, run-off and flooding could increase because of higher wet season rainfall (Eastham et al. 2008). Maintaining irrigated rice yields, however, would require meeting an increased demand for water of 2–8% because of increases in potential evapo-transpiration arising from higher temperatures (Eastham et al. 2008). Shifting interactions among different water uses—hydropower, irrigation and fisheries—will be a major challenge for water resource management and interact strongly with climate-induced changes (Costa-Cabral et al. 2007). In the shorter-term the cumulative impacts of infrastructure on flow regimes are likely to be much larger than those arising from climate change (Keskinen et al. 2010). In longer-term impacts on flood pulse of infrastructure and predicted climate changes appear to be similar in magnitude but in opposite directions (Västilä et al. 2010). The Mekong River Commission (MRC) has promised to establish a Mekong Climate Change Panel (MRC 2009) which would meet every 3 years to analyse and report on the state of climate change and adaptation. Joint assessment activities allow identification and exploration of cooperation opportunities (Sadoff and Grey 2005).

2.4 Alternatives to large-scale supply

For several decades, water resources development in Asia has been oriented strongly towards supply augmentation with large-scale storage and diversions for expanding irrigation schemes. A vicious cycle of over-building of irrigation schemes followed by water scarcity crises leading to decisions for more storage and inter-basin transfers is leading to basin closures that leave some regional social-ecological systems less resilient to future water scarcities (Molle 2008b) including those which might arise from climate change. Investment in storage infrastructure is not necessarily an adaptive solution to increased variability of water flows, because under a changed climate they may require costly moves or upgrades. Uncertainties imply that new decision-making strategies may be needed (Hallegatte 2009), where appropriate climate change risks should be incorporated into the design of water infrastructure and management policies (Huntjens et al. 2010; Palmer et al. 2008).

Alternatives to large-scale supply augmentation, in the longer-term pursuit of adaptiveness to current and future water scarcity problems are needed across Asia. In some locations, increasing local water storage may be a plausible climate change adaptation strategy in the Himalayas (ICIMOD 2009a; Sharma and Sharma 2008); but benefits in one location always need to be assessed against the impacts and risks posed downstream (Dudgeon 2000; MWBP 2005). Efforts to improve water efficiency and reduce water demand are often referred to in lists of adaptation options (Lao People's Democratic Republic 2009; OEPP 2000; Royal Government of Cambodia 2006). Water storage and rainfall harvesting at community level is crucial for dealing with water shortages today for many farmers and likely to be an important component of adaptive responses in the future. Another is to store more water in wetlands, vegetation and groundwater and therefore achieve multiple ecosystem benefits (Postel 2008).

Improved allocation and demand management necessary for coherence in adaptation policies also implies better integration in planning. Climate change is expected to make cooperative and integrative basin-level management even more important (Michel 2009). There are some good reasons for this: the inter-connections along water-ways are important for fish and other aquatic organisms; many of the strong influences of land-use on river flows are within basin; storage, diversion and use of water upstream affects water available or flood risks downstream. But there are also important limitations: basins are increasingly linked by physical diversions and transfers; groundwater interactions may not fully reflect surface flows; administrative and other political boundaries often do not correspond to basins; at levels below that of the entire basin, sub-divisions are usually highly arbitrary. Achieving the required institutional flexibility in current river basin organizations and planning processes is going to be difficult and take time (Biswas and Seetharam 2008). Meanwhile, basins will not be the sole, or even primary, unit of water management or decision-making (Molle 2008a).

3 Protecting places

International cooperation on disaster risk management is often more advanced than on sharing water, but less restricted to formal treaties. Vulnerability to transboundary floods is high for rivers in Asia draining the Himalayas. In international comparisons of flood disasters, India and Bangladesh come out as countries with the highest numbers of shared river floods (Bakker 2009). Countries with the highest displacement tolls included Nepal and Bangladesh. The three international river basins with the highest casualties or affected people from floods are the Indus, Ganges–Brahmaputra and the Irrawaddy (Bakker 2009). Here, we will just look at the Ganges and the Mekong—the latter an example of a shared basin in which seasonal flooding has many positive impacts on livelihoods and to which there is substantial adaptation to the natural flood regime. In the Mekong, changes to the natural flood regimes would itself constitute a disaster (Baran and Myschowoda 2009; Lebel and Sinh 2007; Lebel et al. 2009).

3.1 Ganges

Most countries in Monsoon Asia have entered into agreements with neighbours to cooperate in sharing data related to flood forecasting and warning schemes (Table 1). A bilateral Committee on Flood Forecasting between India and Nepal, for example, established shared meteorological and hydrometric stations and regularly meets to discuss activities.

In 1996, Nepal and India signed the Integrated Treaty on the Mahakali River, a tributary of the Ganges opening the way to build the multi-purpose Pancheswar high dam and West Seti hydropower project. Benefit sharing under this treaty is supposed to be commensurate with costs, but both countries argued about rights to regulate waters (Gyawali and Dixit 1999). A common feeling in Nepal was that the treaty was opening the way for India to exploit Nepal's hydropower (Subedi 1999); India now supplies Nepal with electricity from the Tanakpur Hydel plant situated in India. Private sector actors have become extremely important in the latest wave of hydropower development across the Himalayas. These are often facilitated by inter-state agreements. The India–Nepal Power Trade Agreement of 1996, for example, shifted negotiations over sales of hydroelectric power away from national governments towards private actors (Crow and Singh 2009). Theoretically, a large multi-purpose storage dam in Nepal could be used to help reduce flood risks, but the likelihood is operations will be geared more towards maximizing power generation (Dixit 2003).

According to the Kosi Treaty of 1966 between Nepal and India, the responsibility for maintaining structures in the Kosi River, which crosses the Nepal border, lies with India. However, the specific requirements for maintaining embankments and barrages are vague (Dixit 2009). The transboundary setting has contributed to a series of flood disasters that has affected the region and from which little appears to have been learnt. The recent failure of the Kosi embankment in August 2008 led to local devastation in Nepal and affected more than 3.5 million people in Bihar, India. The breach occurred at water levels below long-term averages for the month and less than one-sixth highest level recorded in 1968 (Dixit 2009; Moench 2010). A meeting of a high-level Nepal–India water committee in October 2008 re-affirmed commitment to infrastructure-based solutions, in particular, the Sapta Kosi high dam for flood control in Bihar.

Other approaches to reducing disaster risks—for example those that leave more space for water and drainage and in which human settlements and infrastructure is tolerant of slow moving and shallow flood waters—may often be a more appropriate and realistic goal than misleading promises of absolute protection (Dixit 2009; McCully 2007). Moreover, climate change can make such infrastructure projects obsolete (Moench 2010). Large-scale, long-lasting water infrastructure that lasts several decades to centuries should be designed to work in a wider range of climatic conditions (Hallegatte 2009). In Nepal, climate change may increase the risks of glacial lake outburst floods with serious consequences, for example, to hydropower infrastructure (Agrawala et al. 2003) and lowland agriculture (Sharma and Sharma 2008). Improving resilience of underlying communication, finance and other systems may do more to build disaster resilience (Dixit 2009).

Successful flood management in Bangladesh is dependent on cooperation with upstream countries in the Ganges–Brahmaputra-Meghna basin, for example, for real-time data needed for flood forecasting and early warning systems. As part of bilateral cooperation India has shared water level data from five stations when water levels reach close to danger levels and rainfall is high (Ahmad and Ahmed 2003). This gives lead times of only 24 h for central Bangladesh and as few as 4 h in border areas. Improved regional cooperation, therefore, is needed.

3.2 Mekong

Under the MRC's programme on Flood Management and Mitigation, agreement was reached to share information about flood levels along the Mekong to help with preparedness and early warning. Daily forecasts and warnings are issued in the main wet season based on forecast points from along the river in different countries. The MRC has promised to integrate flood management considerations in its new Climate Change Adaptation Initiative (MRC 2009).

As a least developed country, Cambodia has received funding under the current climate change adaptation funding mechanism. It prepared a National Adaptation Programme of Action as requested and is now following up with a project on integrated water resources planning for agricultural development with a 1.8 million USD contribution from the Global Environment Facility. Among the project aims are changes in designs of reservoirs and irrigation channels to reduce flood risks from higher peak flows (Biagani 2007). If this approach is pursued at larger scales, then it could be at odds with other analyses that emphasize the value of seasonal floods to fisheries and fishers. The huge inland fisheries of Tonle Sap in Cambodia may be very susceptible to changes in sediment delivery and water levels because of alterations to flood regimes from built infrastructure both nearby and more distant (Baran et al. 2007; Baran and Myschowoda 2009; Kummu et al. 2006;

Sokhem and Sunada 2006). Adaptation policies in Cambodia need to be deliberated much more widely.

One study of the hydrological impacts of climate change on Tonle Sap Lake in Cambodia and Mekong Delta of Vietnam based on scenarios for a warmer and wetter region with more intense rainfall events noted impacts on the lake were primarily through back-flow from the Mekong mainstream, whereas those in the Delta were significantly impacted by sea-level rise as well (TKK and SEA-START 2009; Västilä et al. 2010). Dams and other water infrastructure reduce sediment delivery to coastal deltas like that of the Mekong Delta in Vietnam (Le et al. 2007). Channel modifications that make rivers narrower and flows faster result in banks that erode more quickly (Le et al. 2007). Modelling studies suggest rises in sea level will cause additional flooding in the delta that could exacerbate impacts of reduced sediments due to siltation behind dams (Hoa et al. 2007). Higher average dry season water levels were also projected. Although people are well adapted to seasonal flood pulse, capacities to adapt to high floods is limited (TKK and SEA-START 2009).

Many livelihood systems are sensitive to climate, and societies have over time built and maintained a certain level of resilience to seasonal and inter-annual climate variability. In lowland areas, adaptive measures undertaken to cope with floods and storms include raising buildings on stilts, seasonal shifts in livelihoods and even migration. A practice and policy of 'living with floods' that draws on local experiences and innovations is plausible in some places (Sinh et al. 2009). Along the wetlands of the Nam Songkhram River, a tributary of the Mekong, the majority of residents still view seasonal flood events as positive (Friend 2007). More extreme floods can damage paddy rice crops and affect drinking water supplies or damage houses. Overall droughts are expected to have more adverse impacts than floods because they create larger financial burdens for families (MWBP 2005). Resilience to changing climate in the society comes from diversification of livelihood including off-site income sources (MWBP 2005).

3.3 Local adaptation and ecosystem resilience

Concerns with higher risks from climate change can be used to argue for more attention being given to role of floodplain ecosystems in maintaining the resilience of social-ecological systems (McCully 2007). Intact watersheds, wetlands and floodplain ecosystems provide many services apart from water and fish including: storage of seasonal flood waters, recharging ground water supplies, water purification and habitat for conserving biodiversity (Postel 2008).

In lowland coastal areas, ecosystems provide services crucial for coping with and adapting to changes in flood regimes and individual events. Unfortunately, human modification of rivers and land is often reducing their resilience. The Sundarban wetlands cover the deltas of the Ganges, Brahmaputra and Meghna in Bangladesh and India. Mangroves have been converted to rice and shrimp and river flows altered by dams, barrages and embankments together reducing biodiversity (Gopal and Chauhan 2006). Increased flood in low-lying coastal delta areas as in Bangladesh could produce large numbers of displaced people—climate refugees—and associated security challenges for Bangladesh's neighbours (Biermann and Boas 2010; Podesta and Ogden 2007).

Watershed and river basin management aimed at improving livelihoods while maintaining ecosystem functions should assist with reducing vulnerability to climate change. Upper tributary watersheds provide services valued by both local and downstream actors (Lebel and Daniel 2009). The water cleaning services of soils and vegetation in upper tributary watersheds, for example, are valued locally by people who depend on streams and shallow wells for drinking water supplies. Mature and secondary re-growth forest areas are valued for the different non-timber forest products they provide. Upland societies may have local knowledge and practices important for reducing risks of landslides and flash-flood disasters and thus adaptation to climate change (Xu and Rana 2005). Transhumance, the ancient practice of moving herds from summer to winter pastures ensured that pastures were not overgrazed, thereby preventing erosion. Mountain farmers explore different environmental niches for different products along the altitude gradient—one crop failure could be replaced by another crop in different time and space. High-altitude wetlands, in particular, are important to the hydrology of major Himalayan Rivers and under threat from land—and water-use changes as well as climate change (Chatterjee 2010). Most studies find that high evaporation from these wetlands means that they decrease dry season discharge and through storage help reduce flood peaks.

At basin levels, maintaining a significant cover of mature trees is valued as a way to reduce run-off and risks of disastrous flooding events. Changes at the small tributary level when aggregated may have impacts at the much larger basin level, as in case of possible impact of climate change in changing the river hydrograph of Bagmati River in Nepal impacting on the larger Ganges basin (Sharma and Shakya 2006). Governments in Asia have been exceptionally sensitive and quick to blame farmers in upland areas for a range of environmental problems downstream—including both water shortages and floods (Blaikie and Muldavin 2004; Forsyth and Walker 2008). The impacts of diverse changes in landscape cover on hydrology are understudied, poorly understood and frequently misrepresented (Sidle et al. 2006).

To ensure local experience and knowledge is respected and that interventions, hard or soft, actually reduce risks rather than recreate them or shift them onto more marginal social groups is likely to require much more direct representation and deliberation among affected and vulnerable people (Lebel and Sinh 2007; Paavola and Adger 2006). The concept of 'community-based disaster risk management' could be promoted in parallel with the concept of 'community-based natural resource management', since the management of resources and risks go hand in hand. Local knowledge about managing climate risks is thus likely to be useful for adaptation (Chinvanno et al. 2008; Resurreccion et al. 2008). Learning—from experience and through expectations and model projections—will become increasingly crucial to effective water governance (Pahl-Wostl 2007).

At the same time, extreme events can overwhelm local capacities, implying that higher level support should be available when needed (Adger et al. 2005), for example, to protect drinking water supplies and ensure key infrastructure like hospitals and schools are protected and livelihood recovery is rapid (Blaikie et al. 1994). A collaborative study of local adaptation coordinated by the International Centre for Integrated Mountain Development involving teams in China, India, Pakistan and Nepal underlined the importance of local institutions and social networks as well as livelihood diversification strategies for building adaptive capacity and coping with both too much and too little water (ICIMOD 2009b). At the same time, it is important for governments at national and regional level to provide financial and institutional support that enables and further strengthens these local responses. Long-term resilience is dependent on ensuring access to critical resources and effective governance of water projects. Climate change can be addressed now rather than later by incorporating consideration of risks and uncertainties into current development plans and policy, for instance, in disaster risk reduction (Schipper and Pelling 2006). A key challenge for adaptation planning in transboundary waters is how to ensure that the capacities, knowledge and needs of local, non-state stakeholders are visible in the water governance regime.

4 Framings

Evidence from the Indus, Ganges and Mekong underlines how the pursuits of adaptiveness in Monsoon Asia will increasingly take place outside the range of human experience in a context of large differences in exposure and vulnerabilities, disparate interests and unequal power among and within states. Although policies and actions to adapt or improve adaptive capacity with respect to shared rivers are still in their infancy, key framing contests are already emerging (Table 2).

At the international level, there are two competing framings emerging. On the one hand, various international relations experts and security analysts have suggested that climate change, in particular through increasing the severity of water scarcity problems, raises the risks of serious international conflicts. Treaties, they point out, are often vague, or could be ignored because of power differences among states. On the other hand, the same threat is considered a window of opportunity for building cooperation at basin and regional levels around water or disaster management that help address other security and development needs. Treaties could be made more flexible, for example, by inserting drought provisions or more flexible allocation rules depending on flows. Basin organizations or other joint bodies can help facilitate dialogue, sharing of information and conduct of assessment. Evidence from Monsoon Asia suggests that finding mutual interests with respect to flood forecasting and management seems to be easier than for sharing information or flows when water is scarce.

At both national and international levels, there is a second split in framings based on conventional preferences for different types of interventions in water management. One view is that adaptation to climate change will require large investments in upgrading and building new infrastructure to store water and protect places. Risks it is felt can be best reduced by increasing physical controls on water flow. An alternative view is that the elevated but uncertain risks posed by climate change require a new approach that focuses more on building resilience by taking into account the valuable services that natural (and agricultural) ecosystems provide for storing water and tempering extremes of floods (Rockström et al. 2010). More international cooperation arising out of shared concerns with climate change could easily translate into support for more and bigger infrastructure projects driven by vested political interests rather than adaptation needs of marginalized and vulnerable groups. Most of the evidence from the Indus, Ganges and Mekong river basins suggests that an infrastructure-first framing dominates decision-making circles.

Table 2 Alternative framings of adaptation in managing shared rivers

Dimensions	Conventional framing	Alternative framing
International security	Increases in demand combined with lower flows due to climate change will create more conflicts	Climate change as a shared threat expands the opportunities for collaboration
Infrastructure emphasis	More infrastructure is needed to divert and store water for periods of low flow and to protect places from flooding during high flows	More emphasis needs to be placed on safe-to-fail infrastructure, the services provided by ecosystems, and institutional rather than hardware solutions to managing risks
Scale of response	Adaptiveness in shared rivers should primarily be pursued through agreements among and actions of national governments	Building adaptiveness in shared rivers requires a multi-level response that involves both state and non-state actors

A third framing relates to scale. The dominant framing is that national governments have a major role to play in the governance of adaptation and it is primarily through governments that the pursuit of adaptiveness will take place. National visions and grand schemes for adapting to growing demand and increasing water scarcity have frequently ignored or downplayed possible impacts on neighbouring countries. A politics of scale is apparent in water resources development discourses (Lebel et al. 2005; Molle 2007) and is starting to play a role also in the framing of climate change adaptation. Promotion of integrated regional river basin development with cooperation among countries with close engagement of the private sector engagement is arising as another variant of the 'big' scale framing with its promise of benefits to all actors (Sadoff and Grey 2005).

One problem with large-scale re-framings of development as regional cooperation—like nationalist water grids and interlinking projects—is that the costs to the environment and displaced and adversely affected people tend to be rendered invisible in the quest of mutual benefits at the 'national-level', and, less explicitly, to particular private sector interests. The accountability of private actors, from financiers and constructors through to owners and operators of large-scale infrastructure poses particular governance challenges, given transboundary project impacts. The rescaling of regions, in short, produces significant disconnects with local livelihoods and knowledge (Lebel et al. 2005). Local uses of water resources for irrigation and fishing and for reducing risks of landslide and flash-flood disasters are made invisible by a high, regional, vantage point and the statistics or policies at the higher level. Moreover, small rivers receive much less attention than large rivers in both domestic and international discussions. The notion of climate change as a global phenomenon tends to lend uncritical credence to arguments that responses must also therefore be large scale—international or national.

An alternative framing is that most of the important knowledge and capacity for adaptation is local, and that what is needed from the national level is enabling frameworks, and support when local capacities are exceeded. Moreover, the magnitude of actual or looming adverse changes to water and water-related resources varies widely among peoples, places and basins. It is often misleading, therefore, to list adverse possibilities compounded by climate change as if they apply to an entire country or basin. Multi-level governance approaches to adaptation can help address local heterogeneity without ignoring the on-going needs for capacity sharing (Dore and Lebel 2010).

It is not yet clear how these competing policy-frames will evolve in Monsoon Asia. Much will depend on how systems of water governance develop. There are barriers and openings. As significant barriers, most water bureaucracies remain deeply attached to technocratic planning procedures and infrastructural solutions ignoring conflicts with the local communities and their indigenous expertise (Dixit 2003; Gyawali and Dixit 2001). Climate change—as a complex confounder described with maps and probabilities—can be used to remake water management into a technical issue and thus allow the water bureaucracy to recapture control of planning agendas. But there are also openings, especially in commitments to public consultation in exploring water resources development options (Lebel et al. 2010). Most of these changes have been driven by non-state actors putting pressures on government to reveal plans earlier and carrying out independent critical analyses of project impacts and benefits. There is now a significant transnational network of researchers, concerned bureaucrats and activists able to raise awareness about possible transboundary impacts of poorly conceived projects as well as share ideas on alternatives in all major basins. Even the private sector, from commercial banks seeking to make loans through to construction companies bidding for projects, has become increasingly careful about their image and wants guidelines, standards and clear procedures to reduce financial risks. At the same time, public vigilance must continue to help sort those projects and strategies which are driven primarily by political benefits and those which actually contribute to building adaptive capacities and maintaining social-ecological resilience.

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