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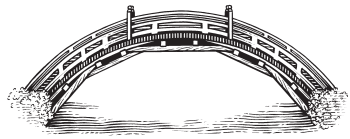
ROUNDTABLE

Himalayan Water Security: The Challenges for South and Southeast Asia



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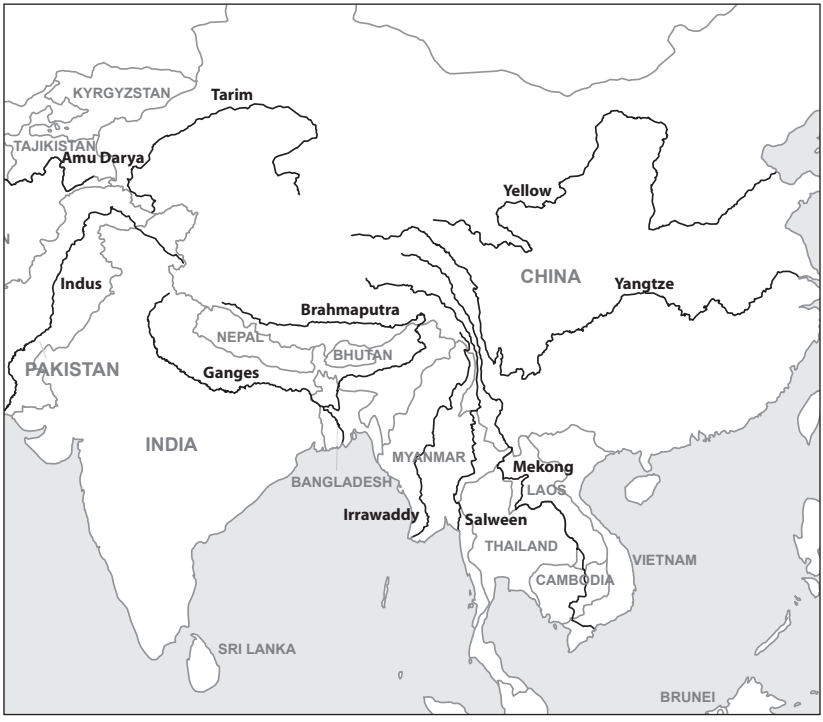
Introduction

The scramble for control of natural resources to support economic and population growth, combined with the uncertain effects of climate change on the Tibetan Plateau, is raising tensions in Asia over Himalayan water resources. Ten of the region's largest and longest rivers (the Amu Darya, Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Salween, Tarim, Yangtze, and Yellow) originate in the Himalayas (see **Figure 1**). These rivers help provide water, food, and energy for nearly 4 billion people in China and across South and Southeast Asia—nearly half of the world's population. However, depletion and diversion of these transborder resources to meet growing industrial, agricultural, and urban demands have the potential to trigger far-reaching economic, social, and environmental challenges.

FIGURE 1

Major Himalayan Rivers



The lack of comprehensive and effective regional frameworks for cooperation hinders sustainable management of these waterways. China, which controls the headwaters of these rivers, has an enormous need for Himalayan water to satisfy economic and energy demands but has little incentive to participate in formal water-sharing and water-management agreements with its neighbors. China's dam-building and water-diversion projects are a source of major concern to the countries downstream, which often complain about Beijing's lack of transparency and reluctance to share information. Although managing water-sharing relations with China might be the most prominent challenge, cooperation is not much easier at the middle and lower reaches of the rivers. Collaboration in South and Southeast Asia is frequently frustrated by competing national interests, economic priorities, political disputes, and weak regional organizations. In addition to the environmental impacts of man-made diversion projects and unsustainable freshwater usage, there is also inadequate cooperation on scientific research to understand and prepare for the effects of climate change on the region's water supplies.

This *Asia Policy* roundtable contains seven essays that discuss the challenges and implications of water security in Asia and recommend steps that both upstream and downstream countries could take to better manage the region's shared water resources. ◈

Asia's Unstable Water Tower: The Politics, Economics, and Ecology of Himalayan Water Projects

Kenneth Pomeranz

Asia's ten largest rivers by volume—including the Yangtze, Mekong, Brahmaputra (which becomes part of the Ganges), and Indus—originate in the Himalayas or on the Tibetan Plateau and collectively serve 47% of the world's population. Inadequate or unreliable water supplies pose serious and worsening problems in all the countries along these rivers, as do energy shortages. To varying degrees, these issues threaten domestic stability throughout the region, leading countries to build dams to control water flows and generate hydroelectric power. Such projects not only pose significant environmental risks but create international tension over water-sharing on transborder rivers. Furthermore, nine of Asia's ten largest rivers begin in China, which has no water-sharing agreements with downstream countries; in some cases, the downstream countries also have no agreements with countries further downstream. Even the sharing of hydrological data is spotty. That China, as the upstream country, is increasingly capable of undertaking projects that would address its needs at the expense of its downstream neighbors makes the situation even more tense. While China has promised to be mindful of other countries' interests, it continues to make decisions unilaterally and often secretly. Climate change, which is likely to reduce the water supply at the source of many Himalayan rivers, will only magnify these disputes and probably make any solution that guarantees specific amounts of water or parts of a joint river to specific countries unfeasible.

This essay discusses the implications of China's dam-building projects within the Himalayan watershed, as well as one possible project that Beijing denies planning but which its neighbors fear. The next section then describes possible solutions to current and future water disputes. The essay argues that the combination of immediate problems and longer-range threats requires, at the very least, three developments. First, more must be done to share basic data, both about hydrology and about planned projects.

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NOTE ~ This essay is partially adapted from the author's chapter in the forthcoming volume *New Security Challenges in Asia,* ed. Michael Wills and Robert M. Hathaway (Washington, D.C.: Woodrow Wilson Center Press/Johns Hopkins University Press, 2013).

Second, steps must be taken to institutionalize at least some cooperation in the exploitation of these rivers—either through multinational organizations or bilateral arrangements (e.g., joint ownership of hydroelectric dams). Third, all countries will need to undertake domestic efforts to manage water demand and reduce waste in ways that lessen dependence on water supplies to deal with future needs. It is particularly important that China implement these changes, since such efforts represent the best option for Beijing to credibly reassure its neighbors that it will not preempt the flow of rivers that begin in Chinese territory. Fortunately, waste reduction and recycling efforts are also likely to offer China more water security per dollar spent, and at less risk, than the mega-projects that its neighbors fear.

China, Its Neighbors, and the Implications of Dam-building

Increasingly, China's prospects for continued economic growth are threatened by shortages of clean water and rising energy demand. The country has barely a quarter of the global per capita water supply, and decades of emphasis on raising agricultural yields by extending irrigation (often inefficiently), weak enforcement of pollution controls, and economic arrangements that fail to reward conservation have exacerbated the situation. Massive exploitation of underground aquifers since the 1950s masked these problems temporarily, but the country's groundwater is being rapidly depleted. In addition, China, and the world, need alternatives to fossil fuel in order to power this economic growth. Descending from the world's highest mountains, Himalayan water offers enormous, and still largely unexploited, hydropower potential.

With water and energy pressures mounting while its engineering and financing capabilities grow, it is not surprising that China is undertaking numerous water projects in Tibet and adjacent provinces: these include recent or ongoing projects on the Chinese portions of the Indus, Sutlej, Brahmaputra, Salween, Irrawaddy, and Mekong. Although China insists that none of these projects will have adverse effects on any downstream country, this is nearly impossible to ensure, even with complete transparency. Under the current circumstances, downstream countries' anxieties continue to grow.

Lurking in the background is a possibility much more threatening than any current dam: that Beijing will eventually divert huge amounts of water from international rivers that start in Tibet to address chronic water shortages in northern China's Yellow and Hai river basins. Such a diversion has been discussed for years. Its chief public promoter, Guo Kai, is a retired

engineer and army general. The idea also has support from a number of senior military officers, as well as within the Chinese Academy of Sciences, and was the subject of a much-discussed book in 2006 called *Tibet's Waters Will Save China*. The Ministry of Water Resources has publicly rejected the idea as too technically complex, environmentally risky, and dangerous to China's foreign relations. Significant numbers of other Chinese activists have also opposed it, pointing to the unpredictable consequences of mega-projects and problems that have arisen from earlier ones.

But for many of the countries downstream, this is not enough to provide firm reassurance. Among other issues, they note that China still has years of work remaining on an enormous diversion that will move some of the Yangtze's water northward (the most expensive construction project in history), and that the tapping of international rivers would likely make use of tunnels from that project's third, western prong (which has not yet begun). That no further project was included in the current five-year plan is thus not terribly significant. Indeed, the South-North Water Diversion plan, whether it succeeds or fails, could be a prelude to a larger diversion scheme. If it succeeds, the project would build confidence in such solutions and provide much of the infrastructure on which future diversion schemes could piggyback. On the other hand, if the project fails—for instance, if it turns out that the Yangtze cannot spare enough water to solve the north's problems, as many think is likely—expanding the project by tapping into rivers that currently flow out of the country might become very tempting.

Thus, water politics combine conflicts that are already established, but probably manageable, with fears of much greater future conflicts. Without established institutions for cross-border water management, current problems breed distrust that inhibits progress on future issues, while unresolved long-term issues make it harder to address immediate problems. It does not help, of course, that the downstream countries have their own water problems. India and Pakistan are even more water-stressed than China, and both are heavily dependent on irrigated agriculture supported by increasingly decrepit infrastructure. Bangladesh and the mainland countries of Southeast Asia have enough water on average but are nonetheless vulnerable to even modest changes upstream, in part because the flow of their rivers fluctuates enormously over the course of the year. If, for instance, a hydropower dam on the Yarlung Tsangpo (the upper Brahmaputra) retained some water in the early spring, when flow through its turbines might otherwise be inadequate, that could create temporary problems in India and Bangladesh just when

newly planted crops need water. Any changes in the seasonal rhythms of the Mekong have serious implications for the world's largest freshwater fishery, which is crucial to Vietnam and Cambodia; and changes in river flow could increase saltwater invasion at the mouths of several rivers, with serious consequences for delta agricultures. The downstream countries on the Lancang/Mekong (Laos, Thailand, Cambodia, and Vietnam) claim that such problems are already occurring as a result of Chinese dams on the Lancang—and several more such dams are in progress. Meanwhile, many downstream countries are planning their own dams on these same rivers. In many cases, they offer fewer benefits than upstream dams, and similar risks, but seem likely to proceed anyway because they represent the only way that downstream counties can be assured of capturing any of the benefits of dam-building.

Water Problems and Solutions

The status quo is unsatisfactory: shortages of clean water have already created local public health crises in all of these countries and could seriously imperil food security in several states. But new projects bring their own dangers. Large-scale dams in seismically active areas could fail catastrophically, or have huge unforeseen consequences, even if they succeed in engineering terms. Dams in Yunnan and eastern Tibet pose threats to important biodiversity hotspots. Potential conflicts over water resources have led some politicians and journalists to predict "water wars," particularly among China, India, and Pakistan, and to advocate accelerated construction of water projects in order to preempt other nations' plans. Meanwhile, climate change further complicates matters. Himalayan glaciers are shrinking rapidly, and there is evidence for a more general drying-out of the Tibetan Plateau; this could mean that the margin for error—and compromise—on multinational rivers originating there will narrow even faster than expected. Meanwhile, nobody knows for sure what climate change will do to the South Asian and East/Southeast Asian monsoons. It seems likely, however, that greater water storage capacity will be required to cope with increasingly erratic weather. After many years of undertaking the world's largest dam-building effort, China can store about 2,200 cubic meters (m^3) of water per inhabitant. This is in contrast to the over 5,000 m^3 of water storage per inhabitant in the United States and

Australia (rich countries that, like China, have large arid areas of land) and the official figures of a mere 200 m^3 in India and 150 m^3 in Pakistan.[1]

Even from a purely technical and apolitical standpoint, there is no straightforward solution to these problems. That China, with the advantage of being upstream, also has the greatest engineering capacity, ability to finance large projects, and probably the least need to accommodate internal dissent makes it even harder to ensure that the interests of weaker parties are considered. But some useful steps do seem possible.

More international data-sharing would be a good start. It has, for instance, been impossible to either verify or firmly reject Southeast Asian claims that Chinese construction has exacerbated recent droughts and fishery problems. China's recent rejection of Indian requests to expand the exchange of hydrological data on the Yarlung Tsangpo/Brahmaputra—currently the two countries exchange limited data, and only during flood season—does not help that situation.[2] If, as China has stated, both the dams currently under construction on that river and those planned for the future are purely run-of-the-river projects, with no storage or diversion capacity, making it easier to verify this would be beneficial.[3] Tensions between India and Bangladesh over the Brahmaputra-Ganges river system have eased considerably since India, the upstream country, began providing more data. This has led to discussions between the two countries over joint ownership of a number of dams and suggests that greater transparency might have similar benefits elsewhere. If large hydroelectric dams are going to be built on the international rivers that begin in China, upstream sites will often—though not always—offer the best ratio between power generated, people displaced, and environmental risk. Consequently, projects within China in which downstream countries have a stake would probably be better than each country going it alone.

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1 Michael Specter, "The Last Drop: Confronting the Possibility of a Global Catastrophe," *New Yorker*, October 23, 2006 ~ http://www.newyorker.com/archive/2006/10/23/061023fa_fact1; John Briscoe and R.P.S. Malik, *India's Water Economy: Bracing for a Turbulent Future* (Washington, D.C.: World Bank and Oxford University Press, 2006), 30 ~ https://openknowledge.worldbank.org/bitstream/handle/10986/7238/443760PUB0IN0W1Box0327398B01PUBLIC1.pdf?sequence=1; and John Briscoe and Usman Qamar, *Pakistan's Water Economy: Running Dry* (Washington, D.C.: World Bank and Oxford University Press, 2006), 5–6.

2 See "China Spikes India's Proposal for Joint Mechanism on the Brahmaputra," *Hindu*, April 17, 2013 ~ http://www.thehindu.com/news/national/china-spikes-indias-proposal-for-joint-mechanism-on-brahmaputra/article4627285.ece.

3 It did not help that when the first of these dams was acknowledged in November 2010, the English and Chinese versions of the story from China's official Xinhua news agency differed on this crucial point, though so far no evidence has surfaced to contradict the more reassuring English version of the text.

At the same time, however, China and India must also address what appears to be a systemic bias in favor of mega-projects, even when these projects are not particularly good solutions to pressing problems. It is hard to believe, for instance, that the $65 billion to be spent on China's south-north water transfer (assuming no cost overruns) could not do more to alleviate shortages if it were spent on pollution control (allowing greater re-use), more efficient irrigation, and mundane but useful measures such as fixing millions of leaky faucets. Such efforts would certainly involve less risk of unwelcome surprises. China has done a great deal to reduce water waste, but much more is possible. In India and Pakistan, constructing water-control facilities has been so consistently prioritized over proper maintenance that World Bank reports describe both countries as following a "build/neglect/rebuild" philosophy of public works.[4] For obvious reasons, spectacular projects that expand water supply do more to make careers and build political support than many small-scale efforts that reduce unproductive demand, but the latter are probably more dependable solutions, especially given increasing uncertainty about how much water will fall and evaporate in specific locations. They are also, at least in theory, easier to manage democratically.

Last, the critical issue of food security links domestic questions about controlling water demand and waste with international ones, thereby involving outside countries like the United States. Since agriculture continues to dominate water use in all these countries (close to 70% in China and 90% in India), it must be the source of most water savings. But while some such efforts would not reduce farm output, others likely would: for instance, any effort that relied in part on raising water prices (as has already happened to some extent) would inevitably cause some economically marginal crop production to cease. Meanwhile, food demand will continue to grow, especially if, as expected, increasingly prosperous people demand diets with more protein. This raises crucial questions about whether the hard-won self-sufficiency of China and India in basic foodstuffs is sustainable—or even necessarily desirable—given their unfavorable ratios of land and water to population. Probably nobody would like a world in which such huge countries became heavily import-dependent; and the accelerated displacement of farmers would exacerbate already difficult social questions,

[4] On Pakistan, see World Bank, "Better Management of Indus Basin Waters: Strategic Issues and Challenges," January 2006, 2; on India, see Briscoe and Malik, *India's Water Economy,* 55 ~ https://openknowledge.worldbank.org/bitstream/handle/10986/7238/443760PUB0IN0W1Box0327398B01PUBLIC1.pdf?sequence=1.

even if enough food could be purchased abroad to replace the production that would be lost as more people quit farming. Thus, transfers of water-saving technologies are most likely a better long-term palliative for water shortages than greater imports of food. But if less nationalistic attitudes toward transborder rivers must be nurtured, and starting this process must involve restraining agricultural water use, guarantees that food imports will be available if needed could help backstop unpopular decisions. While only a small part of any solution to Asia's water crises, such guarantees might, at the margin, provide incentives to increase regional cooperation; and regional cooperation on these issues cannot wait much longer. ◈

China's Upstream Advantage in the Great Himalayan Watershed

Jennifer L. Turner, Susan Chan Shifflett, and Robert Batten

The four-character Chinese idiom "benefiting from the gifts of nature" (*de tian du hou*) captures China's riparian advantage in the great Himalayan watershed. In Mother Nature's luck of the draw, China is the big winner; many of the largest rivers in the Himalayan watershed originate in the glaciers of Tibet. The Yellow, Yangtze, Mekong, Brahmaputra, Salween, Sutlej, and Indus rivers provide water to 1.5 billion people from the mountains in Tibet down to deltas in Bangladesh, China, India, Myanmar, Pakistan, and Vietnam. As the upstream power, China has the ability to control the quality and flow of water that reaches its downstream neighbors.

The confluence of three factors—China's increasing demand for hydroelectric power, water scarcity, and the transboundary nature of rivers—are raising tensions in the great Himalayan watershed. China's hunger for energy to build cities and fuel industries, while at the same time reducing greenhouse gas emissions, has sparked a new wave of planning for dozens of mega-dams along the mainstreams of these transboundary rivers. Yet Beijing's lack of transparency about its dam-building projects and disinterest in formally cooperating or engaging with the lower riparian states in multilateral forums frustrate its downstream neighbors, which notably are also damming the same rivers for electricity generation.

The region desperately needs institutionalized water-sharing agreements and practices because countries are increasingly overdeveloping and wasting scarce freshwater resources. This overuse is occurring against the backdrop of climate change's unknown effects on the Himalayan river basins. The key challenge to the region's water-sharing efforts is the acute power imbalance between China and its neighbors—China not only controls the headwaters of these rivers but is also the most powerful state in the region, economically and militarily.

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Thus, Beijing has little incentive to enter into formal cooperative water agreements with its weaker downstream neighbors.

This essay first discusses how China's rising demand for both energy and freshwater are driving the dam-building projects that endanger the flow and water quality of rivers feeding the downstream countries of South and Southeast Asia. It then considers how China's aversion to formal water-sharing agreements is frustrating its neighbors. Although no entity can force China to cooperate, more could be done to fill the information gap on the broader costs of dam building. The essay concludes by proposing a "carrot and stick" approach that would encourage Chinese policymakers to sustainably develop the upstream waters—not simply to benefit downstream countries but to protect China's own water security.

The Ripple Effect of China's Water Needs

The domestic implications of China's energy demand. China's voracious appetite for energy continues to grow. The International Energy Agency forecasts that the country's energy demand will rise by 60% from 2012 to 2035.[1] As smog increasingly blankets Chinese cities, Chinese citizens are demanding more aggressive action from the government to clean the air. Beijing has set targets to secure 15% of the country's energy from non–fossil fuel sources by 2020, with 9% projected to come from hydroelectric power. In particular, Chinese leaders recognize the need to move away from coal, which currently supplies 70% of the country's electricity. To reach this goal, China will need to double its output of hydroelectric power.[2]

This demand for hydroelectric power as an alternative to coal is problematic because China is a water-stressed nation. Although water is abundant in absolute terms, the country's per capita freshwater resources are only 2,093 cubic meters, one-quarter of the global average.[3] According to a survey released by the Chinese Ministry of Water Resources in March 2013, an alarming 23,000 rivers in the country have disappeared entirely in just the past 60 years.[4] Rapid urbanization and industrialization have

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1 See "World Energy Outlook 2012," International Energy Agency, 2012 ~ http://www.iea.org/publications/freepublications/publication/English.pdf.

2 Renee Cho, "The Push to Dam China's Rivers," State of the Planet, web log, Earth Institute, May 19, 2011 ~ http://blogs.ei.columbia.edu/2011/05/19/the-push-to-dam-china%e2%80%99s-rivers/.

3 "Renewable Internal Freshwater Resources Per Capita (Cubic Meters)," World Development Indicators, World Bank ~ http://data.worldbank.org/indicator/ER.H2O.INTR.PC.

4 Andrew Jacobs, "Plans to Harness Chinese River's Power Threaten a Region," *New York Times*, May 4, 2013 ~ http://www.nytimes.com/2013/05/05/world/asia/plans-to-harness-chinas-nu-river-threaten-a-region.html.

only accentuated this water scarcity. By 2025, an estimated 350 million people—roughly equivalent to the entire U.S. population—will be added to China's urban population.[5] Not only are massive amounts of resources required to build cities, but urbanites consume more energy. Furthermore, both energy production and agriculture are highly water-intensive in China: coal production, for example, accounts for 20% of the nation's water use, and agriculture constitutes 65%.[6]

To meet the hydropower goals of the twelfth five-year plan, the central government has set a target of constructing 60 medium and large dams by 2016, primarily focused on rivers flowing out of the Himalayas into South and Southeast Asia. Given that the melt water from the 50,000 glaciers situated in the Hindu Kush and Himalayan mountain ranges fill the aquifers and water tables of the river basins throughout the region, the proposed dams threaten the water security of downstream nations and increase tension with China.

Southeast Asia's downstream lament. China began building the first series of dams on the Mekong River in 1986. Since then, Chinese dams have lowered water levels, disrupted sediment flows, and damaged the health of fisheries in Myanmar, Thailand, Laos, Cambodia, and Vietnam. In Thailand, fishermen along the border with Laos have reported that the river has become unpredictable since China began upstream dam construction.[7] Likewise, dams have had a significant impact on downstream agriculture. The Mekong River Delta, for example, supplies water for 50% of Vietnam's rice crop, which provides 16% of the country's annual GDP.[8] During a severe drought in 2011, lower Mekong conservationists claimed that China was not releasing enough water, worsening drought conditions.[9]

According to Ed Grumbine, a biodiversity specialist at China's Kunming Institute of Botany, "there will be significant impacts from the cumulative

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5 See "Mekong/Lancang River," International Rivers ~ http://www.internationalrivers.org/campaigns/mekong-lancang-river.

6 Julian Wong, "China's New Water Efficiency Targets (and Implications for Food and Energy)," Green Leap Forward ~ http://greenleapforward.com/2009/02/17/chinas-new-water-efficiency-targets-and-implications-for-food-and-energy.

7 Yoolim Lee, "China Hydropower Dams in Mekong River Give Shocks to 60 Million," Bloomberg, October 26, 2010 ~ http://www.bloomberg.com/news/2010-10-26/china-hydropower-dams-in-mekong-river-give-shocks-to-60-million.html.

8 Richard Cronin and Timothy Hamlin, "Mekong Turning Point: Shared River for a Shared Future," Stimson Center, January 2012 ~ http://www.stimson.org/images/uploads/research-pdfs/SRSF_Web_2.pdf.

9 "China Denies Dams Worsen Drought in Mekong Basin," *China Daily*, March 31,2010 ~ http://www.chinadaily.com.cn/china/2010-03/31/content_9664697.html.

operation of China's hydropower dams."[10] The leaders of several Southeast Asian countries have protested China's dismissal of the alleged negative downstream effects from its dam-building activities. On the sidelines of the 2012 Asia-Pacific Economic Cooperation (APEC) summit in Russia, for example, Vietnamese president Truong Tan Sang alluded to this issue, stating that "dam construction and stream adjustments by some countries in upstream rivers constitute a growing concern for many countries and implicitly impinge on relations between relevant countries."[11] Likewise, the former Cambodian minister for transport and public works, Khy Tanglim, once commented that Chinese leaders "will work for their own country. We are downstream, so we suffer all the negative consequences. If there is no more water for us, no more fish, no more vegetation, this is a big disaster."[12]

To address water security, Cambodia, Laos, Thailand, and Vietnam created the intergovernmental Mekong River Commission (MRC) in 1995 to jointly develop their shared water resources. China became a dialogue partner of the MRC in 1996, but officials have refused to sign the Mekong Agreement to become a full-fledged member. Southeast Asian countries continue to urge China to participate fully in the MRC. Even though a 2010 MRC agreement commits China to sending water-level data from its Jinghong and Manwan dams, Beijing refuses to release key data on water quality, pollution, and irrigation usage. China's full membership would create a forum in which these states could more effectively advocate for their water rights and pressure Beijing to more seriously consider the downstream implications of dam development.

Anger in South Asia. Thus far, China has proposed seven dams on the main channel of the Brahmaputra River, the lifeline for farmers in India and Bangladesh. China recently approved construction of three new hydropower dams on the middle reaches of the river, ending a two-year freeze on new projects amid concerns from India and environmental groups. The State Council's energy strategy for the twelfth five-year plan period (2011–15) stated that the government "will push forward vigorously the hydropower base construction" on the middle reaches of the Brahmaputra.

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10 Daniel Schearf, "Laos Dam Project Tests Credibility of Mekong River Commission," Voice of America, January 14, 2013 ~ http://www.voanews.com/content/laos-dam-project-tests-credibility-of-mekong-river-commission/1583790.html.

11 Truong Tan Sang, quoted in Parameswaran Ponnudurai, "Water Wars Feared Over Mekong," Radio Free Asia, September 30, 2012 ~ http://www.rfa.org/english/commentaries/east-asia-beat/mekong-09302012160353.html.

12 Raine Boonlang et al., *Representation and Decision-Making in Environment Planning with Emphasis on Energy Technologies* (Bangkok: UNESCO Bangkok), 2011, 98 ~ http://unesdoc.unesco.org/images/0019/001906/190650e.pdf.

China insists that the dams it is building are "run of the river," which operate on the flow of the river without modifying upstream storage, but New Delhi harbors fears that Beijing may eventually divert additional water from transboundary rivers to its dry northern regions to supply the centers of China's coal and grain production. The plan is allegedly part of the proposed western route of the South-North Water Transfer Project, which is scheduled for completion by 2050.[13] The project's east and central canals are already in progress, and all three routes will move nearly 36 billion cubic meters of water per year from the Yangtze River in southern China to the Yellow River Basin in the arid northern part of the country.[14]

Chinese officials and analysts have downplayed the likelihood of the western diversion due to the difficult terrain and associated technical challenges. Despite this reassurance, angry Indian politicians and activists have galvanized public opposition. To moderate the escalating political tension, Prime Minister Manmohan Singh of India issued a statement on August 4, 2011, stating that Chinese leaders had assured him that no such plans were imminent. Although China does provide limited hydrological and flood data to India through a memorandum of understanding renewed in May 2012, Singh has emphasized the need for a joint mechanism for sharing information on transboundary projects. China is currently the only country with which India shares a major transboundary river without a formal water-sharing agreement. The Indian leadership's opposition to China's dams could also stem from concerns that these projects threaten India's own expansive hydropower development plans in the Himalayan Basin, where nearly 300 dams are planned on the Brahmaputra, Ganges, and Indus rivers. These dams, which could help double the country's hydropower by 2030 and stabilize the power supply, highlight how water serves the energy sector in India as well as China.[15]

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13 See "South-North Water Transfer Project," International Rivers website ~ http://www.internationalrivers.org/campaigns/south-north-water-transfer-project.

14 Aaron Jaffe and Keith Schneider, "A Dry and Anxious North Awaits China's Giant Unproven Water Transport Scheme," Circle of Blue, March 1, 2011 ~ http://www.circleofblue.org/waternews/2011/world/a-dry-and-anxious-north-awaits-china%E2%80%99s-giant-unproven-water-transport-scheme.

15 Tim Newcomb, "Will Himalayan Dams Solve India's Energy Woes?" *Popular Mechanics*, January 15, 2013 ~ http://www.popularmechanics.com/science/energy/hydropower-geothermal/will-himalayan-dams-solve-indias-energy-woes-14982175.

The Need for Formal Cooperation

In addition to China's lack of transparency, its resistance to entering into formal water-sharing agreements frustrates the lower riparian states. Thus far, China's gestures toward water cooperation have been mainly rhetorical. Since 1997, China has declined to sign a UN water-sharing treaty that would apply to the thirteen major transnational rivers within its territory. Instead, China has consistently preferred to negotiate with countries bilaterally rather than multilaterally, thus allowing itself maximum maneuverability and facilitating Beijing's preference for informal agreements. China does not have a single water-sharing treaty with any of its neighboring countries. Accentuated by the unpredictable effects of climate change, China's disinterest in binding agreements has increased friction between China's and its riparian neighbors.

The lower riparian states are partly to blame for this situation. China has every incentive to deal with countries bilaterally because infighting among member states has politically weakened the regional institutions of Southeast and South Asia—namely, the Association of Southeast Asian Nations (ASEAN) and the South Asian Association for Regional Cooperation (SAARC). Because ASEAN operates by consensus, the political and socioeconomic diversity of its member states inherently undermines the organization's effectiveness. ASEAN's ten countries—Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam—are rarely able to find common ground on a wide range of issues, including climate change and water security. By comparison, SAARC, which comprises Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka, makes ASEAN look like a harmonious family. Specifically, strong mistrust between India and Pakistan has rendered the institution feckless. Without a united front, regional institutions such as ASEAN and SAARC cannot properly mobilize their political capital, thus weakening their ability to bring China to the negotiating table.

Solutions

To mitigate major conflicts over water originating in the Himalayas, China must reconsider the implications of its dam-development policies, both within and outside its borders. To do this, China will need to increase the transparency and rigor of environmental and social impact assessments prior to project construction. Other Asian countries also have a role to play, as they must put aside bilateral disputes, increase

energy efficiency at home, and seek a unified stance toward Chinese dam development upstream. Although little is known about the long-term impacts of climate change on the Himalayan watershed, there are clear signs that water levels are dropping. Thus, it is vital that the region agrees on frameworks for water sharing and significantly improves efficiency in water and energy management.

Within its borders, China's push to expand energy efficiency initiatives; make coal use more costly through consumption caps, trading, and taxes; and increase wind and solar energy development will help lessen the pressure on water resources from energy demands. Chinese policymakers also need to enforce existing targets and laws that aim to better manage water. Improving efficiency entails fostering a better understanding of the water-energy-food nexus and creating national consciousness of water and energy conservation through better enforced regulations and public awareness campaigns.

Internationally, China needs to show greater engagement in multilateral venues. For example, it could join the MRC as a full-fledged member rather than remaining a dialogue partner that only participates when advantageous. In South Asia, it is time for China to sign a water treaty with India. To build trust, Beijing also needs to make a greater effort to improve transparency in data-sharing and inform downstream neighbors of its dam-construction plans. In addition, China should take the lead in widening regional discussions about water security beyond hydroelectric power to include renewable forms of energy such as solar and wind.

As an upstream country, it is not necessarily in China's best interest to cooperate on these issues, and in the near term Beijing is unlikely to formally enter into any water-sharing agreements. If countries hope to engage with China, they will need to utilize a "carrot and stick" approach. The carrot will require initiatives that clearly demonstrate the economic benefits of responsible dam planning. There are many short-term studies and exchange programs targeting the Mekong and other rivers in the Himalayan Basin, yet few deeply engage Chinese researchers, hydropower companies, banks, and NGOs. The key to promoting sustainable development of the rivers is to broaden engagement with these stakeholders. This will require introducing biodiversity and water security as compelling factors in the economic calculus of dam building. For example, concern for their global reputation has led some Chinese hydropower companies to start adopting the Hydropower Sustainability Assessment Protocol, an enhanced sustainability assessment tool used to guide performance of hydropower companies. On the stick side,

regional organizations such as ASEAN and SAARC must put their bilateral agendas on the backburner to be cohesive multilaterally.

Pressure will need to come from inside China as well. Chinese citizens and civil society groups should continue to press companies and the government for greater transparency using open information tools. Chinese citizens, NGOs, and the news media have recently demonstrated that they can effectively pressure the government to improve environmental protection. When smog blanketed Beijing and much of northern China in December 2012 and early 2013, Chinese citizens broadcast their frustration widely on social media. Some Chinese NGOs even rented out personal air-quality monitors to have citizens post the registered "hazardous" readings online alongside official government air-quality reports that listed the air pollution as "fair" or "moderate." The Chinese media was also highly critical of the government's failure to lessen the choking pollution. The criticism online and harsh news media reporting prompted the government to make policy changes that included expanded monitoring and reporting of air pollutants, stricter targets for cutting coal use, and more stringent auto-emission standards. Thus, there appears to be an avenue for civic action, within bounds, to affect policy. Nascent public-interest lawsuits against polluters are also opening new doors for citizens, lawyers, and NGOs to strengthen environmental law enforcement.

Currently, the way in which water is being used outpaces natural replenishment rates. The United Nations has declared this year the "international year of water cooperation." It is time for China to take the lead before its regional relationships run dry. Chinese policymakers need to remember that if they hope to carve out a harmonious regional environment that is ideal for further economic development, China needs to be a good neighbor. ◈

Melting the Geopolitical Ice in South Asia

Robert G. Wirsing

No one doubts that the six mainland states of the South Asian Association of Regional Cooperation (SAARC)—Afghanistan, Bangladesh, Bhutan, India, Nepal, and Pakistan—harbor an abundance of varied water-resource problems, with a steadily mounting scarcity of freshwater ranking high among them. Because the South Asian region is laced with an array of transboundary rivers vital to the economies of these states, few doubt either that these problems have a geopolitical dimension. There has been vigorous argument about the scale and intensity of this dimension, fed to some extent by mass media–provoked alarm over the imminence of "water wars." While some skepticism is unquestionably warranted in this regard, the weight of informed opinion today, encouraged by a stream of sober warnings from both official and unofficial sources, recognizes that there is a clear and present danger of serious interstate tension caused by transboundary water disputes.

Adding immeasurably to the urgency and uncertainty of deliberations on the region's water circumstances are two further developments: the longer-term and clearly menacing consequences of climate change, and the shorter-term and worrisomely quickening pace of China's dam construction on transboundary rivers shared with South Asia. Under these circumstances, no wonder that many water experts are questioning whether South Asia has in place bilateral and multilateral frameworks adequate to the task of managing the region's increasing water insecurity. The record of interstate relations in this region over the past few decades offers meager assurance in this regard, but there are recent signs that governments are awakening both to the dangers of water insecurity and to the need for interstate cooperation in coping with them.

The Scarcity of Water in South Asia

Even a limited sampling of recent expert studies leaves practically no room for doubt about the magnitude of the region's problem of freshwater scarcity. A 2009 study by the 2030 Water Resources Group estimated, for

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example, that demand for freshwater by 2030 in vastly more populous and urbanized India would grow to almost 1.5 trillion cubic meters—about double its current water supply. "As a result," the group observed, "most of India's river basins could face severe deficit by 2030 unless concerted action is taken."[1] A comprehensive 2013 tri-nation study of the water resources of the Indus Basin gave a similarly dire forecast. With India's population expected to approach 1.7 billion by 2050, and Pakistan's likely to reach nearly 275 million by the same date, the annual availability of renewable water per capita across the basin (with a total population by then of about 383 million) could dip below 750 cubic meters—an internationally recognized threshold for severe water scarcity.[2]

Water resource conditions in the Ganges-Brahmaputra-Meghna Basin—the world's second-largest riverine drainage basin—differ significantly from those found in the Indus Basin but are also largely discomforting. Admittedly, a major recent study of water scarcity in Bangladesh contains some encouraging news. Examining meteorological data gathered from the 1940s to the present, the study finds that annual rainfall totals have held fairly constant. It also reports that only on one of the three major transboundary rivers for which data was collected—the Padma/Ganges—have changes in upstream hydrological patterns (such as rainfall, glacial melt, and water drawing or diversion) caused significant variation over time in dry season flow. However, given the importance of that river to southwestern Bangladesh, the study's finding of a more than 20% decline in the dry season flow since 1960 holds extremely serious consequences for the country's groundwater recharge and agricultural productivity.[3]

What this study's findings highlight is Bangladesh's exceptionally unfavorable freshwater dependency ratio. The country draws an estimated 91.4% of its surface water from 57 out-of-country rivers feeding into it (primarily from India and China). In other words, decisions made by

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1 2030 Water Resources Group, "Charting Our Water Future: Economic Frameworks to Inform Decision-Making," 2009, 10 ~ http://www.mckinsey.com/App_Media/Reports/Water/Charting_Our_Water_Future_Full_Report_001.pdf.

2 Indus Basin Working Group, *Connecting the Drops: An Indus Basin Roadmap for Cross-Border Water Research, Data Sharing, and Policy Coordination* (Observer Research Foundation, Stimson Center, and Sustainable Development Policy Institute, 2013), 18, available at http://www.stimson.org/books-reports/connecting-the-drops.

3 Kristian Hoelscher, "Trends in Rainfall and River Flows: Changing Ground Realities?" in Ashild Kolas et al., "Water Scarcity in Bangladesh: Transboundary Rivers, Conflict and Cooperation," Peace Research Institute Oslo (PRIO), PRIO Report, 2013, 47–54 ~ http://www.prio.no/publications/waterscarcity.

neighboring governments upriver about extraction and diversion are bound to have a major impact on future water security in Bangladesh, which is expected to grow from an estimated population of 161 million in 2012 to over 194 million in 2050. Extensive dam-building activity on the mainstreams and tributaries of the Ganges, Teesta, and Meghna rivers (by India) and on the Brahmaputra River (by China and India) inevitably exacerbates the extreme vulnerability of Bangladesh's water dependence and could very well negate whatever improvements Dhaka makes in domestic water management.

The Uncertainty Wrought by Climate Change

There is considerable uncertainty about the pace of climate change, a likely villain in the region's unfolding water insecurity drama. In May 2013 the U.S. National Oceanic and Atmospheric Administration (NOAA) reported that heat-trapping carbon dioxide gas had reached an average daily level in the atmosphere above 400 parts per million—a concentration not witnessed on earth for over three million years and an ominous warning that if global efforts continue to falter, the effects of climate change may become irreversible.[4] However, another scientific report released within days of the NOAA report claimed that the most extreme rates of warming predicted by some models appeared increasingly less likely.[5] Regardless of whether the consequences of climate change come quickly or not, there is a very strong consensus among climate scientists that the changes—higher temperatures, desertification, extreme weather events, erratic monsoons, rising sea levels, and glacial melt—will come eventually and will strike South Asia at least as harshly as any other region in the world. Taking glacial melt as an example, one of the most sober and careful studies done thus far of Himalayan glaciers maintains that the Hindu Kush–Himalayan (HKH) region's climate is undoubtedly changing, and that the livelihoods of over a billion people dependent on the major river systems with headwaters in this region are bound to be affected. The study concedes that many uncertainties remain about the precise causes and effects of glacial melt, as well as that important subregional variations exist in the rate at which glacial melt is occurring. Nevertheless, it declares unequivocally that "scientific evidence indicates that glaciers in the HKH region are retreating at rates comparable to those

4 Justin Gillis, "Heat-Trapping Gas Passes Milestone, Raising Fears," *New York Times,* May 10, 2013.

5 Alister Doyle, "Extreme Global Warming Seen Further Away than Previously Thought," Reuters, May 20, 2013.

in other parts of the world, and confirms that the rate has accelerated in the past century."[6] The study concludes that some parts of the climate science community believe "that the social effects of climate change are already more extensive than previously thought or recognized, and are mounting more quickly and more extensively than predicted."[7]

The Implications of Dam Building

Uncertainty, although of a quite different sort, also prevails in regard to China's dam-building activities on the Brahmaputra (called the Yarlung Tsangpo in China), the principal river that China shares with its South Asian neighbors. Already China has built a dozen or more dams in the vast Tibetan Plateau on tributaries of the Brahmaputra; and sometime in 2014 the 510-megawatt Zangmu Hydroelectric Project is expected to be completed. The project is the first of four in a cascade of now formally approved major dams on the river's mainstream. Beijing claims that these are all "run of the river" dams that have minimal water storage capacity and are thus unlikely to have any significant impact on downstream co-riparians. China also claims that it has no plans to divert water from the Brahmaputra and will always take into account the interests of downstream countries.[8]

Other observers, however, argue that China's dam construction on the Brahmaputra has significant strategic implications and that the country's leadership is entirely indifferent to the downstream impact of its dams. Foremost among these critics is Brahma Chellaney, who is based in New Delhi and is the author of *Water: Asia's New Battleground.* Chellaney argues that "by having its hand on Asia's water tap, China is therefore acquiring tremendous leverage over its neighbours' behaviour."[9] China now owns more large dams than the rest of the world combined but does not have a single water-sharing treaty with a neighboring state. If its plans for the Brahmaputra follow the pattern adopted on other transboundary rivers,

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6 Committee on Himalayan Glaciers, Hydrology, Climate Change, and Implications for Water Security et al., *Himalayan Glaciers: Climate Change, Water Resources, and Water Security* (Washington, D.C.: National Academies Press, 2012).

7 Ibid., 102.

8 "We Will Consider Interests of Downstream Countries, Says China," *Hindu,* January 31, 2013 ~ http://www.thehindu.com/news/international/we-will-consider-interests-of-downstream-countries-says-china/article4361993.ece.

9 Brahma Chellaney, "Water Is the New Weapon in Beijing's Armoury," *Financial Times,* August 30, 2011.

Chellaney predicts that China will proceed to build a series of ever-larger dams right up to the border with India.[10]

Other observers see the situation differently, arguing that China's dam-building activity is motivated overwhelmingly by the clear-headed recognition that the country's future political and social stability are heavily dependent on continued economic growth, which is, in turn, equally dependent on overcoming the country's mounting water and energy scarcities. China is not a water predator, in other words; its dam-building spree "has more to do with the need to power its energy-intensive economy, than with any policy of weaponisation in order to assert a hegemonic role in the region."[11]

Melting the Ice? Prospects for Regional Cooperation

Whatever its motivation, Beijing's consistently unilateral approach to dam construction on transboundary rivers—namely, its opacity in regard to future plans and strict avoidance of institutionalized water cooperation—justifiably alarms its co-riparians. There is no sign yet of any change in this approach. In April 2013, China rejected a proposal by India to create a new mechanism—for example, a water commission, an intergovernmental dialogue, or a formal treaty—for dealing with water issues between the two countries.[12] For extremely water-dependent Bangladesh, this is an undeniably dire matter; but India, too, finds little comfort in its relatively advantageous water dependency ratio (about 30.5%). Even though as much as 70% of the Brahmaputra's flow within India comes from below the Sino-Indian border, owing to the northeastern region's extraordinarily heavy monsoon rains, the fact remains that the monsoon season is brief and India possesses very modest water storage capacity. According to the Food and Agriculture Organization, "a fair estimate of water resources available for use to a country should include figures of dry

[10] Brahma Chellaney, "China's Great Water Wall: Damming Downstream Flow to Neighbors Could Trigger Water Wars," *Washington Times,* April 8, 2013.

[11] Pau Khan Khup Hangzo, "Transboundary Rivers in the Hindu Kush-Himalaya (HKH) Region: Beyond the 'Water as Weapon' Rhetoric," Centre for Nontraditional Security (NTS) Studies, S. Rajaratnam School of International Studies, NTS Insight, September 2012.

[12] "China Spikes India's Proposal for Joint Mechanism on Brahmaputra," *Hindu,* April 17, 2013 ~ http://www.thehindu.com/news/national/china-spikes-indias-proposal-for-joint-mechanism-on-brahmaputra/article4627285.ece.

season low flow,"[13] and such an estimate would yield a less sanguine reading of China's ability to leverage its control of the Brahmaputra's waters.

China's apparent reluctance to move in the direction of water transparency and joint mechanisms of water management is a formidable roadblock to regional cooperation on water security. Yet there are fairly strong signs that South Asian governments themselves are increasingly inclined to cooperate on this issue. In April 2013, Nepal, India, and Bangladesh forged an important agreement to jointly exploit hydropower and manage water resources for mutual advantage, especially in the Ganges River Basin.[14] Likewise, the Bangladeshi prime minister Sheikh Hasina plans to visit New Delhi in December 2013 for a renewed effort to forge a water-sharing agreement over the Teesta River. The initiative was dealt a near-fatal blow in September 2011 when the chief minister of West Bengal pulled out of the treaty-making exercise at the last minute. Domestic politics in both countries—including pressures on Bangladeshi leaders not to appear subservient to New Delhi and pressures on Manmohan Singh not to rush into a controversial agreement before India's national elections in 2014—ensures that inking a final draft will not be easy.

With respect to cooperation between India and Pakistan on water security, the 1960 Indus Waters Treaty (IWT) has survived over a half century, including the weathering of two major tests of its meticulously drawn conflict-resolution provisions. The first test concerned India's Baglihar Hydroelectric Project on the Chenab River in disputed Kashmir. In 2007 an appointed "neutral expert" granted New Delhi most of what it wanted, including extensive drawdown provisions for flushing silt. The second dispute, still in progress, is over India's Kishanganga Hydroelectric Project on a tributary of the Jhelum River, also in Kashmir. In February 2013 the Court of Arbitration in the Hague issued a "partial ruling" allowing India to proceed with construction of the dam, which will divert water from the Kishanganga River (called the Neelum River in Pakistan) to another tributary of the Jhelum. Of great importance, however, the court ruled that drawdown sediment flushing below the dead-storage level in the dam violates the IWT and that India, if it wishes to complete the project, must redesign the dam. Additionally, the court postponed until December 2013

13 "General Summary Asia: Water Resources," Food and Agriculture Organization, AQUASTAT ~ http://www.fao.org/nr/water/aquastat/countries_regions/asia/print3.stm.

14 Sujay Mehdudia, "Nepal, India & Bangladesh to Make Most of Ganga Water, Hydropower," *Hindu,* April 15, 2013 ~ http://www.thehindu.com/news/international/south-asia/nepal-india-bangladesh-to-make-most-of-ganga-water-hydropower/article4617600.ece.

a decision on the dam's minimum flow in downstream Pakistan during the dry season, a stipulation uniquely protective of the riverine environment and also indicative that India may have won the battle to build the dam but lost the war over the type of dam it can build.[15]

One may hope that the Court of Arbitration's decision will cause Indian and Pakistani leaders to consider adopting a new approach to management of the Indus Basin's water resources that would regard water "as a collective resource for the improvement of the entire region."[16] Similarly, in the wake of media reports that Indian expertise has been offered to Afghanistan to help in building as many as twelve hydropower projects on the Kabul River, which is a troubling prospect from Pakistan's perspective, one may hope that Afghan and Pakistani leaders will give thought to an IWT-like agreement for this east-flowing tributary of the Indus.[17]

Developments of these sorts, if they happen, would signal the long-awaited and—unlike glacial melt in the Himalayas—entirely welcome melting of the geopolitical ice in South Asia. Even if we choose to disregard warnings that the region is increasingly at risk of interstate water wars, the unmistakable signs of rapidly growing water insecurity leave no room for "business as usual" complacency. Replacing deeply ingrained habits of unilateral action with cooperative bilateral and multilateral water-sharing initiatives will undoubtedly prove daunting. But ensuring a decent existence for the hundreds of millions of people dependent on the Himalayan region's transboundary river waters demands no less. ◈

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15 John Briscoe, "Winning the Battle But Losing the War," *Hindu,* February 22, 2013 ~ http://www.thehindu.com/opinion/lead/winning-the-battle-but-losing-the-war/article4439676.ece.

16 "Leaders Call for Modernizing Indus Water Treaty," Atlantic Council, April 3, 2013 ~ http://www.acus.org/print/75408.

17 Khalid Mustafa, "India to Help Afghanistan Build 12 Dams on Kabul River," *News International,* May 12, 2011 ~ http://www.thenews.com.pk/PrintEdition.aspx?ID=5933&Cat=13&dt; and Gitanjali Bakshi, Michael Kugelman, and Ahmad Rafay Alam, "Bridge Over Troubled Waters," *Times of India,* December 8, 2011 ~ http://articles.timesofindia.indiatimes.com/2011-12-08/edit-page/30486468_1_dams-indus-water-treaty-water-security.

Himalayan Water Security: A South Asian Perspective

Tushaar Shah and Mark Giordano

South Asia has emerged during recent decades as a major theater of tension and conflict around shared rivers. The region is made up of predominantly rural, poor, and agrarian societies. While in recent years India has been showcased as an emerging economic power, the benefits of Indian economic growth have mainly been concentrated in the southern and western areas. Rural populations in eastern India, Nepal, Pakistan, and Bangladesh continue to have a high concentration of poverty. Persistent agrarian poverty has heightened tension over shared rivers. Concern is also growing among South Asian states that China's quietly but rapidly expanding dam-building activity in the Himalayan region will increase political tensions in South Asia, potentially leading to conflict.

This essay explores the myriad sources of water-related tensions between India and Pakistan in the Indus Basin and between India and Nepal and Bangladesh in the Ganges Basin. The essay first reviews the nature and sources of tensions among these South Asian neighbors. It then discusses newly emerging concerns about the potential impact of Chinese activities in Tibet on the lower riparian states in South Asia.

The Importance of Water Sharing

Although water wars rarely, if ever, take place between nation-states, water can play an important role in broader political conflict and tensions. Few regions in the world are home to as much interstate tension as South Asia. Pakistan and India were born out of war, and relations are still strained today with even simple transport and trade links severely restricted. Despite the fact that India helped Bangladesh gain its independence, the two countries still have problems, including sharing the waters of the Ganges, Teesta, and other rivers. Overarching all these disputes is the perception of India as the regional hegemon. India's actions on water issues are thus often viewed by its neighbors with suspicion. Adding ominously to this mix is China's growing use of eastern Himalayan waters.

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Despite these tensions, water forces the nations of South Asia to interact with each other. Nearly all the water in Pakistan, Nepal, Bangladesh, and Bhutan comes from a river shared with at least one other South Asian state. Even in India, where the large Deccan Plateau is hydrologically removed from the rest of the subcontinent, over 30% of water resources are shared. This water is crucial for lives and livelihoods in South Asia. The region is among the most populated in the world, with densities ranging from less than 300 people per square kilometer in the west of South Asia to over 1,000 in Indian Bihar and Bangladesh. While India has been recognized as an emerging economic power, it, like the region as a whole, remains predominantly rural, poor, and agrarian. The Ganges-Brahmaputra-Meghna Basin covering eastern India, Nepal, and Bangladesh has been dubbed South Asia's "poverty square," with substantially more people below the dollar-per-day poverty line than in all the countries of sub-Saharan Africa combined.[1] The fruits of much of South Asia's growth have been in southern and western Indian towns and cities—those generally not supplied by transboundary waters.

Obstacles to Water Sharing

Challenges in the west. When India and Pakistan were formed in 1947, the new boundary cut across long-established irrigation systems and the Indus tributaries that fed them. In 1960 the World Bank facilitated the signing of the Indus Water Treaty (IWT) between the two countries, under which India, as the upper riparian, ceded 80% of Indus waters to Pakistan (approximately 220 billion cubic meters) and kept the remaining 20% for its northwestern plains. While substantial tensions remain, the IWT has survived half a century and three wars between the neighbors. Islamabad remains understandably concerned that New Delhi might use water as a political tool and has challenged every move by India to undertake even IWT-approved run-of-the-river hydropower generation projects. These use flowing water merely to run turbines without reducing supplies to downstream users. General Ashfaq Kayani of Pakistan has often cited water as the justification for his India-centric military stance.[2] In India, too, there is growing doubt, especially in Jammu and Kashmir, about former prime minister Jawaharlal Nehru's generosity in committing, for all time to come,

[1] World Bank, *World Development Indicators 2009* (Washington, D.C.: World Bank, 2009).

[2] "Unquenchable Thirst," *Economist,* November 19, 2011 ~ http://www.economist.com/node/21538687.

the bulk of the Indus water to Pakistan when India's own northwest remains perennially parched. India is also frustrated because, as a lower riparian on the Brahmaputra River, it has received nowhere near the same considerate response from its upper riparian neighbor, China.

The problem in the east. Whereas the primary water issue in the west is scarcity, in the east it is abundance. Controlling the 380 billion cubic meters of annual flood flow in the Ganges River Basin presents a unique opportunity for hydropower generation in Nepal and flood control in Indian Bihar and Bangladesh. The technical problem for India and Bangladesh is that the flat plains of the lower Ganges Basin offer no sites for storing water. Dams in Nepal could yield an astounding 40 gigawatts of hydropower (57 times the country's current hydropower capacity) and provide flood control to the lower riparian states but are a cause for environmental, social, and political concern. For example, agreements signed by Nepal and India during the mid-1950s on the Kosi and Gandak tributaries to promote goodwill instead strained the relationship between the two countries because of issues related to compensation for land.

This strain was not fully mended even after rewriting the agreements a decade later to address Nepali concerns. While some progress has been made, much more could be done if Nepal's national politics were to stabilize and New Delhi could assuage fears that dam construction might infringe on Nepali sovereignty and primarily benefit India. India now takes much pride in what it views as a win-win collaboration with Bhutan on hydropower generation. Bhutan now earns over 60% of its rapidly growing GDP from hydropower sales to India.[3] Similar collaboration with Nepal could produce comparable benefits, and the two countries have created the Nepal-India Joint Ministerial Level Commission on Water Resources. However, early cooperation between India and Bhutan rested on an agreement to let India "guide" Bhutanese foreign and defense affairs. Addressing the real or perceived threat to sovereignty will be necessary for water cooperation to become politically viable in Nepal.

As the lowest riparian state in the Ganges-Brahmaputra-Meghna Basin, Bangladesh is most susceptible to flooding. Yet even in one of the world's most water-endowed countries, water scarcity has emerged as a prime concern in the dry season. When India constructed the Farakka Barrage to divert a portion of the Ganges waters to a Calcutta port, tensions built

[3] Sara Sidner, "Bhutan's Moving Gold: How Water Is Powering the Country," CNN, November 7, 2011 ~ http://www.cnn.com/2011/11/07/world/asia/bhutan-green-energy.

up in Bangladesh and created political upheaval. Under a 1996 treaty, India has promised minimum low-season flows from the Farakka Barrage to Bangladesh. While the accord at least establishes a mechanism for sharing water and resolving disputes, India's actual track record has caused Bangladesh considerable heartburn—yet another sign of a smaller country's mistrust of the regional power. In September 2011, Indian prime minister Manmohan Singh tried to make a similar commitment to Bangladesh on the Teesta tributary. However, the newly elected chief minister of West Bengal, Mamata Banerji, nipped the proposed Teesta accord in the bud at the last moment, greatly embarrassing the Indian prime minister.

China. The elephant in the South Asian drawing room, however, is China, which possesses territorial control over the vast Tibetan Plateau, the world's largest repository of freshwater. Unhindered by the dense human populations found elsewhere within its own borders, China has embarked on mammoth water projects on the plateau. This aggressive dam building has already made the downstream riparians in Southeast Asia—Vietnam, Laos, Thailand, and Cambodia—nervous. While continuing to build more dams upstream on the Mekong and Salween rivers, China is also now working on very large hydroelectric and river-diversion schemes on the Yarlung Tsangpo River, known as the Brahmaputra River in India.

Beijing reveals little about its current and future projects. According to observers, however, China has already constructed 10 dams on tributaries of the upper Brahmaputra, with 3 more under construction at Dagu, Jiacha, and Jiexu. It is also constructing a 510-megawatt dam at Zangmu as part of a plan to build 28 dams on the Brahmaputra before the river enters India. Most worrisome for New Delhi is a gigantic 38-gigawatt hydropower project that China is planning at the "great bend" at Motuo, where the Brahmaputra drops 2,500 meters into India.

Unlike all the co-riparians in South Asia, who have some mechanisms in place for discussing and negotiating water issues, China refuses to discuss such mechanisms. Despite high-level Indian officials having repeatedly raised their concerns about Chinese dam building on the Brahmaputra and its possible impacts on India, Beijing has refused to participate in an intergovernmental dialogue, a joint water commission, or a forum to discuss the creation of a treaty to deal with the water issues between the two countries. As the upper riparian state, China has in the past even refused to provide flood alerts or warn India about water releases from dams. In June 2000 a breach in an upstream dam in Tibet raised the Brahmaputra's water levels in Arunachal Pradesh by a massive 30 meters, leaving 26 dead

and 35,000 homeless. This damage could have been contained if China had alerted India. Instead, Beijing refused to even acknowledge the dam burst for months after the event. Similar unannounced releases of excess water by China also caused flash floods in Himachal Pradesh in 2000, 2001, and 2005. Bangladesh, as the lowest riparian state on the Brahmaputra, will bear the brunt of dam building by China in Tibet (and India in Arunachal Pradesh) but has even less influence than India in this runaway appropriation and development of the river's vast potential.

What Could the Future Hold?

One major obstacle to improved transboundary water governance within South Asia is political fluidity. None of the South Asian co-riparians, India included, have strong, stable, and confident governments capable of taking a long-term, diplomatic view of opportunities as well as threats. A second problem is strident nationalism, coupled with fears of India as a hegemon. A case in point is India's construction on a 2.9-hectare piece of Nepalese territory in the border town of Tanakpur. Under the agreement, India offered Nepal irrigation for 5,000 hectare and 20 megawatts of power per year as compensation. But the Nepali opposition used the small incident to bring down the government. This in turn led to a drastic amendment to Nepal's constitution requiring a two-thirds majority in the parliament to sign any water treaty with India.

A related barrier to cooperation has been the difficulty in disentangling water disputes from other bilateral problems and disassociating them from national political struggles. Discussions on water security between India and Bangladesh are influenced by issues such as the Bangladeshi migrant influx in India's northeast, Chakma refugees, porous borders, and insurgent groups in India's northeast. The Teesta accord mentioned earlier would have been highly favorable to Bangladesh and was offered to earn Dhaka's support in clamping down on two of the most lethal insurgent groups in India's northeastern region that operate out of Bangladesh. Yet, as mentioned above, the treaty was aborted because of state politics within India. Negotiations between India and Pakistan on water security are obviously colored by the broader territorial dispute in Kashmir and long-standing distrust, while Nepal's insecurities as a land-locked state dependent on India for trade and transit play a major role in its discussions with India. All three countries—Bangladesh, Pakistan, and Nepal—share in common a distrust and touchiness about India as the regional hegemon.

India, in turn, is frustrated in its attempts to reason with China, which exercises control over and has ambitious plans for the headwaters of all the rivers that flow into the subcontinent.

What can be done? Within South Asia, the overall improvement of bilateral relations would be a major step toward the improvement of water security. But since water security could also be a catalyst for cooperation, it may be prudent to find ways to build initial cooperation in this area as a step in solving other problems. Smarter internal politics will also be required to ensure that the central decisions of transboundary diplomacy have broader domestic support and do not turn into political tools. One positive development is the growing popularity of Track 2 discussions at civil society levels, where nongovernment players, with no power or role in government-level negotiations, offer open forums to air grievances and explore solutions before they become political.

On the surface at least, bringing China to the table appears to be one of the most vexing obstacles to water security in the Himalayan region. There are signs, however, that the time for change may be here. China is already India's largest trading partner, and their trade continues to grow. Harming this relationship would be economically disastrous for both countries. Li Keqiang just made India his first foreign visit as Chinese prime minister, with the stated purpose of building mutual trust and cooperation. Growing trade and economic interdependence in the Himalayan region may offer the best chance for a win-win resolution of regional water issues. ◈

Hydropower Dams on the Mekong: Old Dreams, New Dangers

Richard P. Cronin

Today, the Mekong River Basin is on the edge of a two-pronged calamity as a result of both the long-term and near-term actions of humans and governments. Of the two, short-term actions such as deforestation, the unsustainable consumption of groundwater, and the construction of large silt-trapping dams are having a far more immediate impact than global warming, sea-level rise, and the greater frequency of violent weather events. These near-term actions of governments—especially the construction of massive cascades of large dams on the Mekong mainstream and major tributaries—are accelerating and magnifying the now inevitable long-term effects of global warming and climate change, especially sea-level rise.

The current threat to the life-giving ecology of the world's most productive freshwater fishery stems from long-standing dreams of exploiting the river's valuable forests, minerals, rich alluvial deposits, and hydropower potential as a basis for economic development and industrialization. Because of the unavoidable trade-offs among energy, food security (fishing and agriculture), and other uses of water, these dreams may be not only unattainable without a cooperative, basin-wide approach but also a significant source of danger to regional peace and stability.

As part of its multibillion-dollar "go west" development program, China has set its course to fully exploit the huge hydropower potential of the upper Mekong River, which it calls the Lancang, without any consideration for the interests and concerns of its downstream neighbors. Beijing regards the upper Mekong as its national river and treats information on development plans, operational matters, and even the level of its reservoirs as national security secrets.

The downstream impact of China's dams in Yunnan Province on the lower, Southeast Asian half of the river can hardly be overestimated. Despite the recently accelerating pace of GDP growth throughout the river basin, tens of millions of people, mainly in Thailand, Cambodia, and Vietnam's Mekong Delta, still depend on the river's natural bounty for much of their food and livelihoods. The reservoirs of China's Yunnan dams, two of which are among the world's largest, together have the capacity to store at least

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half the average annual discharge of the upper Mekong. In addition to significantly changing the river's hydrology, the dam cascade will trap an estimated 80% of the historical load of nutrient-rich silt flowing from China, thereby reducing the fertility of the soil downstream and contributing to the intrusion of seawater into the Mekong Delta.[1]

Although the governments of the most vulnerable lower Mekong countries are increasingly aware of the threat posed by China's Yunnan cascade, they have yet to show the political will to curb even their own mismanagement of water, let alone make a serious effort to influence Beijing. Vietnam has long been constructing large dams on major tributaries of the Mekong in the Central Highlands. Cambodia is allowing the rampant destruction of its forests for dams and plantation agriculture. The Mekong Basin countries' equities in terms of trade, investment, and infrastructure loans are such that they are reluctant to openly challenge Beijing, especially when different levels of the Chinese government have made clear that downstream criticism will not deter China from pursuing its goals.

Revived Plans for Dams on the Lower Mekong

Even more consequential than the impact of the Chinese dams on the river's flow and sediment loads, the massive water storage capacity behind two of the dams (Xiaowan and Nuozhadu) has enabled the revival of a plan dating from the Cold War era for damming the lower Mekong. Nine of the dams would be constructed by commercial developers on the Lao (seven) and Lao-Thai (two) stretches of the mainstream, with two more in Cambodia. All but one of the planned dams would be large, ranging from 38 to 68 meters high, but with comparatively small reservoir storage capacity. The dams will decimate hundreds of species of fish consumed as food that migrate long distances to spawn and will trap additional silt from the already reduced flow from China.

Building the lower Mekong dams will also create a new and potentially very costly dependency on Beijing. Unless China releases enough water in the dry season, most, if not all, of the proposed dams would not be able to generate power during the driest months of the year. In light of China's growing water crisis and the impact of climate change, it is not out of the

[1] International Centre for Environmental Management (ICEM), "Strategic Environmental Assessment of Hydropower on the Mekong Mainstream: Final Report," October 2010, 69 ~ http://www.mrcmekong.org/about-the-mrc/programmes/initiative-on-sustainable-hydropower/strategic-environmental-assessment-of-mainstream-dams.

question that at some point in the future Beijing could revalue the water-energy trade-off and withhold water to satisfy other higher priority needs.

The proposed lower Mekong dams are all commercial projects that will be built, owned, and operated mostly by Thai and Chinese companies for 20–25 years, with Thailand's state-owned electric utility as the main customer. The planned Lao dams have created a storm of controversy involving not only environmental and human rights organizations and local civil society groups but also strong opposition from the Vietnamese and Cambodian governments.[2]

Inadequate Institutional Frameworks for Water Cooperation in the Mekong Basin

Efforts to promote cooperative and sustainable management of water resources have been stymied by two sets of problems. One set is political and psychological—jealous guarding of recently recovered sovereignty, vast differences of economic development and military power, and geography (upstream versus downstream locations). The other is the practical impossibility of equitably dividing and developing a shared water resource whose immense productivity of aquatic life and agricultural bounty is dependent on the maintenance of a signature flood-pulse hydrology that has evolved over millions of years.

The Mekong River Commission (MRC), headquartered in Vientiane, Laos, provides an institutional architecture for cooperative water management but does not have any decision-making authority of its own. Rather, the MRC secretariat works under the authority of the national Mekong committees of Cambodia, Laos, Thailand, and Vietnam. These committees, in turn, are chaired by officials from the ministries of natural resources and environment—among the weakest ministries in every one of the governments.

The Xayaburi Dam in northern Laos, which will sell 95% of its output to Thailand, provided the first test of the MRC's Procedures for Notification, Prior Consultation and Agreement (PNPCA). The outcome was regarded as disappointing at best and a debacle by its local and international critics.

Initially, at an MRC meeting in April 2011, following the end of the six-month review period prescribed by the PNCPA, Vietnam and

[2] Although its opposition to the Lao dams seems inconsistent, the Cambodian government has not made a final decision about a proposed dam at the Sambor. That decision could be influenced by what happens upstream in Laos.

Cambodia (and Thailand, temporarily) balked at accepting the project out of concern about the downstream impact on fisheries, sediment trapping, and livelihoods. These and other serious risks and uncertainties about mainstream dams had been raised by a strategic environmental review that had been carried out by expert consultants for the MRC and released in October 2010.[3]

In May 2011 the Lao government agreed to "suspend" the project to allow further studies because of strong opposition from the governments of Vietnam and Cambodia, in addition to civil society opposition in those countries and Thailand. Because work on site preparation had continued without interruption, it came as little surprise when, with strong Thai backing, the Lao government announced in November 2012 that the project would go ahead. The government's claims that downstream objections had been addressed by some still undocumented engineering changes met with strong disavowals from relevant Vietnamese and Cambodian officials. The outcome raised a fundamental question about the future of the MRC and the prospects for cooperative water development and management.

Another framework for Mekong Basin cooperation, the Greater Mekong Subregion (GMS) was initiated by the Asian Development Bank at the end of the Cambodian civil war in 1992. Comprising all six Mekong countries,[4] the GMS is a multibillion-dollar infrastructure development project that is building "corridors" with improved roads, bridges, and railroads and a regional electrical grid linking the major cities of the Lower Mekong Basin to each other and to Kunming, the capital and economic hub of China's Yunnan Province. Unfortunately, cooperative management of the river that gives the region its name is not part of the GMS agenda. China and some of the lower Mekong countries are happy to have improved transportation links but have not wanted to give up one iota of sovereignty when it comes to their stretches of the river.

The Obama Administration's Lower Mekong Initiative

In early 2009 the Obama administration's decision to launch the Lower Mekong Initiative (LMI) reflected Washington's serious concern about the uncertain future of cooperative water management in the Lower Mekong Basin, as well as about the growing geopolitical influence of China. The LMI

[3] ICEM, "Strategic Environmental Assessment of Hydropower on the Mekong Mainstream."

[4] The Greater Mekong Subregion comprises Cambodia, Laos, Myanmar, Thailand, Vietnam, and China (Yunnan Province and the Guangxi Autonomous Region).

drew on the United States' ability to convene countries to promote capacity-building. Cambodia, Laos, Thailand, Vietnam, and subsequently Myanmar embraced the opportunity to diversify their sources of diplomatic and development support.

The LMI was never intended to become another framework for regional cooperation, and its funding averages only about $200 million a year. However, the initiative complements the MRC in two ways. First, the MRC countries and Myanmar each accepted responsibility for one (or in Thailand's case, two) of the LMI "pillars," which include education, health, environment and water resources management, and regional connectivity. These meetings involve different ministries, as appropriate to the particular pillar under discussion, whereas the MRC involves only the ministries of natural resources and the environment. Second, the LMI requires higher-level political engagement because of the United States' role.[5] In the Mekong region, the LMI is the most significant nonmilitary element of the Obama administration's decision to "rebalance" U.S. military assets to Asia and the western Pacific.

Last Chance for Cooperative Water Development in the Lower Mekong Basin

Growing contention over constructing mainstream dams on the lower Mekong is creating new divisions in a region still recovering from decades of bitter conflict and threatening the very idea of a shared river for a shared future. Thus far, Laos has placed its goal of becoming the "battery of Southeast Asia" above its commitment to the letter and spirit of the 1995 Mekong Agreement and the PNPCA process. Likewise, Thailand, under the strongly pro-business government of Yingluck Shinawatra, has put the goal of diversifying its sources of energy over its interest in supporting multilateral cooperation among the MRC countries, instead emphasizing bilateral relations. In the case of Laos, the government has announced its decision to go ahead with two more dams: Pak Beng in the north and Don Sahong at Khone Falls on the border with Cambodia. The Lao government has said that it will submit the Pak Beng Dam to a PNPCA review but not the Don Sahong Dam. The latter dam, though not spanning the entire river,

5 The Obama administration also counts the twelve-country Trans-Pacific Partnership as an important nonmilitary aspect of its "rebalancing" toward Asia, especially given Vietnam's participation. The negotiations, however, were not initiated by the United States and also include four Western Hemisphere members (Canada, Chile, Mexico, and Peru).

will block the most important channel through the falls for fish migration. Unless the MRC is able to carry out a more effective PNPCA review of both projects, and Laos is more responsive to downstream countries, tensions will continue to rise.

One possibility to bridge the current divide would be negotiating a consensus agreement on the maximum acceptable transboundary impact of mainstream dams—a kind of "Mekong standard." Data gathered by the now uncertain follow-up study to the 2010 Strategic Environmental Assessment would be used to identify metrics for assessing the transboundary impacts of individual dams and the cumulative impacts of alternative scenarios for multi-dam cascades. The underlying objective of such an agreement would be to ensure that development of the lower Mekong's hydropower potential occurs in a coordinated and equitable fashion that maximizes the benefits and minimizes the transboundary costs of any configuration of dams. Such an agreement would not be without precedent. The 1995 Mekong Agreement already requires that mainstream diversions do not interfere with acceptable "natural" minimum dry-season flows and flood season reverse flows into the Tonle Sap.

The *sine qua non* of more coherent, equitable, and sustainable hydropower development would be the construction of a power grid in the Lower Mekong Basin. A grid linking the four MRC countries (and theoretically even Myanmar and China) would make it possible to confine dam construction to northern Laos, where the river is narrower and fisheries are less important, and avoid the much greater impact on fisheries and agriculture from dams in southern Laos and Cambodia. Any national or regional power deficits could be made up by a combination of conservation measures—for which there currently is great scope, especially in Thailand—and other energy sources. The Strategic Environmental Assessment estimated that if all of the planned mainstream dams were built, they would only satisfy 6%–8% of the estimated power demand in the Lower Mekong Basin by 2025—the equivalent of one year's increase in demand from 2015 to 2025—and that Laos would gain about 70% of the total power benefit (mainly revenues and avoided thermal power costs) of the eleven dams.[6]

[6] For the purposes of calculating the total projected electric power output, the strategic environmental review also included a twelfth project that is a water diversion, not a dam. All the environmental, socioeconomic, and other impacts identified by the environmental review were calculated on the basis of eight Chinese dams and eleven lower Mekong dams. See ICEM, "Strategic Environmental Assessment of Hydropower on the Mekong Mainstream," 11–12.

Cambodia, which now depends almost totally on diesel-fueled generators, could purchase power from the grid.

Ultimately, neither the MRC nor the GMS can effectively promote cooperation on sustainable development without the requisite political will. Unwittingly, the tendency of the four MRC countries thus far to prioritize one kind of national interest over their broader shared interest in regional cooperation may jeopardize a more important but insufficiently recognized interest in regional peace and stability. ◈

Climate Change and Water Security in the Himalayan Region

Richard Matthew

The hydrological system of the Himalayan region, upon which some 1.5 billion people depend, is under enormous stress.[1] Expected changes in water availability could threaten the region's agricultural economies, place pressure on rapidly growing urban areas, impose constraints on economic development, amplify and introduce public health challenges, compel governments to use scarce funds to manage disasters, and contribute to corruption, institutional breakdown, and violent conflict on different scales. Policies are needed that bring the countries in this turbulent region together to address the factors causing water stress, ensure that new sources of water stress do not emerge or grow too large, and manage the mounting social effects of this problem.

Causes of Water Stress

Water stress typically refers to a decline in the annual supply of blue water measured on a per capita, or per hectare of arable land, basis and then compared with a global average or with local and projected demand. Water stress often manifests as scarcity, drought, and flooding. Population growth contributes to this problem, but it is the product of many other forces as well, most notably climate change.[2] According to the 2007 reports of the Intergovernmental Panel on Climate Change (IPCC), the mean temperature of the planet is increasing, ice sheets and mountain glaciers are melting, sea levels are rising, the planet's mid-latitudes are becoming drier, the high and low latitudes are becoming wetter, and the frequency and intensity of floods, droughts, and wildfires are increasing.[3]

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[1] I use the term "Himalayan region" to represent the area encompassing the large, young mountain ranges of Asia—the Karakoram, Himalayan, and Hindu Kush—that run from Afghanistan through Pakistan and India to China along with the Tibetan Plateau and the Indian subcontinent, which are separated by these mountain ranges and which depend on water flowing from them.

[2] Kenneth Pomeranz, "The Great Himalayan Watershed: Water Shortages, Mega-Projects and Environmental Politics in China, India, and Southeast Asia," *Asia-Pacific Journal,* no. 29 (2009).

[3] S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, eds., *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge: Cambridge University Press, 2007) ~ http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html.

By virtue of its geography, the Himalayan region is particularly vulnerable to the impact of climate change. The rise in mean temperature here has been higher than the global average, and this trend is expected to continue. Glacial retreat is occurring very quickly in the eastern and central Himalayas, and at high elevations this is expected to translate into a significant reduction of stream flow. At lower elevations, climate change is likely to affect the timing, location, and volume of the monsoon in significant ways. While there is much uncertainty, the evidence compiled to date describes a region at the forefront of global climate change.

Second, according to recent analysis of satellite data measuring fluctuations in gravitational force on the earth's surface, both the South Asian subcontinent and the Tibetan Plateau, which the Himalayan, Hindu Kush, and Karakoram mountain ranges divide, are losing groundwater. While climate change might affect the replenishment of some stocks of groundwater, or lead to their contamination due to salt intrusion from rising sea levels, groundwater loss is due mainly to overuse for irrigation. This is a classic "tragedy of the commons" scenario, in which the small-scale unsustainable actions of individuals aggregate into enormous collective losses. Pakistan, for example, which is a very arid country, depends on groundwater for more than 50% of its irrigation and is especially sensitive to this trend.[4]

Third, and further complicating matters, in recent years countries on both sides of the Himalayas have developed plans for hundreds of new dams, mainly for hydroelectric power but also as reservoirs to hedge against drought.[5] All of Asia's major rivers—including the Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Salween, Yangzte, and Yellow—originate in these mountains, and most of them begin across the Chinese border in Tibet. They represent enormous hydroelectric power potential, but large dams invariably impose large social and environmental costs—harnessing sacred waters, displacing people, affecting river and silt flows, and destroying habitats. Some analysts are concerned that the impacts of climate change on water have not been factored sufficiently into dam design. For example, dams may be damaged by outburst floods from glacial lakes or suffer higher than normal rates of evaporation from reservoirs due to warmer

4 Simi Kamal, "Use of Water for Agriculture in Pakistan: Experiences and Challenges" (presentation at the Conference on the Future of Water for Food, University of Nebraska, Lincoln, May 3–5, 2009) ~ http://research.unl.edu/events/futureofwater/ppt/SKNebraska.pdf.

5 M. Tajuddin Sikder and K. Maudood Elahi, "Environmental Degradation and Global Warming—Consequences of Himalayan Mega Dams: A Review, *American Journal of Environmental Protection* 2, no. 1 (2013): 1–9.

temperatures. Because they are cheap to operate, dams tend to provide a handsome rate of return for many years, but climate change could dramatically subvert this calculation. Other analysts worry that China may have a hidden agenda insofar as the region's water resources are concerned. One well-known claim, for example, is that if China builds a dam on the Yarlung Tsangpo River in Tibet, Beijing will divert this water to the planned South-North Water Diversion Project. This is water that currently flows into the Brahmaputra River and is crucial to its health, as well as to the water resources of South Asia.

Outlook for Water Security in the Himalayan Region and Opportunities for Cooperation

Climate change, unsustainable groundwater use, and plans for hundreds of new dams combine to create a deeply alarming picture of dramatic hydrological change. In the worst-case scenarios the social consequences are devastating. The six main countries of this region are already overrepresented on Maplecroft's Natural Disasters Risk Index (Pakistan is 4th, India is 11th, China is 12th, and Afghanistan is 15th) and the Fund for Peace's Failed States Index (Afghanistan is 6th, Pakistan is 13th, and Nepal is 27th).[6] Recent studies, such as the National Academy of Science's 2012 report *Himalayan Glaciers: Climate Change, Water Resources, and Water Security*, envision changes in water availability leading to population displacement, agricultural and fishing losses, disease outbreaks, and conflict that could become violent and spill over state boundaries.[7] These effects are expected to be especially severe for downstream countries—i.e., all countries other than China. Some effects are already clear. For example, dams in India already affect the flow of silt into Bangladesh. This silt is critical to maintaining the Sundarbans as a forest barrier against flooding; as silting declines, flooding worsens and the human costs mount.

Of course, many effects are not certain. Variables that are hard to model, such as changing cloud cover, could have a dramatic and unforeseen effect on the region's hydrology. Human adaptiveness and ingenuity might prove sufficiently agile so as to target and avoid worst-case outcomes. But current trends provide no basis for policy complacency. The arid areas of the

6 "Asia Most at Risk from Natural Disasters," IRIN, May 10, 2010 ~ http://www.irinnews.org/report/89305; and Failed State Index, Foreign Policy and Fund For Peace, 2012 ~ http://www.foreignpolicy.com/failed_states_index_2012_interactive.

7 See National Research Council, *Himalayan Glaciers: Climate Change, Water Resources, and Water Security* (Washington, D.C.: National Academies Press, 2012).

region are becoming drier, mean temperature is rising faster than the global average, flooding is becoming more frequent and intense, many glaciers are shrinking, and the monsoon is changing in terms of timing, location, and intensity. Unfortunately, while water connects the fates of some one and a half billion people in the region, and in theory could unify them around a common agenda, history and politics divide them, and these divisions run deep. In the 21st century alone, for example, violent conflict has plagued Afghanistan, Bangladesh, Bhutan, Burma, India, Kashmir, Pakistan, Nepal, and Sri Lanka.

Still, the Himalayan hydrological system begs for strong regional management institutions. The great rivers that originate in Tibet and Kashmir flow into Afghanistan, Bhutan, China, India, Nepal and Pakistan Some of this flow moves farther south as the Mekong River system into Burma, Cambodia, Laos, Thailand, and Vietnam. Unfortunately, cooperation among these countries has been largely ceremonial and ineffective. There is little to build upon in this regard.

There are many ways to think about the prospects for cooperation. Considerable research has focused on the importance of a great power, or a hegemon, that is willing to lead and provide much of the funding for cooperation. In this case, the only viable contender is India, but New Delhi has tense relationships with all of India's border countries and no particular status in Southeast Asia, has not yet found a compelling way to align national and regional interests, and faces considerable domestic challenges as the country seeks to improve the living standards of roughly 400 million people. Absent a hegemonic power, cooperation can be very difficult to establish and maintain. In this case, there is a large number of actors, some of which have very little interaction with each other. Furthermore, the benefits of cooperation, at least in the short term, are not entirely clear and may be a long time in coming. These are conditions that tend to mitigate against high levels of cooperation.

Without the familiar conditions that enable and reinforce regional cooperation, it is perhaps not surprising that existing institutions, such as the South Asian Association for Regional Cooperation (SAARC), have done little in the sphere of water management. SAARC, for example, has produced a report on the region's environmental challenges, established a few technical and management committees, and adopted the Thimphu Statement on Climate Change—modest actions with little tangible effect. It may be particularly handicapped as a consensus-based organization that avoids the many contentious areas of bilateral conflict, such as the reform

of the Indus River Treaty between Pakistan and India. SAARC also cannot build on achievements in economic or security integration, which are often the first issues to mobilize regional attention and cooperation, because these have been modest.

Although moving from the status quo to effective regional cooperation may not be a quick process, there is an obvious next step that should be taken. Weather, topography, and borders have made the Himalayan region a very difficult one to study. Many questions remain about how this unique area has managed warming in the past and how exactly climate change is playing out today. Better data is critical to agenda setting and policy formulation, as well as to infrastructure design and social adaptation. In this regard, the International Centre for Integrated Mountain Development, located in Kathmandu, currently brings together eight countries of the region to carry out research and share knowledge.[8] The organization offers a platform for expanding regional hydrological science that should be carefully built up. Expanding the region's epistemic community of scientists may generate a shared understanding of the fundamental characteristics of growing water stress and a shared commitment to finding efficient, effective, and equitable solutions. It might also encourage transparency in other areas, such as dam construction, where imperfect information and mistrust kindle tension.

The United States can support the buildup of scientific cooperation, share its experiences with regional cooperation, and use its great technical and diplomatic resources to encourage more productive political relationships. The recent National Research Council report *Himalayan Glaciers: Climate Change, Water Resources and Water Security* (2012) is a good example of how the U.S. scientific community can collaborate with local scientists and hence assist in understanding the region's water stress.[9]

Though limited in many ways, the role of the United States might be expanded if it were to deepen its physical presence in the region. Some obvious strategies would be to encourage American students to study abroad, especially in China and India; support university-based research collaboration; and promote social enterprises that have U.S. participation and are addressing important regional issues such as the use of inefficient cook stoves, which add vast quantities of black carbon into the region's air.

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8 The eight SAARC members are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

9 Committee on Himalayan Glaciers, Hydrology, Climate Change, and Implications for Water Security et al., *Himalayan Glaciers: Climate Change, Water Resources, and Water Security* (Washington, D.C.: National Academies Press, 2012).

Ultimately, however, reducing water stress in the Himalayan region will depend on the foresight and commitment of key regional countries like China, India, and Pakistan. Scientific collaboration can nurture this process, but political and private sector leadership needs to be mobilized soon. The region is tracking toward a worst-case scenario of lower agricultural yields, more frequent and intense natural disasters, population displacement, public health setbacks, and conflict over access to water resources. Unfortunately, attempts at regional cooperation, such as SAARC, provide little basis for optimism. At this point, it is not clear that China, India, and Pakistan can overcome political differences that have persisted since the 1947 partition and find fair and effective solutions to their shared water challenges. Kashmir, the site of violent conflict in 1947, 1965, and 1999, would be a good problem to resolve quickly, building trust and laying the foundations for tackling larger issues. A beautiful valley with a polarized population, rapidly degrading freshwater, chronic turmoil, contested borders, and competing visions of what its future should be, perhaps Kashmir could be granted independence or redefined as an international peace park with a high level of political autonomy. Trapped by three immovable giants, however, it seems sadly destined to experience more human and ecological violence in the years ahead. Still, a conference scheduled for mid-2013 in Islamabad will bring the various parties together, and perhaps some good news will emerge from that meeting. ◈

Securing the Himalayas as the Water Tower of Asia: An Environmental Perspective

Jayanta Bandyopadhyay

The crucial role of mountains as the creators and providers of large volumes of freshwater and as the natural storage site of this vital ecosystem service attracted the special attention of world leaders after the United Nations Conference on Environment and Development in 1992.[1] This essay addresses the role of the Himalayas as the provider of crucial freshwater supplies to a larger number of people than any other mountain range in the world. The essay first describes the eco-hydrology of the Himalayan region, and then turns to examine the role of the Himalayan rivers in Asia's economic and demographic growth. It concludes by analyzing the ecological imperative of sustaining the Himalayan waters.

Himalayan Waters: An Eco-hydrological Background

In terms of the number of people who depend on such "water towers" for their survival and well-being, the Himalayas are the most important. The Himalayan region, encompassing the Hindu Kush mountains and the Tibetan Plateau, spans an area of more than 4.3 million square kilometers spread across Afghanistan, Bhutan, China, India, Myanmar, Nepal, and Pakistan. The region stores more snow and ice than anywhere else in the world outside the two poles and thus is popularly known as "the third pole."[2] Containing the highest mountains of the world, the Himalayas act as a great barrier to global atmospheric circulation. The Indian summer monsoon and the East Asian monsoon interact in this environment to provide a large portion of the water supply of Asia. Ten major rivers emerge from the Himalayan region, making it a crucial ecological buffer. These rivers include the Yellow and Yangtze, which emerge from the

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[1] For further discussion of the role of mountains as the "water towers of the world" in the global freshwater supply, see Jayanta Bandyopadhyay, "Water Towers of the World," *People and the Planet: People and Mountains, Pinnacles of Diversity* 5, no. 1 (1996) ~ http://lib.icimod.org/record/9992/files/297.pdf.

[2] See "What Is the Third Pole?" International Centre for Integrated Mountain Development Foundation (ICIMOD) ~ http://www.icimod.org/?q=3487.

Qinghai Plateau and provide water to densely populated parts of the north China plain; the Mekong, Salween, and Irrawaddy, which flow southward from Tibet into Southeast Asia; the Ganges-Brahmaputra-Meghna, which drains large areas both north and south of the Himalayas and provides about two-thirds of the total annual river flow for India; and the Indus, which is the lifeline of Pakistan.

The scale of the ecosystem services that the Himalayas provide is almost without parallel in human history. The Himalayan river basins are home to about 1.3 billion people and supply water, food, and energy to more than 3 billion people.[3] Human intervention in the flow of these rivers must be based on adequate knowledge of three vital constituents of the Himalayan rivers—water flow, sediment load, and energy potential.

Since a large amount of the precipitation in the high mountain areas is stored in snow cover and glaciers, there are natural delays in the outflow of the melt water. In this way the Himalayan rivers provide crucial water supplies during dry periods. While the importance of high sediment loads in the eco-hydrology of the Himalayan rivers is well-known, knowledge of the amount of sediment carried and its role in the rivers' morphological dynamics is still at a rudimentary stage. Despite early research on the geological denudation of the Himalayas and the expansion of the Bengal deep-sea fan at the end of the Ganges-Brahmaputra-Meghna Basin,[4] accurate information on the generation, transportation, and final deposition of sediment from the Himalayas is difficult to find. In addition, only recently have attempts been undertaken to quantify the amounts of water produced by the Himalayas. Bodo Bookhagen and Douglas Burbank have developed a hydrological budget and established an important correlation between precipitation and run-off in 27 Himalayan rivers of South Asia, starting from the Yarlung Tsangpo in the east to the Indus in the west.[5] The relative contributions of rainfall, snow melt, and glacier melt—the three factors that constitute the river flows—vary significantly from the eastern extreme of the Himalayas to the western. For example, Yarlung Tsangpo in the eastern part of the region receives about 34% of its flow from snow and glacier melt, while the Indus in the west depends on melt for 66% of its flow.[6]

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3 "What Is the Third Pole?"

4 Joseph R. Curray and David G. Moore, "Growth of the Bengal Deep-Sea Fan and Denudation in the Himalayas," *Geological Society of America Bulletin* 82, no. 3 (1971): 563–72.

5 Bodo Bookhagen and Douglas W. Burbank, "Towards a Complete Himalayan Hydrological Budget: Spatiotemporal Distribution of Snowmelt and Rainfall and Their Impact on River Discharge," *Journal of Geophysical Research: Earth Surface* 115, no. F3 (2010).

6 Bookhagen and Burbank, "Towards a Complete Himalayan Hydrological Budget."

Himalayan Waters as Input for the Asian Economic Growth

While irrigation remains the principal form of water use in Asia, in recent decades the Himalayan rivers have also helped power the region's high rates of economic growth, particularly in burgeoning urban and industrial parts of China and India. To meet rising demand, governments initially took a business-as-usual approach to augmenting water supply. China has undertaken a large-scale project to transfer water from the Yangtze River in the south to the north, while India began trying to link water-rich rivers with those in drier areas. There are three transfer projects in China, though the third one in the province of Sichuan has not materialized yet. The linking project in India has connected some rivers, but the scale of the transfer is not still very high. The cumulative impact of earlier diversion projects led to lower river flows and quickly caused environmental degradation and the loss of related ecosystem services. Water quantity dwindled and water quality was drastically reduced. For example, one of the two mother rivers in China, the Yellow, dried up and had no ability to flow out to the Bohai Sea for long periods.[7] The Ganges, one of India's mother rivers, is now polluted from almost its glacial roots, despite liberal funding from the Indian government for cleaning it. The situation is similar in Bangladesh, Nepal, and Pakistan.

The problem of freshwater scarcity becomes more critical when projected future water requirements are considered. In 2025, water demand in China will reach more than 1,100 billion cubic meters (bcm) in the business as usual approach, while only about 873 bcm of water is presently usable. Similarly, in India there is presently only 1,123 bcm of usable water, while demand is projected to reach 1,180 bcm in 2050. The continued rapid economic growth and improvement in the quality of life in Asia thus depends on sustaining the available supplies of freshwater and innovating a more resource-efficient economic path. This poses a great challenge for water science, engineering, and policy, especially in the region's two largest and economically strongest countries, China and India.

The urgency of the above objectives becomes absolutely clear when the potential impacts of global warming and climate change on the flows of the Himalayan rivers are considered. According to the International Centre for Integrated Mountain Development,

[7] Yanbo Sun, Deng Qun, and Xia Jun "The Making of Artificial Floods and Impact Assessment in Yellow River," in *Water Security to Climate Change and Human Activity in East Asia and Pacific Region,* ed. Xia Jun and Liu Suxia (Beijing: China Meteorological Press, 2008).

> Mountain systems are particularly sensitive to climate change…. The rate of warming in the Third Pole region is significantly higher than the global average, and the rate is higher at higher altitude, suggesting a greater vulnerability of the cryosphere environment to climate change. This trend is expected to continue. Climate change projections suggest that all areas of South Asia are likely to warm by at least 1°C by the end of the century, while in some areas the warming could be as high as 3.5–4°C. The life and livelihoods of the people in the Third Pole region is challenged due to climate change, and the stability and prosperity of the region affected by the Third Pole is at risk, which will have implications for all of Asia and for the world.[8]

The deeper crisis is that there is still a large gap in scientific knowledge of these processes and their potential implications for Himalayan rivers. The absence of a dependable database for effective climate modeling that fits the micro-climatic details in the Himalayas is a serious problem in need of immediate attention.[9] While Lamadrid and MacClune have made a push toward filling this gap, further research into the environmental sustainability of the Himalayan watershed is an urgent prerequisite for sustained economic growth and development in Asia.[10]

The Environmental Sustainability of the Himalayan Rivers: A Regional Task of Global Significance

The Himalayas offer suitable landforms for storage dams, and the quickly growing water demands of the surrounding plains have led to the rapid building of dams there. The Xiaolangdi Dam on the Yellow River and Bhakra Dam on the Sutlej River, for example, were heralded as great contributors to economic growth in China and India, respectively. With the passage of time, however, the environmental impacts of dams have generated concerns and environmental movements pushing for a new understanding of the role of engineering interventions in the Himalayan rivers. The Three Gorges Dam on Yangtze River in China and the Tehri Dam on the Bhagirathi River in India generated serious concerns over sustainability. High sediment loads have further complicated matters, since separation of the sediment from water becomes a costly engineering challenge.[11]

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8 "What Is the Third Pole?"

9 Jayanta Bandyopadhyay, "Climate Change and Hindu Kush-Himalayan Waters: Knowledge Gaps and Priorities in Adaptation," *Sustainable Mountain Development,* no. 56 (2009): 17–19.

10 See Lamadrid and MacClune, "Climate and Hydrological Modeling."

11 K.G. Ranga Raju, U.C. Kothyari, and M.K. Mittal, *State of Art Report on Reservoir Sedimentation* (Roorkee: National Committee on Hydrology, 2010).

Nevertheless, the Himalayan rivers have continued to be the major focus of dam-building efforts. In future decades, hundreds of hydropower dams are slated to be built on the tributaries of the Brahmaputra on the southern aspect in India and Yarlung Tsangpo in China. This river had not been interfered with until recently, and the extent of the strategic environmental implications are not clearly known. In particular, the proposed structural intervention by China at the Yarlung Tsangpo bend has drawn global media attention to the possibility that the Brahmaputra will dry up downstream in India during the lean season. In reality, the Yarlung Tsangpo is a minor contributor to the total flow of the Brahmaputra. Further, snow and glaciers supply about 34% of its total flow. What is significant in the flow of the Yarlung Tsangpo is not the water but the very large potential for energy generation. A hydropower project at the Yarlung Tsangpo bend would be more attractive for China than a project to physically transfer water. Dams that are being built or planned on the Mekong and Salween rivers require more serious attention with respect to changed flow patterns and reduction in the total flows, if any.

In view of the challenge of food security given the large population in Asia, the task of ensuring the environmental sustainability of the Himalayan rivers is of paramount significance. Further, predicting the impact of global warming and climate change on the Himalayan rivers has attained very high priority for Asia as a whole. It is in the broader regional interest, as much as in their own interest, that the countries sharing the Himalayas take early collaborative steps to address these issues before environmental changes—in particular, climate change—leaves them fewer options. As larger stakeholders, in terms of both population and scientific capability, China and India must play a central role in creating such a collaboration. There is an immediate need for collaborative research to provide greater clarity about the details of hydro-meteorological processes in the Himalayas. The devastating flood in the Indian Himalayan state of Uttarakhand that occurred in June 2013 and killed thousands of people is a case in point.

Further, the task of developing suitable modeling for predicting the impacts of global warming and climate change is equally urgent.[12] The controversy over the rate at which the Himalayan glaciers are shrinking

[12] T.D. Yao et al., "Third Pole Environment," UNESCO-SCOPE-UNEP Policy Briefs, no. 13, June 2011.

shows the need for high-level scientific research on this topic.[13] There actually may be more water in total flowing in the Himalayan rivers as a result of increased rainfall under a warmer climate regime. This would reduce the ability of the mountains to store water naturally in snow and glaciers and there may create new pressure for the construction of additional storage structures. On the one hand, the new climate regime may enhance the existing problem of floods in Himalayan rivers, while also leading to greater sediment generation and transportation. On the other hand, the greater availability of rainfall could be a win-win situation if ecologically sustainable and socially acceptable policies for its storage are put in place. The advancement of science and policies for achieving the goal of sustainability is a global challenge that will need to be achieved through extensive regional collaboration at various levels ranging from water science to hydro-diplomacy. Specifically, this is an opportunity for China and India to establish their credibility as leaders in sustainability science and engineering. ◈

[13] V.K. Raina, "Himalayan Glaciers: A State-of-Art Review of Glacial Studies, Glacial Retreat and Climate Change," Indian Ministry of Environment and Forests and the G.B. Pant Institute of Himalayan Environment and Development, November 12, 2009.