Asia Society

Asia's Next Challenge:
Securing the Region's Water Future

A report by the Leadership Group on Water Security in Asia

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Asia Society

Leadership Group on Water Security in Asia

Chairman

Tommy Koh, Singapore's Ambassador at Large; Chairman, Asia Pacific Water Forum

Project Director

Suzanne DiMaggio, Director, Asian Social Issues Program, Asia Society

Principal Advisor

Saleem H. Ali, Professor of Environmental Planning and Asian Studies, University of Vermont

Members

Andrew Benedek, Founder, Chairman, and CEO, ZENON Environmental, Inc.

Gareth Evans, President, International Crisis Group; former Foreign Minister of Australia

Ajit Gulabchand, CEO, Hindustan Construction Co. (India); founding member of the Disaster Resource Network (DRN) in collaboration with the World Economic Forum

Han Sung-joo, Chairman and Director, Asan Institute for Policy Studies; former Foreign Minister of South Korea

Yoriko Kawaguchi, Member, House of Councillors; Chair of the Liberal Democratic Party Research Commission on Environment; former Foreign and Environment Minister of Japan

Rajendra Pachauri, Chairman, Intergovernmental Panel on Climate Change; Director-General, The Energy and Resources Institute (TERI)

Surin Pitsuwan, Secretary-General, Association of Southeast Asian Nations (ASEAN); former Foreign Minister of Thailand

Jeffrey Sachs, Director, Earth Institute, Columbia University

Nafis Sadik, Special Advisor to the UN Secretary General; former Executive Director of the UN Population Fund

N.G. Wickremeratne, CEO, Hayleys Limited (Sri Lanka)

Erna Witoelar, Chair, Partnership for Governance Reform; former UN Special Ambassador for Millennium Development Goals in Asia and the Pacific; former Minister of Human Settlements and Regional Development of Indonesia

Xianbin Yao, Director General, Regional and Sustainable Development Department, Asian Development Bank

Yuan Ming, Director, Institute of International Relations, Peking University

Contributing Writers

Margaret Chan, Director-General, World Health Organization

Upmanu Lall, Director, Columbia Water Center, Earth Institute at Columbia University

Kapil Narula, Director, India Office, Columbia Water Center, Earth Institute at Columbia University

Rajendra K. Pachauri, Director General, The Energy and Resources Institute (TERI), and Chairman, Intergovernmental Panel on Climate Change (IPCC)

Jennifer L. Turner, Director, China Environment Forum, Woodrow Wilson International Center for Scholars

Vitoon Viriyasakultorn, Senior Governance Specialist, United States Agency for International Development/Environmental Cooperation-Asia (USAID/ECO-Asia)

Partners

Asia-Pacific Water Forum

Earth Institute's Water Center at Columbia University

Woodrow Wilson International Center for Scholars

Advisory Group

Wouter Lincklean Arriens, Lead Water Resources Specialist, Asian Development Bank

Aslam Chaudhry, Chief, Water, Natural Resources & SIDS Branch, Department of Economic and Social Affairs, United Nations

Geoffrey D. Dabelko, Director, Environmental Change and Security Program, Woodrow Wilson International Center for Scholars

Michael Gerrard, Director, Center for Climate Change Law, Columbia University

Peter Gleick, Founder & President, Pacific Institute for Studies in Development, Environment & Security

Tanya Heikkila, Assistant Professor, Environmental Science & Policy, School of International and Public Affairs, Columbia University

Ramaswamy Iyer, Former Secretary of Water Resources, Government of India, Member of the UNSGAB High Level Expert Panel on Water & Disaster

Khoo Teng Chye, Chief Executive, Singapore Public Utilities Board

Marc Levy, Deputy Director, Center for International Earth Science Information Network (CIESIN), Columbia University

Priscilla Lewis, Director, U.S. in the World Initiative (USITW), Demos

Ravi Narayanan, Vice-Chair, Asia-Pacific Water Forum Governing Council; former CEO of WaterAid UK

Hideaki Oda, Councillor to the President of the Japan Water Forum and Asia-Pacific Water Forum; Member of the UN Secretary General's Advisory Board on Water and Sanitation

Erik R. Peterson, Senior Vice President, Center for Strategic & International Studies (CSIS); Director, Global Strategy Institute

Frederik Pischke, Associate Expert, Division for Sustainable Development, United Nations

Rachel Posner, Research Associate, Center for Strategic & International Studies (CSIS); Director, Global Water Futures

Anne Rogers, Senior Economic Affairs Officer, Department of Economic and Social Affairs, United Nations

Robert Schoellhammer, Deputy Resident Director, North American Representative Office, Asian Development Bank

K. E. Seetharam, Founding Director, Institute of Water Policy; Visiting Professor, Lee Kuan Yew School of Public Policy, National University of Singapore

Daniel Stellar, Assistant Director, Columbia Water Center, Earth Institute at Columbia University

Kazuo Tase, Chief, Human Security Unit, Office for the Coordination of Humanitarian Affairs (OCHA), United Nations

Ti Le Huu, Chief, Sustainable Development & Water Resources Section, Environment & Sustainable Development Division, UN Economic & Social Commission for Asia and the Pacific (UNESCAP)

Rong Wang, Professor, China University of Political Science & Law; Director, China Center for Law and Sustainable Development Research

Aaron Wolf, Professor of Geography, Department of Geosciences, Oregon State University

Project Staff

Robert W. Hsu, Program Officer, Asian Social Issues Program, Asia Society (Project Coordinator)

Earth Institute/Water Center Research Team:
Christopher DeRusha
Laura Keating
Lisa Hook
Scott MacKenzie
A. Tianna Scozzaro
Victor Vasquez Alvarez

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Foreword

Water connects us in the most fundamental way. We cannot survive without it. Moreover, water is intrinsically linked to the most immediate challenges we face today, including food security, health, climate change, economic growth, and poverty alleviation.

Water problems in Asia today are severe—one out of five people (700 million) does not have access to safe drinking water and half of the region's population (1.8 billion people) lacks access to basic sanitation. As population growth and urbanization rates in the region rise, the stress on Asia's water resources is rapidly intensifying. Climate change is expected to worsen the situation. According to the Intergovernmental Panel on Climate Change, by 2050, more than one billion people in Asia alone are projected to experience negative impacts on water resources as a result of climate change. Experts project that reduced access to fresh water will lead to a range of consequences, including impaired food production, the loss of livelihood security, large-scale migration within and across borders, and increased geopolitical tensions and instabilities. Over time, these effects will have a profound impact on security throughout the region.

In an effort to address this emerging crisis, Asia Society—working in partnership with the Earth Institute's Water Center at Columbia University, the Asia-Pacific Water Forum and the Woodrow Wilson International Center for Scholars—launched a Leadership Group on Water Security to examine decreased access to a safe, stable supply of water as a driver of political and socioeconomic instability in Asia. Through this report, the Leadership Group focuses attention on some of the most significant current and future water-related challenges facing Asia and puts forward an agenda in support of cooperative approaches to prevent, manage, and respond to water scarcity and its impacts.

We are indebted to the members of the Leadership Group and to the many analysts, experts and officials who generously shared their time and insights. Without their vision and intellectual contributions, this report would not have seen the light of day. We extend special thanks to Tommy Koh for chairing the Leadership Group, Saleem Ali for serving as our lead advisor, Tanya Heikkila and Dan Stellar at the Earth Institute's Water Center, K. E. Seetharam at the National University of Singapore's Institute of Water Policy, and Margaret Chan, Upmanu Lall, Kapil Narula, Rajendra K. Pachauri, Jennifer L. Turner and Vitoon Viriyasakultorn for the essays they contributed to this report.

Special thanks are also due to Suzanne DiMaggio, Director of the Asian Social Issues Program at the Asia Society, for leading this initiative from its inception, and to Robert Hsu for expertly coordinating the process.

Finally, we are grateful to the Rockefeller Brothers Fund and the Alfred and Jane Ross Foundation for generously supporting this effort.

While Asia—and the world—is in the grips of an economic crisis, it is clear that common efforts to solve water-related challenges are needed now more than ever. Access to clean water and sanitation is a necessity, not a luxury. With effective planning and leadership, this resource crisis can be transformed into a catalyst for lasting cooperation between countries and across communities.

Vishakha N. Desai
President, Asia Society

Introduction and Executive Summary

The global demand for freshwater is soaring as supply is becoming more uncertain. Today, one out of six people—more than a billion—do not have adequate access to safe water. The United Nations projects that by 2025, half of the countries worldwide will face water stress or outright shortages. By 2050, as many as three out of four people around the globe could be affected by water scarcity.

Water-related problems are particularly acute in Asia. Although Asia is home to more than half of the world's population, it has less freshwater—3,920 cubic meters per person per year—than any continent other than Antarctica. Almost two-thirds of global population growth is occurring in Asia, where the population is expected to increase by nearly 500 million people within the next 10 years. Asia's rural population will remain almost the same between now and 2025, but the urban population is likely to increase by a staggering 60%.

As population growth and urbanization rates in Asia rise rapidly, stress on the region's water resources is intensifying. Climate change is expected to worsen the situation significantly. Experts agree that reduced access to freshwater will lead to a cascading set of consequences, including impaired food production, the loss of livelihood security, large-scale migration within and across borders, and increased economic and geopolitical tensions and instabilities. Over time, these effects will have a profound impact on security throughout the region.

Through this report, the Asia Society's Leadership Group on Water Security aims to raise awareness of the importance of water as a means of security at multiple levels in Asia. We take as our immediate point of departure the *Asian Water Development Outlook 2007*, an assessment of Asia's possible water future published by the Asian Development Bank in cooperation with the Asia-Pacific Water Forum[1]. The *Outlook* emphasizes that the majority of Asia's water problems are not attributable to an actual shortage, but rather are the result of poor water governance. As such, they are solvable through more effective governance and better management practices.

Our goal is to build on the far-ranging findings presented in the *Outlook* by considering the security dimensions associated with decreased access to a safe, stable water supply in Asia. The term "security" is often used to connote conflict, but it has a much broader meaning for the purposes of this effort. The nexus between an essential resource such as water and security encompasses individual physical safety, livelihoods, health and human welfare, as well as a realization of the cooperative potential between nation-states and subnational jurisdictions. The report highlights the significance of water as a source of livelihoods, a vector of pathogens, a potent force behind extreme events and natural disasters, and also a mechanism for cooperation among governments and communities.

The report also draws attention to some of the most significant current and future water-related challenges facing the region—from water disputes involving hostile states such as India

[1] Asian Development Bank and Asia-Pacific Water Forum, "Achieving Water Security for All," in *Asian Water Development Outlook 2007* (Manila: Asian Development Bank, 2007). Available at http://www.adb.org/Documents/Books/AWDO/2007/AWDO.pdf (accessed March 13, 2009.)

and Pakistan to water conflicts in China's villages and provinces resulting from agricultural and industrial pollution, and from the alarming rise in waterborne diseases, especially among children, in Indonesia attributable to inadequate wastewater facilities to the negative impact that climate change will have on Asia's glaciers, which for many countries are the primary freshwater source. The scope and scale of these problems demonstrate in stark relief that no matter how we approach water resources—whether it is on the basis of quality and quantity, or as the most potent manifestation of extreme climatic events—hydropolitics is likely to be a growing force in Asian security that will require a broader understanding of and strengthened institutional capacities for water governance.

This effort does not seek to "securitize" water. Indeed, the problems highlighted in this report cannot be addressed by traditional tools of national defense. However, the current approach, which views water scarcity and quality issues through a predominantly environmental lens, is not sufficient either. The U.S. National Intelligence Council's *Global Trends 2025* report has forecasted that "cooperation to manage changing water resources is likely to become more difficult within and between states" in Asia[2]. The emerging picture underscores an urgent need to reframe the debate and to begin looking at these issues in a more comprehensive way that takes into account the complex national security and development challenges that countries and communities will face as water scarcity intensifies.

Solutions are well within reach, but they will require high-level political will and a sufficient amount of investment. Governments need to develop coherent national responses and policies to simultaneously address multiple problems, with the aim of reducing security risks and vulnerabilities and providing economic benefits, such as investments in infrastructure for water conservation and management. Countries should forge a regional approach in which governments and other key stakeholders, including nongovernmental organizations, civil society groups, and businesses, work together to clarify responsibilities and coordination mechanisms to address water security concerns.

The Asia Society's Leadership Group recommends a ten-point agenda to avert a water crisis in Asia:

Raise the profile of water security on the political and developmental agendas of national governments in Asia. There is an immediate need for governments in Asia to strengthen their capacities to engage in preventive diplomacy focused on water and to start setting policies and making investments in support of infrastructure for water conservation and management. A substantial package of financial support, including public and private funds, should be established, and greater coordination between relevant government ministries should be pursued.

Include water in security policy planning. Governments in Asia should ensure that water management organizations have direct communication with defense agencies and develop integrated water management and conflict prevention capacities where needed. Conflict avoidance and resolution mechanisms to address intra- and transboundary water issues

[2] National Intelligence Council, *Global Trends 2025: A Transformed World, Washington D.C.* (November 2008). Available online at: www.dni.gov/nic/NIC_2025_project.html.

should be developed. Disaster-warning systems and international coordination in response to water-related disasters should be strengthened.

Encourage investment in and increased collaboration on water management technologies. Emphasis should be placed on spurring greater investment in the infrastructure and knowledge systems needed to manage complex water systems for the benefit of all. Incentives are needed to increase developing-country adoption of, and private-sector investment in, technologies that advance water security, such as improved methods to desalinate water, low-cost drip irrigation, and new crop varieties that can tolerate low water levels and drought.

Generate better policies through dialogue. Policy makers at every level, as well as nongovernmental organizations, civil society groups, and private enterprises, must be stakeholders in the responsible management of water resources. As part of this effort, best practices drawn from local leaders across sectors and societal spheres who are advancing sustainable water management practices and models of mediation and conflict resolution to address water-related disputes should be collected and disseminated.

Address the emerging water crisis through a post-2012 climate agreement. Measurable and verifiable targets to reduce greenhouse gas emissions should be adopted by all countries, and adaptation is necessary to lessen the impacts on water resources resulting from global warming. This will require forward-looking investment and far-sighted policies that go beyond short-term responses to current climate variability.

Utilize the Intergovernmental Panel on Climate Change (IPCC) data on water and climate change to develop early-warning systems. There is a vast amount of scientific research under way on climate change and water availability that is accessible through the IPCC. This information needs to be linked to the development of early-warning systems on a regional level to consider the impacts of desertification, sea-level rise, and other consequences related to climate change.

Develop concrete ways of implementing existing statements and regional agreements such as the Asia-Pacific Water Summit Declaration of 2007.[3] Existing efforts at the ministerial level among Asian countries to support water management, such as the Asia-Pacific Water Summit, which unanimously issued the Beppu Declaration in 2007, should be supported and implemented.

Expand the Water Financing Partnership Facility initiated by the Asian Development Bank. The Water Financing Partnership Facility was initiated by the Asian Development Bank to provide financial and technical support in the areas of rural and urban water services and river basin water management, including adaptation to climate change. The initial commitment of US$26 million needs to be supplemented with private-sector support and market incentives to sustain this effort across Asia.

[3] Available at http://www.apwf.org/archive/documents/summit/Message_from_Beppu_080130.pdf (accessed March 13, 2009).

Harmonize the Millennium Development Goals that pertain to water under a unified United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) task force on rapid implementation to meet the 2015 targets in Asia. The Asian Development Bank's *Asia Water Watch 2015* study estimated that annual investments of US$8 billion will be needed to meet the Millennium Development Goal targets for safe drinking water. A coordinated strategy that links the goals through water management is needed and can be initiated by a task force managed by UNESCAP for the Asian region.

Improve data quality in order to generate better policies. The lack of accurate water resource data across Asia is an impediment to effective policy making. To address these shortcomings, the United Nations should be endowed with a data-collection capacity that is authorized to gather water quality data worldwide, similar in scope to the data collected on nuclear issues by the International Atomic Energy Association (IAEA). The development of indices for comparisons of water resource performances across countries, as initiated by the Asia-Pacific Water Forum, should be expanded with greater institutional support.

These recommendations are not meant to be exhaustive, but rather are indicative of the scope and precision of the efforts needed to tackle the water challenges facing Asia. The good news is that the vast majority of the water-related problems plaguing Asia are solvable through environmentally and politically sustainable water management, and the technologies and policy tools that are required to make progress are well known. What is needed now is action. With effective planning and leadership, this resource crisis can be transformed into a catalyst for lasting cooperation between countries and across communities.

Linking Water Challenges and Security

Water as a security concern is beginning to gain attention worldwide. Researchers and international organizations are developing specific indicators to consider watersheds that could be vulnerable to ecological stress and resultant conflicts. The first comprehensive study to examine "basins at risk" for conflicts over freshwater resources was published in 2003 by Yoffee, Wolf, and Giordano, in which they identified the following key criteria to delineate high-risk areas:

- High population density (more than 100 people per square kilometer)
- Low per capita gross domestic product (less than US$765 per person)
- Overall unfriendly relations between constituents sharing the resource
- Politically active minority groups
- Proposed large dams or other water development projects
- Limited or no freshwater treaties[4]

Even though this early analysis did not consider some of the more contemporary areas of concern such as climate change, 9 out of 12 of the basins at risk were located within Asia.

Much of the popular reporting on water security has been polarized between those who believe that conflicts can arise over water scarcity and those who view such an approach to be sensationalistic and point to the paucity of "water wars." Indeed, the ambivalence toward water as a potential source of conflict as well as an agent of cooperation has been the subject of considerable research. The historical record demonstrates that water issues have generated more cooperation than conflict (see Figure 1: Water-Related Cooperation versus Conflict: 1948–1999). According to Yoffee, Wolf, and Giordano, 28% of all recorded international water-related events between 1948 and 1999 were conflictive, while two-thirds were cooperative.

The absence of major conflicts over water suggests that we should consider the cooperative aspects of hydropolitics more seriously. At the same time, we must recognize that the past may not be an adequate basis from which to draw conclusions about the potential for future conflicts arising from water security issues. Demographic pressures and resource scarcity dynamics in the coming decades will be unprecedented, and the potential for conflicts sparked by the direct and indirect impacts of an increasingly volatile water supply should not be underestimated, particularly in light of rising concerns about climate change. As Rajendra K. Pachauri, chairman of the IPCC, observes in his essay on page 31 of this report, "climate change challenges the traditional assumption that past hydrological experience provides a good guide to future conditions, because the consequences of climate change may alter the reliability of current water management systems and water-related infrastructure."

[4] Shira Yoffe, Aaron T. Wolf, and Mark Giordano, "Conflict and Cooperation over International Freshwater Resources: Indicators of Basins at Risk," *Journal of the American Water Resources Association* 39, no. 5 (October 2003): 1109–26.

The debate about water scarcity and security has centered largely on whether countries will "go to war" over water. The Leadership Group does not find this to be a useful way to frame the problems that confront us and instead advocates a more nuanced view. Greater rates of change and uncertainties related to water availability and the perception of insecurity may cause individuals, communities, and nations to react in ways that we have not seen in the past. Therefore, a relevant question to ask is, how will the water disputes of tomorrow look different from today? Given the fundamental importance of water to human existence, and ultimately to health, food production, livelihoods, energy security, poverty reduction, and economic growth, the Leadership Group sees an urgent need to begin planning for change now and to seize opportunities to forge a cooperative water future.

Transboundary Water Concerns in Asia

A good gauge of the transboundary significance of water is the dependency ratio, which measures the amount of water resources originating outside a country (see Figure 2: Water Resources and Dependency, and Figure 3: Total Water Availability per Capita).[5] Pakistan has one of the highest dependency ratios among the major Asian countries at around 77%. Therefore, it is not surprising that Pakistan had to negotiate an international treaty with India soon after independence despite the continuation of hostilities between the two states. At the other end of the spectrum, Kyrgyzstan has a dependency ratio of zero because all of its water comes from within its borders.

Central Asia is rich in water resources. However, more than 90% of the water in this vast region is concentrated in Kyrgyzstan and Tajikistan, where the region's two main rivers—the Syr Darya and the Amu Darya—originate. Uzbekistan and Kazakhstan are the region's main water consumers, with Uzbekistan alone consuming more than half of the region's water resources, largely for agriculture. Kyrgyzstan and Tajikistan control the water needed by the other Central Asian states, which, in turn, view water as a means of strategic influence. Since the dissolution of the Soviet Union brought an end to the decades-old centralized system of water management, competition for water has been increasing at a troubling rate in Central Asia, a region that is already rife with political and ethnic tensions. With ongoing border disputes and record droughts in the region, conflicts over water will likely grow. Water will also play a key role in the economic reconstruction of Afghanistan, as regional cooperation over the Amu Darya will be necessary to revitalize the country's agricultural sector.[6]

The transboundary salience of water conflicts in Asia is exemplified by some of the water disputes between Russia and China, particularly in the Amur-Heilong River Basin.[7] These two regional powers occupy comparable shares of this 2,000,000-square-kilometer basin (48% and 43%, respectively). Most of the 4,300-kilometer border between the two countries, in China's northeast, is composed of rivers in the basin. This little-known river was the subject of global attention when a benzene spill on the Songhua (Sungari) River in Jilin, China, temporarily endangered the water supply of the Russian city of Khabarovsk in November 2005. During the Cultural Revolution in 1969, Chinese and Soviet armies exchanged fire over contested claims of sovereignty along the border formed by the Heilong River. Eventually, both countries formally delimited their borders in agreements negotiated over a period of 40 years that concluded in 2004. In recent years, water has become a conduit for cooperation as the two countries have focused on developing hydropower stations. China and Russia established the first free trade zone in 2006 at the border of the nearby Suifen River.

[5] See United Nations Food and Agricultural Organization, *Review of World Water Resources by Country*, Water Report no. 23, 2003, 16, for an explanation of how dependency ratios are calculated.

[6] Erika Weinthal, "Water Conflict and Cooperation in Central Asia," *Human Development Report Office Occasional Paper*, United Nations Development Programme, 2006.

[7] The discussion of Russian–Chinese water disputes is derived largely from James E. Nickum, "The Upstream Superpower: China's International Rivers," in *Management of Transboundary Rivers and Lakes*, ed. Olli Varis, Asit K. Biswas, and Cecilia Tortajada (Berlin: Springer, 2008).

China's most notable success in the use of shared river water is the Yalu River, which it shares with North Korea. Interestingly, the cooperation began with the large Shuifeng (Sup'ung) Hydropower Station (780-megawatt capacity), which was constructed from 1937 to 1944, toward the end of the Japanese occupation. Four of the six sets of power generators were taken by the Soviet army during its occupation of the region in 1945–1946. Restoration of the facility was undertaken with design assistance from the Soviets in 1955. Farther east, the relatively small Tumen River Basin (less than 30,000 square kilometers) lies mostly in China, but it is strategically located at the border intersection of Russia, China, and North Korea. The river delineates the boundary first between China and North Korea and then between North Korea and Russia.

Kazakhstan and China have engaged in negotiations on joint use of another major northern river, the Irtysh, since 1999. Both countries signed an agreement on the joint use of 23 transborder rivers, including the Irtysh and the Ili, in 2002, wherein they agreed to establish a Joint Committee on Transboundary Rivers. Many of these efforts remain ceremonial in nature, and there is a clear need for greater regional and international involvement to strengthen such institutions. Perhaps the most celebrated case of a regional water commission concerns the Mekong River, which is shared by China and its southern neighbors.

The Mekong River Commission

By Vitoon Viriyasakultorn, Senior Governance Specialist, United States Agency for International Development/Environmental Cooperation-Asia (USAID/ECO-Asia)

Beginning at over 4,500 meters elevation in the Tanggula mountain range in Qinghai Province, the Mekong River flows for more than 4,800 kilometers through China, Myanmar, Laos, Thailand, Cambodia, and Vietnam, terminating in the South China Sea and draining more than 795,000 square kilometers of land. Thailand and Laos share the highest percentage of area in the basin with 23% and 25%, respectively, while Laos contributes the greatest amount of flow (35%). Vietnam has the highest population density (236 persons per square kilometer) and the lowest percentage of basin area (8%), posing concerns with respect to its political influence. The Mekong's annual flow varies widely based on the monsoon season, ranging from 78 to 475 cubic kilometers from dry to rainy seasons, respectively.

As in most international river basins, the relationship between the upstream and downstream states in the Mekong River system is politicized and controversial, imbued with power relations based on present water utilization and alleged future needs. In general terms, China occupies a much stronger position in the basin because of its political power. China is also the upstream state, which results in an extreme asymmetry of power relations.

The diverging interests among the downstream co-riparians since the early 1990s can be described as follows:

- Thailand seeks cheap energy (hydropower), more water for its modernized agriculture sector, and enhanced flows in the Chao Praya Basin stretching through the central part of the country.
- Laos primarily wishes to realize its hydropower-generating potential.
- Cambodia would be best served by the conservation of the current hydrological regime, including the seasonal flooding that gives rise to the huge fishery.
- Vietnam wishes to construct hydropower facilities in the central highlands, as well as to protect the efficient agriculture and aquaculture production in the delta.

These varying interests were successfully negotiated and codified in a framework agreement of the Mekong River Commission (MRC), which was signed in April 1995 between the governments of Cambodia, Laos, Thailand, and Vietnam. This agreement sets a mandate for the organization "to cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin."

The Mekong faces some monumental challenges in the years to come. More than 21% of the basin is eroding, with only 31% of its original forests left intact and only 5% under protection. Population growth of more than 2% over the next 50 years, combined with increasing environmental degradation, has led the UN Environment Programme to predict severe negative impacts in the areas of stream flow, pollution, loss of habitat, fish populations, and community health for those who rely on the Mekong for their livelihoods.[8] The developments that are under way or proposed—including dams and diversions, irrigation expansion, and large-scale land use change, with associated alterations to the natural flow regime—are also expected to bring high risks to the production and livelihoods derived from the environment and its natural resource base.

Another challenge is cooperation with China and Myanmar—neither is a member of the MRC, but both participate in the MRC's annual meeting as "dialogue partners." China presents a particular challenge, as it has embarked on a major dam-building program in the upper reaches of the Mekong. Significant impacts are already evident in terms of changes in flow patterns and sediment transport, and it is likely that the construction of further dams will exacerbate these fundamental ecological problems. The role of the MRC in dealing with the impacts, perceived or real, caused by dam construction in the upper reaches of the Mekong has not been well received by the public. Additionally, the potential impacts caused by unpredictable meteorological conditions, climate change, and rising sea levels call for new consideration and action by the MRC.

[8] Anond Snidvongs and Seng-KeyTeng, *Mekong River: GIWA Regional Assessment* 55 (Sweden: University of Kalmar, UNEP, 2006).

Another challenge relates to accelerating development in the Mekong River Basin, which is rapidly changing the context of the MRC's activities. While the MRC's approach is to help advance continued economic growth within its member states, it is also creating pressures on available water and related resources in the basin.[9]

A recent review of the MRC noted that the commission has had little engagement with nongovernmental organizations and recommended formalizing a consultative process for involving stakeholders.[10] A consultancy is now under way to define approaches for stakeholder involvement—but how to engage stakeholders at various levels in a meaningful way is still a challenge facing the MRC.

Looking ahead, the MRC needs to carefully prioritize its activities in order to achieve its planned goals and demonstrate its value. A more open and transparent approach to the organization's internal management, as well as institutional capacity building, are needed to fulfill its roles. Of course, this should be done in parallel with better coordination among the four MRC member countries. Relationships with China and Myanmar, as well as with nongovernmental stakeholders in the basin, must be further developed.

[9] Mid-Term Review of the Mekong River Commission Strategic Plan 2006–2010, Executive Summary of the Final Report, January 2009.
[10] Independent Organizational, Financial and Institutional Review of the Mekong River Commission Secretariat and the National Mekong Committees, Final Report, 2007.

Water can act as a conduit for fostering cooperative mechanisms, as exemplified by agreements involving hostile states, such as the Indus Water Treaty between India and Pakistan. Although the treaty withstood three wars between India and Pakistan, it was not able to play any role in averting conflict. Internally, the dispute resolution system of the treaty, which was negotiated with financial and institutional support from the World Bank, has withstood many security challenges, but it has not led to broader regional conflict resolution. This is largely because the institutions that deal with water and environmental resources are purposely divorced from national security strategies. More recently, we have seen how water resources can be used as a means of reinforcing existing suspicions between hostile parties. After the Mumbai attacks of November 2008, Pakistani military commentators began to focus on India's violations of the Indus Water Treaty, suggesting that water resources were a latent cause of the perpetuation of the Kashmir conflict.[11] While such causality is plausible with a limited distributional resource even within countries, the underlying factors that lead to a lack of trust and violations of agreements are usually extant factors such as ethnic rivalries, inequalities, and a lack of institutional arrangements for monitoring and enforcement of allocation regimes. As such, consideration of institutional responses to the transboundary resource allocation of water is essential to ensuring long-term security in unstable geopolitical areas.

[11] Shaukat Qadir (retired brigadier general), interview on *Newseye*, Dawn News Channel, Islamabad, Pakistan, January 18, 2008.

In addition to international riparian concerns, there are several internal water disputes in India and Pakistan. For example, high demand for surface water has led to interstate disputes in the Godavari and Krishna River Basins in India. These disputes, temporarily solved by two interstate agreements arbitraged by specific tribunals in 1975 and 1980, respectively, are reappearing as a result of increasing water scarcity during the dry season. Andhra Pradesh, the fourth-largest state in India, has alleged that Karnataka, the neighboring state to its west, has violated agreements, unilaterally constructing irrigation projects in the Krishna River Basin, especially in the Tungabadra and Pennar sub-basins. The drastic reduction in dry season flows is affecting environmentally fragile ecosystems such as the Krishna River Delta, where the situation has been worsened by the effects of the blue revolution (intensive development of shrimp farms). Ethnic identities along provincial lines are very pronounced in India and Pakistan, and water resource conflicts are often used by provincial nationalists to demonstrate the hegemonic dominance of one region over another. Pakistan's four provinces have frequently exchanged misgivings about transboundary water rights and the construction of dam projects, such as the Kalabagh over the Indus River.

Another security concern is conflict along ethnic lines over water access within China, where migration patterns affect water allocation even if the rivers themselves do not cross provincial borders. There is significant unrest among Uyghur communities, which are typically poorer than Han immigrants to Xinjiang. The Uyghurs are often destitute, not well educated, and discriminated against when competing for the best jobs. Many feel encroached upon and at times religiously oppressed. One could certainly foresee the potential for conflict as urbanization and industry begin to deplete already scarce water supplies, particularly if certain Han-run businesses are perceived to be receiving favorable treatment in water resource allotment. Such conflicts require us to understand the linkages between demography, scarcity, and land degradation as well.

Ecosystems transcend political borders, and water is the lifeline for all biological systems. Given the centrality of water to human life, the Leadership Group recognizes that any attempts to contain water by geographies are bound to have serious consequences on the natural system and also increase economic and political tensions. As noted earlier, transboundary water issues in Asia are complex and already tense areas, and fragile states in the region are of particular concern. Experts have noted that future transboundary water conflict will have less to do with the absolute scarcity of water and more to do with the rate of change in water availability. As such, the Leadership Group calls on the governments of Asia to work together with international institutions to explore better ways to govern and manage water resources. Balancing competing interests over water allocation and managing scarcity will require stronger institutions. Efforts should focus on strengthening capacities to engage in preventive diplomacy focused on water and developing integrated water management and conflict prevention capacities where needed.

Rising Populations and Growing Demand

Population growth is a fundamental driver of natural resource stress. Asia's increasing population is straining the ecological systems that provide water for drinking, agriculture, and other life-sustaining services, while causing a rapid increase in land degradation. Related demographic challenges, including higher-consumption lifestyles, particularly in South Asia and China, and rising life expectancies across the region underscore the urgent need to plan for increasing demands on water resources.

Massive urbanization in Asia will present a new set of water management challenges in the coming decades. By 2015, the percentage of the global population living in Asian megacities (those with populations of 10 million or more) and large cities (those with populations of 5–10 million) is expected to grow to 4.7% and 3.7%, respectively. Asian urban centers with populations of 500,000 or less will constitute a staggering 27% of the global population by 2015, posing even bigger challenges than megacities. As the *Asian Water Development Outlook* warns, unless greater attention is focused on resolving the water problems of small urban centers, these areas are likely to become "major water and wastewater black holes of the future." [12]

Water challenges are acute in China, where economic growth and urbanization rates exemplify the trends of higher demand and new water use patterns that are common in the Asian region. Forecasts for the next 15 to 20 years see continued mass migration from China's countryside to the cities, which is likely to exacerbate the current challenges of water pollution and supply shortage. Nationwide, the demand for water in China's urban areas is growing more than 10% annually, and it is expected to increase 40% by 2020. China's double-digit economic growth has also greatly increased water demand for industry while decreasing the quality of supply because of rampant waste dumping and pollution by the industrial sector.

Water is required not only for direct consumption and industrial use, but also for any kind of food production activity. Land degradation is a particular concern across Asia, as rampant water withdrawals coupled with deforestation have allowed wind to scour out arable soils, making vast expanses of the landscape vulnerable to desertification (see Map 1: Land Degradation in Asia and Its Impacts). According to a leading global survey conducted in 1981–2003, more than 1 billion people in Asia were directly affected by land degradation. This represents two-thirds of the total population directly affected by land degradation across the world, with China, India, Indonesia, and Bangladesh alone accounting for close to 800 million people. The survey also noted that the proportion of land being degraded in Thailand was the fourth largest in the world at 60%, which is more than two times the global average of just over 23%.[13]

The link between land degradation, water scarcity, and food security is of great concern across Asia. The secretariat of the UN Convention to Combat Desertification estimates that

[12] Asian Development Bank and Asia-Pacific Water Forum, "Achieving Water Security for All," 14.

[13] Z. G. Bai, D. L. Dent, L. Olsson, and M. E. Schaepman, "Global Assessment of Land Degradation and Improvement: Identification By Remote Sensing," Report no. 2008/01, Food and Agricultural Organization and International Soil Reference and Information Center, 2008. Available at http://www.isric.org/UK/About+ISRIC/Projects/Current+Projects/GLADA.htm (accessed March 13, 2009).

in China, an average of nearly 2,500 square kilometers of land is being lost to advancing deserts each year. Nearly 400 million people live in these areas, and the economic loss to China has been estimated at around US$6.5 billion a year.[14] As China's population continues to increase and rapid urbanization leaves less land for agriculture, China will need to increase its own domestic agricultural productivity and, at the same time, import more food, which will reduce national food security. To illustrate the scale of the problem, 10% of China's demand for rice is equal to one-half of world rice exports, and China's imports of soybeans already account for one-third of world soybean trade.[15]

India has an advantage over China in terms of consumption behavior, as more than 30% of the country's population is vegetarian and more than 70% consists of infrequent meat eaters. China's population, on the other hand, is far more carnivorous, and with a growing middle class, meat consumption is likely to increase. The water needed to support a meat-eating diet is two times greater than that required to support a vegetarian diet.

Water Security Challenges in India

By Kapil Narula, Director, India Office, Columbia Water Center, Earth Institute at Columbia University, and Upmanu Lall, Director, Columbia Water Center, Earth Institute at Columbia University

India supports one-sixth of the world's population, one-twenty-fifth of the world's water resources, and one-fiftieth of the world's land. India also supports about 20% of the world's total livestock population, more than half of which are cattle. Agriculture is the major consumer (80%–85%) of available freshwater. The average per capita availability of water, estimated at 1,600 cubic meters per year, is expected to fall to around 1,000 cubic meters per year by 2050 based on current population projections. The effects of climate change on the availability of future water resources are uncertain, but it is expected that the frequency of extreme events (floods and droughts) will increase.

Climatic variability has always been a source of water stress in India. Monsoon failures and floods have significant social impacts. Both food security (as a result of reduced grain production) and rural livelihoods are adversely affected. Thus, a former finance minister quipped that his budget was a gamble on the monsoon. Surface reservoirs are an infrastructural response to the mitigation of flood and drought impacts. However, per capita water storage (200 cubic meters) is the lowest in India relative to comparable countries (e.g., 1,960 cubic meters per capita for the United States, 1,100 cubic meters per capita for China, and a world average of 900 cubic meters per capita).

[14] United Nations Convention to Combat Desertification, "Combating Desertification in Asia," *Asia Factsheet 12*. Available at http://www.unccd.int/publicinfo/factsheets/showFS.php?number=12 (accessed March 13, 2009).
[15] Han Jun, "Effects of Integrated Ecosystem Management on Land Degradation Control and Poverty Reduction," in *Environment, Water Resources and Agricultural Policies: Lessons from China and OECD Countries* (Paris: Organisation for Economic Co-operation and Development, 2006), 82.

Thus, adding storage is a critical infrastructure need, and the government of India has proposed a massive River Inter-Linking Project to store and convey water across the country. However, this project faces much opposition, and without critical analysis and access to information, its future is uncertain.

In the absence of significant public investment in surface water–based irrigation infrastructure over the last 30 to 40 years, the need for reliable water supplies has translated into extensive and essentially unregulated groundwater pumping by individuals across the country. This trend has been facilitated by free or highly subsidized electricity and other energy sources for agricultural pumping that is sanctioned by states in which a large population is engaged in agriculture. Groundwater irrigation now contributes to 50% to 55% of total irrigation water use, and it is responsible for two-thirds of total agricultural production, or approximately 10% of total gross domestic product. It is also responsible for almost 30% of total electricity consumption. Both groundwater and electricity consumption are higher in agricultural states such as Andhra Pradesh, Gujarat, Karnataka, Uttar Pradesh, Punjab, and Haryana, where agricultural electricity use accounts for 35% to 45% of total generated electric use and groundwater use is 70% to more than 100% of the estimated annual recharge. In such places, aquifers are being depleted (mined) at a rate of 0.2 to 0.5 meters per year, with higher rates locally. Farm water use efficiencies are typically very low (5%–15%) given the free provision of energy and water.

The central government's policies for food security contribute to this situation. The government offers minimum support prices above international and local prices through a food grain procurement program. These "incentives" and subsidies for energy, fertilizer, and water have promoted food self-sufficiency, with annual food grain production increasing from 51 million tons in the early 1950s to 206 million tons at the turn of the century. However, food grain production may need to double to meet the requirement of 380 million to 420 million tons in 2050. Dramatic increases in irrigated area and in crop yields per unit of water used and per unit of land are needed if such a target is to be achieved endogenously. This, in turn, may lead to very high rates of water source depletion, degradation, and pollution, spurring resource and environmental catastrophe and, in turn, food insecurity. Public and private action and investment are urgently needed to achieve a more sustainable trajectory for Indian agriculture, water, and energy futures.

The policy reform that is needed to promote more efficient use is difficult in a populist democratic environment, where politicians cater to the perceived desire of the rural masses to be shored up by an ever-growing web of subsidies and support mechanisms in the short run. However, the increasing competition for water and energy resources between the relatively affluent urban and industrial users and the rural poor involved in agriculture is creating a new tension that may prove to be an agent of change.

So far, the private sector has not engaged in a serious assessment of the need for or the development of water infrastructure on any large scale. In fact, while reminders

of water scarcity in the country are reinforced daily through limited hours of urban supply, recognition of the role that the private sector could play in either developing infrastructure, improving agricultural water productivity, or providing for the associated investment needs and opportunities is only just emerging. Addressing cost recovery for the electricity supplied to the agricultural sector for pumping groundwater, and the large water losses from urban water supply systems, are emerging areas of concern where limited private-sector engagement is now evident.

The absence of a concerted public- and private-sector effort to improve water supply reliability and access has led to increasing conflict between rural and urban/industrial users. Interstate and international disputes over the shared use of river water have also emerged without any clear, long-term resolution in the face of population growth and climate variability. States typically have not had the capital to invest in or properly maintain water infrastructure, and multiple states are engaged in disputes where such developments have taken place, impacting the ability to store or access water. Even small-scale rainwater harvesting systems have proliferated to such an extent in some areas that downstream flows in rivers are negatively impacted.

Another area of concern is the widespread pollution of rivers, lakes, and groundwater because of the release of untreated municipal and industrial wastewater, and because of the excessive application of fertilizers and pesticides in agriculture. Virtually all streams in the country now show the presence of chemical and biological contaminants at concentrations that are well in excess of international health standards. Investment in wastewater treatment and the regulation of water quality is grossly below what is needed, given the loads generated by the growing population. This is another area that needs urgent intervention and investment.

In India, the drive for food independence is placing enormous stress on its groundwater resources. Many states situated within the Indo-Gangetic Plains—Punjab, Haryana, northeast Rajasthan, Gujarat, and portions of Uttar Pradesh—are among the hardest hit. The green revolution, which has been based on fertilizer use, improved seeds, extension of arable land, and intensive irrigation, has resulted in a tripling of food production from 1965 to 2000 and a drop in the poverty level to 31.9% by 2000.[16] However, agricultural intensification has led to overexploitation of groundwater, which is used by an estimated 60% of India's irrigation systems. Pressure to develop surface water storage and diversions has increased, creating interstate tensions. Over the long term, severe groundwater depletion may force poorer farmers out of the sector, increasing migration and poverty, while declining crops could produce economic stagnation and widespread food insecurity.

[16] R. B. Singh, "Environmental Consequences of Agricultural Development: A Case Study from the Green Revolution State of Haryana, India," *Agriculture, Ecosystems and Environment* 82, nos. 1–3 (December 2000): 97–103.

The Leadership Group finds that as Asia's population increases, meeting water demands will become an increasingly difficult challenge. Rising demand for food will place more pressure on water for agriculture. At the same time, rapid urbanization in cities throughout Asia will place more pressure on water resources for energy and industry. In addition to the need for sound water management reforms and policies at all levels of government, the Leadership Group recommends greater involvement of the private sector and more public–private partnerships to spur new technologies, new markets, and new financing ideas to solve the water challenge. Incentives are needed to increase developing-country adoption of, and private-sector investment in, technologies that advance water security. Innovations and investments aimed at producing more food with less water, such as new crop varieties that can tolerate low water levels and drought, as well as brackish and even saline water, and policies that create incentives for farming communities to invest in better water management should be actively encouraged.

Human Health: The Ultimate Measure of Water Quality and Security

Water pollution in Asia resulting from factors such as population growth and greater demand from the agricultural and industrial sectors not only will contribute to increasing rates of food insecurity and land degradation, but also will have detrimental impacts on human health. Research by the Pacific Institute suggests that even under the most optimistic scenario in achieving the Millennium Development Goal (established in 2000) of halving the number of people worldwide who lack access to safe drinking water and adequate sanitation facilities by 2015, some 34 million to 76 million people will perish by 2020 as a result of waterborne ailments.[17] As Asian water resource specialist Asit K. Biswas explains, "It is likely that if there will be a water crisis in the future, it will not come because of actual physical scarcity of water—as many predict at present—but because of continuing neglect of proper wastewater management practices."[18]

Safe Drinking Water and Health in Asia

By Margaret Chan, Director-General, World Health Organization

Drinking water in Asia is something of a success story. The population with access to improved drinking water infrastructure increased from 72% in 1990 to 87% in 2006. This represents improved access for 1.15 billion people, an increase of 53% over the 2.1 billion who had access in 1990. Asia is currently on track to meet the Millennium Development Goal water target.

This success in water and sanitation is leading to extensive benefits:

- Health: Achieving the water and sanitation Millennium Development Goal target in Southeast Asia could reduce the number of diarrheal disease cases by 146 million. In some Asian countries, water-related diseases represent up to 16% of all causes of death.
- Development: More convenient drinking water and sanitation services will translate into better quality of life in terms of time savings and the potential increase in school attendance. In Southeast Asia, it is estimated that achieving the Millennium Development Goal target for water and sanitation could increase school attendance by 67 million days exclusively as a result of reduced diarrheal disease episodes.
- Economy: It is estimated that in Southeast Asia, achieving this target would represent a total annual economic benefit of US$5.6 million.

[17] Peter H. Gleick, *Dirty Water: Estimated Deaths from Water-Related Diseases: 2000–2020* (Oakland, CA: Pacific Institute, 2002).
[18] Asit K. Biswas and K. E. Seetharam, "Achieving Water Security for Asia," *International Journal of Water Resources Development* 24, no. 1 (2008): 145–76.

However, these remarkable gains over recent decades must be consolidated. First, we must continue to ensure that the services and infrastructure provided are properly maintained. In addition, while we must focus on bringing safe water to the nearly 480 million people who still do not have access, we must also plan to provide for a growing population and wider factors, including climate change and its potential impact on water scarcity.

Moreover, water supply now faces new threats. Had this report been written a year ago, the strong rates of economic growth in Asia would have been a positive consideration. Yet today, we are forced to reflect on the impacts of a global financial crisis. Too many sectors are pleading for special consideration as social protection. We would like to go further. Water and sanitation represent not only the most socially progressive investment areas for both health and development, but also rational priorities at a time of economic crisis. Why? One-tenth of the global disease burden is preventable by achievable improvements in water management. Worldwide, the estimated economic benefits from investing in drinking water and sanitation come in several forms:

- Health care savings for health agencies and individuals reaching a total of US$7.3 billion annually
- Millions of productive days, extra school attendance days, and healthy days for children under five years of age, together representing productivity gains of US$9.9 billion a year
- Time savings resulting from more convenient drinking water and sanitation services, giving a productivity payback of some US$63 billion a year
- Value of deaths averted, based on discounted future earnings, amounting to US$3.6 billion a year

All of these issues—health impacts, economic savings, and productivity gains—come together as dimensions of water security. Water security is one of the central priorities of the twenty-first century. It matters for every household—whether it is my own near Geneva, a rural village in Cambodia, or an urban shanty in Mumbai.

It is also an emerging policy concern. Water and sanitation have special importance for the World Health Organization—they are both causes of disease and powerful tools in disease prevention. Water-related diseases continue to exert an unreasonable burden and constrain global efforts to achieve the Millennium Development Goals. Diarrheal disease alone accounts for 865,000 deaths across Asia every year, and a significant share of these could be prevented though achievable interventions in water and sanitation. Accelerating our efforts in this crucial sector would have the most tangible impact on child health and could radically reduce infant mortality.

Today, we need to create a framework to secure, sustain, and advance water security as a central underpinning of health security. We can and must accelerate progress. Governments, the private sector, nongovernmental organizations, and regional and international organizations all have roles to play. Effective international action and cooperation depends on a common understanding of the elements of the problem and priority objectives, shared commitment, and continued monitoring to measure progress.

Pollution of Asia's water supplies from inadequate wastewater management is already a significant problem. The problem is particularly acute in Asia's urban slums, which have grown as a result of rapid urbanization. Many countries have not been able to meet the growing demand for sanitation services. Furthermore, there has been a focus on ensuring adequate supplies of water without appropriate consideration for water supply safety and security, water treatment and disposal, and demand management. The result is dependence on increasingly contaminated water sources. In Indonesia, for example, the UN Children's Fund found that only 53% of the country's population obtained water from sources that were more than 10 meters from a waste disposal site. And in Jakarta alone, fecal coliform was found in all but 16% of shallow well samples.[19] The country is regarded as having high health risks with respect to waterborne diseases, especially among children.[20]

Industrial pollution also poses a grave threat to human health and livelihood. Lake Tai, located on China's southeastern coast on the border between Jiangsu and Zhejiang provinces, is the nation's third-largest freshwater body and its ancient "land of fish and rice." Now home to 2,800 chemical factories, Lake Tai has been devastated by agricultural and industrial pollution as a consequence of China's economic boom and poor management of waste. As a result, 2 million people have lost access to their primary freshwater source, and fish yields, rice production, and tourism—all significant sources of local income—have declined.

Water Conflicts: Catalyzing Change in China

By Jennifer L. Turner, Director, China Environment Forum, Woodrow Wilson International Center for Scholars

People in China have been fighting over water for centuries. Ancient conflicts tended to focus on gaining access to water or rebelling against an emperor who did not invest sufficiently in dyke and dam infrastructure to protect lands from monstrous flooding. Today, conflicts over water supply still explode between villages, counties, and provinces, particularly in China's dry north, where per capita freshwater resources are one-tenth of the world average. The dominant water conflict in China today, however, is water pollution, which threatens economic, human, and environmental health.

The statistics on water pollution paint a grim picture—approximately 40% of China's waterways are Grade V to V+, meaning that the water is unsuitable for drinking, industry, or agriculture. Anecdotal evidence gathered by journalists, researchers, and environmental activists suggests that along major rivers and large lakes in China, communities are suffering from higher than normal rates of cancer, tumors, spontane-

[19] UNICEF, "Indonesia Overview: Water and Environmental Sanitation." Available at http://www.unicef.org/indonesia/wes.html (accessed February 11, 2009).
[20] Central Intelligence Agency, "Indonesia," *CIA World Factbook*, 2007. Available at https://www.cia.gov/library/publications/the-world-factbook/geos/id.html (accessed February 10, 2009).

ous abortion, and diminished IQ as a result of the high level of contaminants in the soil and water. Nearly 700 million Chinese lack access to clean water, and each year 60,000 people—half of whom are children in rural areas—die from diarrhea caused by drinking contaminated water. Over the past few years, the Chinese Ministry of Health has become more candid in discussing the link between water pollution and health, noting in 2007 that in China, 190 million people were drinking water that was making them sick, and that pollution-related cancer rates had increased considerably between 2005 and 2007 (rising 19% in urban areas and 23% in rural areas).

While pollution accidents, such as the 2005 benzene spill in the Songhua (Sungari) River, grab headlines, it is actually municipal wastewater and agricultural runoff that are the main sources of water pollution. Currently, only 46 percent of municipal wastewater in China is treated, and nearly 300 Chinese cities lack any wastewater facilities.

Examining water pollution trends in China through the lens of conflict offers insights into the key drivers of the problem and the broadening involvement of citizens, activists, lawyers, and journalists in the debate on cleaning up China's waterways. China's Ministry of Environmental Protection claimed that in 2006, the country saw 51,000 pollution-related protests, many of which involved water pollution. In early April 2005, villagers in Huaishui village in Zhejiang staged a huge protest against polluting factories in which 30,000 to 40,000 citizens clashed with police. This protest arose after years of unanswered complaints about water pollution from a chemical industrial park that had been damaging crops and sickening communities—a story that is not unique in rural China. The central government stepped in to quickly resolve the conflict, but resolution often means the dirty industries move off to another village. Water pollution problems are notably moving from urbanized eastern provinces to rural inland areas as the enforcement of pollution control laws improves in cities.

In the 1990s, the Chinese government addressed severe water pollution problems primarily through campaigns rather than significant changes to pollution control laws. The dismal water quality in the Huai River (China's most polluted river) and Lake Tai (which turned green with a toxic algae bloom in the summer of 2007) are indicative of the overall failure of a decade of top-down water cleanup campaigns.

However, over the past few years, the Chinese government has revised previously weak pollution control laws and added new laws and regulations aimed at circumventing the overly powerful local governments. Most important is the amended Water Pollution Control Law, which increases fines and gives greater leeway for class-action cases. New regulations requiring public participation in environmental impact assessments have also created greater citizen involvement that could prevent polluting companies from moving into communities. The Institute for Public and Environmental Affairs, a Chinese nongovernmental organization, publicizes the Ministry of Environmental Protection's list of top water-polluting companies and works with these companies to help them clean up their practices. The Chinese nongovernmental Center for Legal Assistance for Pollution Victims has helped dozens of water pollution class-action cases

navigate through the courts, although few have won compensation.

At the government level, the Ministries of Environmental Protection and Finance have created rules that prevent companies on the water pollution blacklist from getting loans. Over the past two years, five "green courts" were set up in southern China, with the main goal of addressing cross-jurisdictional water conflicts. While the trends in declining water quality continue, the amount of protests, activism, and policy making in this area suggests that water quality is finally getting the attention it deserves.

Despite the economic slowdown, it merits mention that nearly 10% of China's economic stimulus package included investment in clean energy and ecological projects. Nearly 9% of the 350 million yuan allotted for ecological projects is targeting some of China's municipalities and dirtiest industries to adopt more wastewater treatment, recycling, and reuse. It is encouraging that despite the economic crisis, investment into water cleanup has remained on the agenda, most likely as a result of the continued health, economic, and political instability threats posed by severe pollution in China's waterways.

Surface water is not the only water source that is being threatened by pollution. An estimated 32% of Asia's population gets its supply of drinking water from groundwater. Even where surface water is abundant, communities prefer groundwater sources because they are considered safer. In actuality, however, groundwater pollution is often difficult to identify and treat. Despite such pollution concerns, overdraft from aquifers in India and Pakistan is estimated to be between 120 million and 160 million acre-feet per year.[21]

Moreover, in parts of Asia, such as Bangladesh, water quality from underground sources is naturally impaired as a result of infiltration from mineral deposits of poisonous compounds, such as arsenic salts. In some cases, people are forced to seek groundwater when municipalities cannot provide clean water. In Jakarta, for example, public utilities providing freshwater serve only 46% of the city's population, requiring the remainder to extract water from underground sources to meet their daily needs. This extraction, however, is not regulated or managed properly, leading to reduced water levels, increased water salinity, and growing subsidence rates of 3 to 6 centimeters per year in parts of coastal northern Jakarta. This has greatly increased the vulnerability to flooding during high tides—and climate change–induced sea-level rise—and is preventing the implementation of flood control measures. [22]

In its 2006 *Global International Waters Assessment*, the UN Environment Programme attempted to quantify the long-term environmental and socioeconomic impact of water pollution across eight key indicators: suspended solids, eutrophication (excessive nutrients in aquatic systems caused largely by sewage and fertilizer runoff), microbial pollution, solid wastes, chemical pollution, suspended solids, solid waste, oil spills, and microbial pollution.

[21] John Mitchell, "The Coming Water Crisis," *Environment: Yale* (Spring 2007).

[22] United Nations Environment Programme, *Groundwater and Its Susceptibility to Degradation: A Global Assessment of the Problem and Options for Management* (Nairobi: UNEP Publications, 2003).

Based on these indicators, the study found that half of the 24 greater Asian and Australian regions were severely or moderately affected by pollution. The study further projected that the condition of 17 areas will deteriorate by 2020, with only three—in the Mekong River watershed and southern Australia—expected to improve.[23] Where the former is concerned, anticipated improvement may be attributed to multilateral agreements and Mekong River Commission management.[24]

The *Global International Waters Assessment* further warned that the socioeconomic impacts of pollution on water resources not only contribute to declining health standards and the worsening of local poverty, but also could lead to growing conflicts among users.[25] In the medium to long term, for example, worsening water pollution will translate into isolation or abandonment of areas because of the difficulty of removing pollutants, especially in groundwater. In this case, the increase in migration to areas where the availability of water is more secure will not only strain existing water infrastructure, but also could lead to social and political instability, and possibly conflict, in migrant-receiving areas.[26]

The Leadership Group sees the impact of water quality on health as perhaps the most compelling reason to consider the human security dimensions of water. Inadequate water, sanitation, and hygiene are leading to rising rates of waterborne diseases in Asia, where the burden of illness and death is falling on the region's poorest, especially women and children. Diarrheal disease alone accounts for 865,000 deaths across the region every year; a significant share of these deaths could be prevented though achievable interventions in water and sanitation. Accelerating our efforts in this crucial sector would have the most tangible impact on child health and could radically reduce infant mortality. Until adequate measures to control the contamination of water sources from human and industrial waste are implemented, freshwater scarcity will intensify and health indicators in the region will decline.

[23] United Nations Environment Programme, "Challenges to International Waters: Regional Assessments in a Global Perspective," in *The Global International Waters Assessment Final Report* (Nairobi: UNEP Publications, 2006), 38–39.
[24] For an excellent comparative discussion of water governance considering an integrated approach, see Ken Conca, *Governing Water: Contentious Transitional Politics and Global Institution Building* (Cambridge, MA: MIT Press, 2005).
[25] UNEP, *Global International Waters Assessment Final Report*, 10.
[26] Nils Petter Gleditsch, Ragnhild Nordas, and Idean Salehyan, "Climate Change and Conflict: The Migration Link," *Coping with Crisis: Working Paper Series* (New York: International Peace Academy, 2007).

Climate Change, Sea-Level Rise, and Planning for Global Change

Climate change resulting from anthropogenic and natural factors will have consequential impacts on global hydrology. As the IPCC warns, unlike the effects that demographics and pollution will have on water resources, the adverse change brought on by global warming "poses a major conceptual challenge to water managers, water resource users (e.g. agriculture, industry), as well as to policy makers in general, as it is no longer appropriate to assume that past climatic and hydrological conditions will continue into the future."[27]

Climate Change and Water

By Rajendra K. Pachauri, Director General, The Energy and Resources Institute (TERI), and Chairman, Intergovernmental Panel on Climate Change (IPCC)

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change carries an extensive assessment of the hydrological cycle as it relates to climate change in different regions of the world. Given the importance of the subject, the panel decided to prepare a technical paper on climate change and water that would consolidate all of the knowledge contained in the AR4 linking climate change with the subject of water. Observed evidence indicates that the warming of the earth has led to increased atmospheric water vapor; constant changes in precipitation patterns, particularly with respect to intensity and extremes; reduced snow cover; widespread melting of ice; and changes in soil moisture and runoff. Changes in precipitation show substantial spatial and interdecadal variability. Over the twentieth century, increased precipitation occurred mostly over land in high latitudes, while precipitation decreased from 10° south to 30° north. Since the 1970s, the frequency of heavy precipitation events and the proportion of total rainfall from heavy precipitation have increased over most areas. Globally, the area of land classified as very dry has more than doubled since the 1970s. At the same time, there has been a significant decrease in water storage in mountain glaciers and Northern Hemisphere snow cover.

Simulations for the twenty-first century also indicate precipitation increase in high latitudes and parts of the tropics, with decreases in some subtropical and lower mid-latitude regions. As a result, by the middle of the twenty-first century, average annual river runoff and water availability are projected to increase as a result of climate change at high latitudes and in some wet tropical areas, and decrease over some dry regions at mid-latitudes as well as in the dry tropics.

[27] Bryson Bates, Zbigniew W. Kundzewicz, Shaohong Wu, and Jean Palutikof, eds., *Climate Change and Water*, Technical Paper IV of the Intergovernmental Panel on Climate Change (Geneva: IPCC Secretariat, 2008), 127.

The changes that are projected to take place will increase the risk of flooding and drought in many areas. In the case of glaciers and snow cover, water supplies are projected to decline during the course of the century, thus reducing water availability during warm and dry periods in regions that are supplied by melt water from major mountain ranges, where more than one-sixth of the world population currently lives. Higher temperatures and changes in extreme events, including floods and droughts, would also affect water quality and exacerbate water pollution as a result of changes in sediments, nutrients, dissolved organic carbon, pathogens, pesticides, and salt, as well as thermal pollution. These could have negative impacts on ecosystems, human lives, and water system reliability, as well as on operating costs.

Sea-level rise has extended areas of salinization of groundwater and estuaries, decreasing the availability of freshwater for human consumption and ecosystems in coastal areas. Overall, climate change challenges the traditional assumption that past hydrological experience provides a good guide to future conditions, because the consequences of climate change may alter the reliability of current water management systems and water-related infrastructure. Examples can be found in recent occurrences, when large-scale precipitation received over a short period of time has led to floods, particularly in coastal cities. It has been observed that in such cases, the drainage infrastructure proved to be inadequate, as it had apparently been designed on the basis of past practices and precipitation, when occurrences were neither as severe nor as frequent as what is currently being experienced. Inevitably, therefore, the drainage infrastructure will have to be enhanced to reduce the risks associated with a regime that would faced with higher frequency and intensity of extreme events.

From a policy perspective, an integrated approach is necessary for adaptation, for which demand-side as well as supply-side strategies must be implemented together. Water use efficiency, for instance, can be improved by recycling water. At the same time, metering and rational pricing would provide economic incentives for water conservation, and water markets could be developed such that reallocation would take place for highly valued uses. Supply-side strategies would require increases in storage capacity, abstraction from water courses, and water transfers. An integrated water resources management approach would create the right framework for achieving adaptation measures. It is clear that water resources management would have major implications, influencing other policy areas such as energy, health, food security, and nature conservation. A better understanding of all these issues can be fostered by modeling climate change related to the hydrological cycle at scales relevant to decision making. Ideally, these would relate to watersheds at the basic micro level, as well as to systems on a larger scale. Overall, a long-term view of changes in the water regime resulting from climate change would help us arrive at appropriate strategies and directions for managing risks that are likely to develop in the future.

The impact that climate change will have on Asia's glaciers is perhaps most consequential for water resources in the region. Climate change is already causing more rapid melting of the region's glaciers and ice caps, which for many countries are the primary freshwater source. Research on changes in glacial mass balance over time reveals some annual variation between the major glacial regions of Asia (see Figure 4: Asia's Disappearing Glaciers). Overall, there is a noticeable decline in Asian mountain glacial cover. Although there are a few glaciated regions in Tibet and Northern Tibet that appear to have higher mass balance, these are minor compared to the overall declining trend. Moreover, the Northern Tibetan glaciers do not have as much annual melting because of the much lower summer temperatures there, and thus do not have the same level of water availability potential as the glaciers in the Himalayas and southern ranges, which supply water to the much higher population density regions of South Asia.

The glaciers of the Himalayan mountain ranges are at the center of Asia's water supply, and their decline in recent decades is alarming. Glaciers melt at different rates depending on a combination of altitude and solar orientation. Glaciers in lower altitudes and those that are exposed to more hours of solar radiation tend to melt faster, but the general trend in the area is that glaciers are thinning at an average rate of approximately 1 meter per year.[28] Annual glacial melt water from the Himalayas in spring and summer, which is replenished during winter snowfall, accounts for as much as 70% of the summer flow in the Ganges River and 50% to 60% of the flow in Asia's other major river systems. Recent measurements show that there is a regression of approximately 30 days in the maximum spring flow period and an increase of 30% to 38% in the glacial runoff. This would mean that in the span of 30 years, the Himalayan rivers that depend on glacial melting—such as the major Ganges, Indus, Brahmaputra, and Mekong River systems—would become seasonal rivers when the glaciers disappear. When the shortage arrives in approximately 20 to 30 years, it will be quite abrupt, as the flow will be dramatically reduced in the dry season.

One area of particular concern is the Himalayan glaciers of the Tibetan Plateau. Located in western China, these glaciers account for up to 70% of the glacial coverage in the Himalayas. The melting of these glaciers provides water to a significant portion of China's population and also feeds three mega-deltas in that country: the Changjiang (Yangtze), Zhujiang, and Huang (Yellow) deltas.[29] Nearly 23% of the country's large population lives in the western regions where glacial melt provides the principal dry season water source, making it an important source of livelihood. However, studies forecast that the glaciers in this region are shrinking rapidly as a result of climate change. It is predicted that glacial coverage in western China will decrease 27% by 2050, leading to increased variability in water flows for glacier-fed rivers and deltas.

Another major threat that climate change poses for water resources is sea-level rise as a

[28] Etienne Berthier, Yves Arnaud, Rajesh Kumar, Sarfaraz Ahmad, Patrick Wagnon, and Pierre Chevallier, "Remote Sensing Estimates of Glacier Mass Balances in the Himachal Pradesh (Western Himalaya, India)," *Remote Sensing of the Environment* 108 (2007): 327–38.

[29] Tim P. Barnett, Jennifer Adam, and Dennis P. Lettenmaier, "Potential Impacts of a Warming Climate on Water Availability in Snow-Dominated Regions," *Nature Reviews* 438, no. 17 (2005): 303–9.

result of rapidly melting ice caps. Sea-level rise will extend salinization areas and contaminate freshwater resources in coastal areas and cities. Because most of Asia's largest cities—including Mumbai, Karachi, Shanghai, Tokyo, and Jakarta—are located near the coast, the challenge of sea-level rise will be particularly acute for the continent (see Map 2: Population Density in Low-Lying Coastal Regions). Even robust economies such as Japan are not immune from the potential impact of sea-level rise. Despite having the most advanced infrastructure to withstand earthquakes and other natural disasters, the Japanese government estimates that 3.2 million people who live at or below sea level in the country are at high risk because of sea-level rise. More than 36 trillion yen worth of property (approximately US$388 billion) would also be at risk in these areas.[30]

The security implications of climate change for Asia's water resources are many and varied. Glacial melting may increase the potential for hydropower generation in the short term, and some analysts have argued that the infrastructure to harness the energy of this fleeting resource should be put in place, even if it is nonrenewable. However, any rapid development of this kind of hydroelectric infrastructure could lead to conflict between upstream and downstream users. Increased competition for water resources could also pose a threat to security in an environment in which ethnic and economic disparities are already an issue. Increased internal migration of majority ethnic Han Chinese to the Tibetan Plateau, for example, has resulted in greater density and demand for already scarce resources in the region. This is of particular concern because the region is already the poorest in the country. Residents experience substantially lower living standards than the rest of China. According to the UN Development Programme's Human Development Index, in 2008, Tibet had the lowest score of all Chinese provinces at 0.59, only slightly ahead of Myanmar at 0.58. Tensions between Han and Tibetan peoples are already stressed, and further competition resulting from increased resource demands is likely to further complicate the situation.[31]

The linkage between climate change and security has been acknowledged more generally by defense establishments worldwide, as in a 2004 report commissioned by the U.S. Department of Defense on abrupt climate change. Many of the factors underlying the scenarios of such exercises are directly linked to water availability or water-induced disasters. Developing scientific and political institutions to cope with such factors in a timely and effective way is essential.

Scientists have projected that climate change will likely result in increased frequency and intensity of extreme events. In Asia, the effects of extreme events and natural disasters, such as floods, typhoons, and tsunamis, are widely felt by people in the region. According to Japan's Public Works Research Institute, nearly 40% of all global water-related disasters from 1990 to 2004 occurred in Asia.[32] Moreover, Asia accounted for more than 45% of water-related fatalities between 1980 and 2006 (see Figure 5: Water-Related Disaster Fatalities and People Affected: 1980–2006). Not only is this an indication of an increase in the frequency of

[30] Data from the Japanese Ministry of Construction.
[31] Preeti Bhattacharji, *Uighers and China's Xinjiang Region," Council on Foreign Relations Backgrounder* (New York: Council on Foreign Relations, 2008). Available at http://www.cfr.org/publication/16870/ (accessed March 13, 2009).
[32] Data from the Public Works Research Institute, Japan. Available at http://www.pwri.go.jp/team/suisitsu/index_e.htm (accessed March 13, 2009).

water-related disasters, but also it highlights the demographic changes in Asia's cities—areas of which are more disaster prone—and the gap in disaster preparedness among many local and national governments. The tsunami that struck Aceh Province, Indonesia, in December 2004, for example, revealed the vulnerability that weak infrastructure, poor planning, and inadequate governance can entail.

Extreme events, moreover, can be compounded by other environmental problems in a country. In such circumstances, not only are people affected, but so are freshwater resources. For example, deforestation leaves large hillside areas barren and the underlying soil vulnerable to heavy precipitation, which greatly increases the likelihood and severity of floods and landslides. When heavy precipitation overwhelms an aquifer's rate of absorption, flooding occurs and urban infrastructure is overwhelmed, leading to sewage spillover and even greater contamination. An increase in water flow and resultant flooding could also lead to an increase in water contamination and pollution as water flow comes into contact with agricultural fertilizer and pesticides. The cleanup and repair costs associated with these events are immense and could exacerbate existing poverty conditions, creating a poverty trap. Increased variability in water flow also affects the salinity and thus the availability of water, which has an effect on biodiversity and on the fisheries that communities rely on for their livelihoods.

The problem of natural disaster management is even more complex for the Asian monsoon countries, where most of the annual rainfall occurs within 60 to 100 hours, although these durations are not consecutive. These seasonal periods of rain and arid dryness threaten to disrupt regular weather patterns and exacerbate extremes. The dry season may become more arid, and the rainy season may see higher precipitation levels within shorter time intervals, leading to floods that overwhelm infrastructure and damage crops. These seasonal swings may create feedbacks as rapid precipitation in larger volumes makes natural water replenishment and storage more difficult, while the increasingly arid dry season further drives demand for water access. Managing water scarcity in the dry season and excess volume during rainy months is a critical challenge for monsoon countries such as Indonesia and much of Southeast Asia.

The 2006 *Stern Review on the Economics of Climate Change* estimated that by 2050, the costs of extreme events will be 0.5% to 1% of the world's gross domestic product. The *Stern Review* further noted that between 150 million and 200 million people worldwide will be displaced permanently by drought, flooding, and sea-level rise. Countries with populations living in low-lying coastal regions, such as Vietnam, Bangladesh, parts of China, and India, are especially vulnerable.[33] The potential for disasters leading to short-term cooperation between erstwhile adversaries exists in some cases, but disasters can also exacerbate existing conflicts. For example, the 2006 Indian Ocean tsunami led to an accelerated resolution of the Aceh conflict in Indonesia but exacerbated the Tamil conflict in Sri Lanka.[34]

[33] Nicholas Stern, "Part II: The Impact of Climate Change on Growth and Development," in *The Economics of Climate Change: The Stern Review* (New York: Cambridge University Press, 2006), 10–11, 77.

[34] For an analysis of the environmental security implications of the tsunami and other disasters, see Michael Renner and Zoe Chafe, *Beyond Disasters: Creating Opportunities for Peace*, Worldwatch Report (Washington, DC: Worldwatch Institute, 2007).

Climate change is one of the key multidimensional issues that will affect water security. Indeed, climate change can abate or erase the progress made in achieving development targets and will very likely contribute to increased competition for water resources throughout the Asian region. Among climate change experts, it is commonly noted that mitigation is largely about "gas," while adaptation is about "water." This point is particularly relevant as governments are currently focused on reaching a global agreement to tackle the challenge of climate change in Copenhagen in December 2009. The Leadership Group recommends that long-term policies, as well as measurable and verifiable targets, be adopted by all countries as part of the Copenhagen process to lessen the impact of climate change on water resources. Overall, a long-term view of changes in the water regime resulting from climate change would help to determine appropriate strategies and directions for managing risks that are likely to develop in the future. The Leadership Group recommends utilizing IPCC data on water and climate change to develop early-warning systems on a regional level to consider the impacts of desertification, sea-level rise, and other consequences related to climate change. Given that the Asia-Pacific region is most vulnerable to water-related disasters, countries in the region should work together to strengthen disaster-warning systems and improve coordination to respond to water-related disasters.

Institutional Responses to Water Security

There is no comprehensive global strategy or overarching international treaty to address water security, but rather an assemblage of regional agreements and conventions, particularly between riparian states.[35] Specific conventions may deal with some aspects of water resources, such as the Ramsar Convention on Wetland Protection or the Law of the Sea Convention. However, their impact on global water policy at an integrative level is very limited.

Several regional and topical conferences related to water have been convened by the United Nations since the first global meeting on water in Mar del Plata, Argentina, in 1977. Today, virtually every organization, fund, specialized agency, and entity of the United Nations is tasked with addressing water sustainability at some level. The significance of water resources is also enshrined in the Millennium Development Goals—a set of time-bound and measurable goals and targets for combating various environmental and development problems that were adopted by heads of state gathered at the UN Millennium Summit in September 2000. One of the targets is to halve the number of people who lack access to safe drinking water by 2015. According to the *World Water Development Report*, the Asian region that has made the greatest progress toward sustained access to safe drinking water is South Asia, where coverage increased from 71% to 84% between 1990 and 2002. Still, more than 60% of the region's population did not have access to sanitation in 2002.[36]

UN Water, an interagency mechanism established in 2003, monitors and reports on the world's progress toward meeting water and sanitation development targets, such as those outlined in the Millennium Development Goals. UN Water also ensures coherence at the regional and country levels for UN projects and develops partnerships with the public and private sectors and civil society organizations to forge a common approach to water challenges. The Secretary-General's Advisory Board on Water and Sanitation, formed in 2004 to provide substantive advice on global water issues, is a collaborating partner of UN Water.

Although the desire for an integrative approach to water resources has existed for several decades, the establishment of international water dispute mechanisms has been painfully slow. The UN Convention on the Law of the Non-Navigational Uses of International Watercourses was promulgated in 1997, but it has failed to muster the 35 votes needed to take effect. Even when the convention was initially adopted in 1997 by the UN General Assembly, China was one of only three countries—with Turkey and Burundi—to vote against the agreement. The Chinese government has also resisted becoming a full member of the Mekong River Commission, although it is a dialogue member and has not been fully encouraged to join the commission by some member states.

Established in 2001 as a forum for regional cooperation among Asian powers, the Shanghai Cooperation Organization (SCO) has grown in strength and legitimacy and may be another conduit for water-related cooperation. The six member states of the SCO—China,

[35] See Appendix for a listing of multilateral and bilateral water agreements between Asian countries.
[36] World Water Development Programme, *Water: A Shared Responsibility: World Water Development Report 2* (New York: UNESCO/Berghahn Books, 2006), 221.

Kazakhstan, Kyrgyzstan, Russia, Tajikistan, and Uzbekistan—cover more than two-thirds of Asia's land area. The organization also has four observer states—India, Iran, Mongolia, and Pakistan—that may eventually become full members. Water resources figured prominently in the SCO's meeting in 2004, when water pollution from uranium operations, dam construction, and desertification, among other issues, were on the agenda. The organization has moved away from its initial stance of being a foil to U.S. power and has helped to broaden the Chinese security concept (*xin anquan guan*) that first appeared in 1996. The SCO has also signed a memorandum of understanding with the well-established Association of Southeast Asian Nations (ASEAN), which initiated a strategic plan of action on water resources in 2005.[37] This strategic plan underscores the critical importance of water among its member countries and builds on a number of agreements dating to 1999 in an effort to promote integrated water resources management in the region.

Asian countries may also consider lessons from other parts of the world in terms of water-related institutional reform. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes, signed on behalf of the European Community in Helsinki in 1992, established a framework for cooperation between the member countries of the UN Economic Commission for Europe. The goal of this convention is the prevention and control of pollution of transboundary watercourses by ensuring the rational use of water resources, with a view toward sustainable development. The parties to the Convention agree to take all appropriate measures to prevent, control, and reduce any transboundary impact pledge to ensure that transboundary waters are managed in a rational, environment-friendly, and equitable manner and that the conservation and restoration of ecosystems are supported. The actions of the parties to the Convention must be guided by the following principles:

- **The precautionary principle**: Action to avoid the release of hazardous substances must not be postponed, despite the lack of a proven causal link between the substances and the transboundary impact.
- **The polluter pays principle**: The costs of pollution prevention, control, and reduction measures must be borne by the polluter.
- **Sustainability**: Water resources must be managed so that the needs of the present generation are met without compromising the ability of future generations to meet their own needs.

There also are various voluntary mechanisms by which water issues have been deliberated worldwide. The Global Water Partnership, established as a follow-up effort to the Dublin Conference on Water and the Environment in 1992, aims to establish a more comprehensive approach to water management through the lens of sustainable development. Supported by the World Bank, the UN Development Programme, and the Swedish International Development Agency, the partnership officially started functioning in 1996. This initiative was

[37] Association of Southeast Asian Nations, *ASEAN Strategic Plan of Action on Water Resources Management* (Jakarta: ASEAN Publications, 2005).

based on promoting and implementing integrated water resources management through the development of a worldwide network that could pull together financial, technical, policy, and human resources to address the critical issues of sustainable water management.[38] A similar organization that facilitates dialogue on water issues worldwide is the World Water Council (also established in 1996), which hosts the World Water Forum every three years.

The creation of the Asia-Pacific Water Forum in 2006—an idea that was put forward and endorsed by the region's water ministers—is a notable development. It seeks to establish an effective mechanism to encourage more collaborative efforts on water resources management and to accelerate the process of effective integration of water resources management into the socioeconomic development process of the region. The forum convened the first Asia-Pacific Water Summit in Japan in 2007, bringing together leaders from the region and partner organizations to discuss financing for water-related infrastructure and human capacity development. The next summit is set to be held in Singapore in 2010.

Taken together, the Leadership Group sees the aforementioned efforts as a foundation on which to build a regional strategy. In order to address the most urgent water-related challenges in Asia, it is necessary to have stronger institutions, better coordinated policies, and the political will from all stakeholders to move from a reactive to a proactive stance.

[38] Details about the mandate of the Global Water Partnership can be found at http://www.gwpforum.org (accessed March 13, 2009).

A Way Forward

The Asia Society's Leadership Group on Water Security aims to provide the impetus required for a lasting and measureable policy shift to link water and security at multiple levels in Asia. In view of the wide range of consequences that impaired water availability and quality may have on global processes, the policy recommendations offered here have been crafted to provide a clear and pragmatic path toward action.

- **Raise the profile of water security on the political and developmental agendas of national governments in Asia.** There is an immediate need for governments in Asia to strengthen their capacities to engage in preventive diplomacy focused on water and to start setting policies and making investments in support of infrastructure for water conservation and management. Good water governance should be viewed as part of a set of sustainable development strategies to alleviate poverty and advance human security. Such strategies should include conducting vulnerability assessments, providing access to information, building human and institutional capacity, and promoting public and private investments in developing countries. Finance is a critical element of any strategy to address water security. Currently, only about 5% of development aid worldwide is devoted to water. A water resources fund that includes both public and private resources should be established to support activities in developing countries. To achieve these goals, greater coordination among government ministries—such as the ministries of finance, health, environment, and education—will be required.
- **Include water in security policy planning.** Governments in Asia should ensure that water management organizations have direct communication with defense agencies and develop integrated water management and conflict prevention capacities where needed. By the same token, policy-setting discussions on water sustainability should be expanded to include traditional security actors. As a preventive measure, conflict resolution mechanisms to address intra- and transboundary water issues between countries and communities should be developed or strengthened. Given that the Asia-Pacific region is most vulnerable to waterborne disasters, countries in the region should work together to strengthen disaster-warning systems and improve coordination to respond to water-related disasters.
- **Encourage investment in and increased collaboration on water management technologies.** Emphasis should be placed on spurring greater investment in the infrastructure and knowledge systems needed to manage complex water systems for the benefit of all. To fill the water investment gap, both public funding and private financing will be required. Incentives are needed to increase developing-country adoption of, and private-sector investment in, technologies that advance water security. Low-tech approaches, such as improved methods to desalinate water and low-cost drip irrigation, as well as more affordable opportunities for low-cost water investment, are needed. Innovations and investments aimed at producing more food with less water, such as new crop varieties that can tolerate

low water levels and drought, as well as brackish and even saline water, and policies that create incentives for farming communities to invest in better water management should be actively encouraged.

- **Generate better policies through dialogue.** The importance of dialogue among the range of actors with a stake in water policy cannot be overstated. Policy makers at every level, as well as nongovernmental organizations, civil society groups, and private enterprises, must be stakeholders in the responsible management of water resources. Public- and private-sector partnerships should be strengthened to ensure broad and equitable ownership of water resources. Nongovernmental organizations, civil society groups, scientists, and researchers are often at the front line of improving water access at the local level and should be consulted on water-related policy-setting processes. Drawing on local knowledge should be a priority. Women and poor communities should be given greater input into the management of water resources. The experiences and expertise of local leaders across sectors and societal spheres from cities, states or provinces, communities, grassroots organizations, and businesses who are advancing sustainable water management practices and models of mediation and conflict resolution to address water-related disputes should be collected and disseminated, with a view toward extrapolating best practices for broader application.

- **Address the emerging water crisis through a post-2012 climate agreement.** This report comes at a time when governments are focused on reaching a global agreement to tackle the challenge of climate change, culminating in the next U.N. Climate Change Conference to be held in Copenhagen in December 2009. As part of this process, measurable and verifiable targets to reduce greenhouse gas emissions should be adopted by all countries. Moreover, adaptation is necessary to lessen the impacts on water resources resulting from global warming that are already unavoidable because of past emissions. This will require forward-looking investment and far-sighted policies that go beyond short-term responses to current climate variability.

- **Utilize the Intergovernmental Panel on Climate Change data on water and climate change to develop early-warning systems.** A long-term view of changes in the water regime resulting from climate change would help to advance cohesive strategies and policy directions for managing risks that are likely to develop in the future. There is a vast amount of scientific research under way on the impact of climate change on water availability that is accessible through the IPCC. This information needs to be linked to the development of early-warning systems on a regional level to consider the effects of desertification, sea-level rise, and other impacts related to climate change. The UN Environment Programme's Division of Early Warning and Assessment can also play a facilitative role.

- **Develop concrete ways of implementing existing statements and regional agreements such as the Asia-Pacific Water Summit Declaration of 2007.** (See Appendix 2) Existing efforts at the ministerial level among Asian countries to support water management, such as the Asia-Pacific Water Summit, which unanimously issued the Beppu Declaration at a meeting in Japan in 2007, should be supported and implemented. Clear metrics of perfor-

mance to meet the targets of such declarations are essential. To advance the water agenda in the region, governments as well as nongovernmental and private-sector groups involved in water-related sustainability efforts should work together to help build momentum for the second Asia-Pacific Water Summit, which is set to be held in Singapore in 2010.

- **Expand the Water Financing Partnership Facility initiated by the Asian Development Bank.** The Water Financing Partnership Facility was initiated by the Asian Development Bank with financial support from Australia, Austria, the Netherlands, and Norway to provide financial resources and technical support in the key areas of rural and urban water services and river basin water management, including adaptation to climate change. The initial commitment of US$26 million needs to be supplemented with private-sector support and market incentives in order to sustain this effort across urban and rural areas in Asia.

- **Harmonize the Millennium Development Goals that pertain to water under a unified United Nations Economic and Social Commission for Asia and the Pacific task force on rapid implementation to meet 2015 targets in Asia.** The Asian Development Bank's Asia Water Watch 2015 study estimated that annual investments of US$8 billion will be needed over the next decade to meet the Millennium Development Goals target for safe drinking water alone. Investments in water are also crucial in meeting broader targets such as halving the incidence of poverty, halving the proportion of the world's poor who suffer from hunger, reducing child and maternal mortality, reducing the incidence of major diseases, and improving environmental sustainability. A coordinated strategy that links the goals through water management is needed and can be initiated by a task force managed by UNESCAP for the Asian region.

- **Improve data quality in order to generate better policies.** One of the key findings of the *Asian Water Development Outlook 2007* was the unreliability of water resource data across the region. The *Outlook* documented huge variations in officially reported figures on water quantity and quality throughout Asia. The lack of accurate data is an impediment to effective policy making. The production of high-quality data needs to be a priority across the region. To address these shortcomings, member states should considering endowing the United Nations with a data-collection capacity that is authorized to gather water quality data worldwide, similar in scope to data collected on nuclear issues by the International Atomic Energy Association. The development of indices for comparisons of water resource performances across countries is clearly needed. Inspired by the success of the Human Development Index, the Asia-Pacific Water Forum has started to develop an Index of Drinking Water Adequacy. Such an effort needs to be expanded with greater institutional support.

These recommendations are not meant to be exhaustive, but rather are indicative of the scope and precision of the efforts needed to tackle the water challenges facing Asia. The good news is that the vast majority of the water-related problems plaguing Asia are solvable through

better water management, and the technologies and policy tools required to make progress are well known. What is needed now is action. With effective planning and leadership, this resource crisis can be transformed into an opportunity for lasting cooperation between countries and across communities.

Figure 1. Water-Related Cooperation versus Conflict: 1948-1999[39]

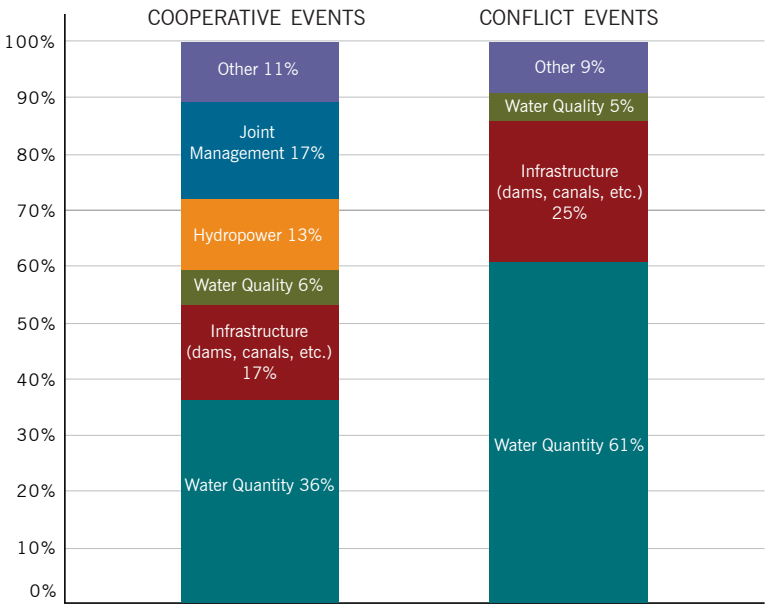
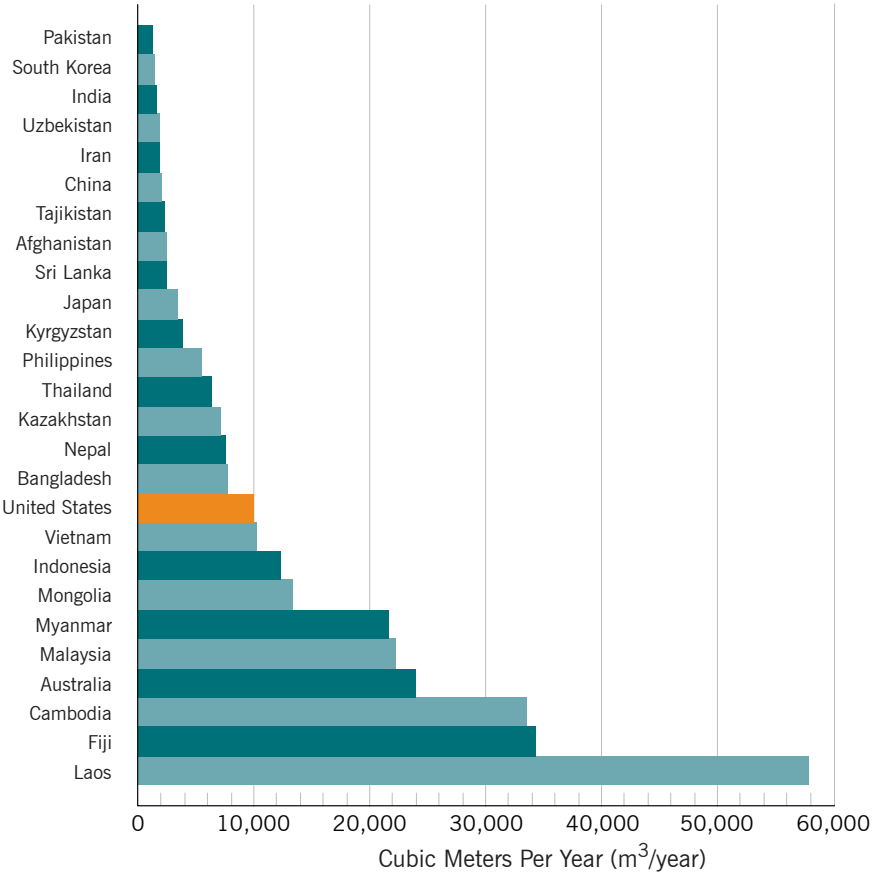


Figure 2. Water Resources and Dependency[40]

Country	Total Internal Renewable Water Resources (km^3)	Total External Renewable Water Resources (km^3)	Dependency Ratio (%)
Afghanistan	55	10	15
Australia	492	0	0
Bangladesh	105	1,106	91
Cambodia	121	356	75
China	2,812	17	1
India	1,261	636	34
Indonesia	2,838	0	0
Iran	128	9	7
Japan	430	0	0
Kazakhstan	75	34	31
Kyrgyzstan	46	-26	0
Laos	190	143	43
Malaysia	580	0	0
Mongolia	45	0	0
Myanmar	881	165	16
Nepal	198	12	6
Pakistan	55	170	77
Philippines	479	0	0
South Korea	65	5	7
Sri Lanka	50	0	0
Thailand	210	200	49
United States	2,800	51	8
Uzbekistan	16	34	77
Vietnam	366	525	59

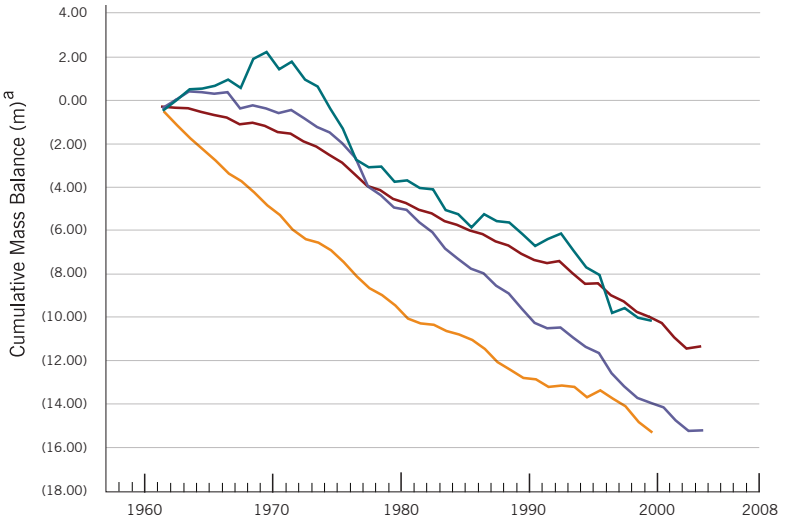
[39] Adapted from Shira Yoffe, Aaron T. Wolf, and Mark Giordano, "Conflict and Cooperation Over International Freshwater Resources: Indicators of Basins at Risk," *Journal of the American Water Resources Association* 39 (2003): 1109-1126.
[40] Food and Agricultural Organization, *Aquastat Database*, 2008

Figure 3. Total Water Availability per Capita[41]



[41] Food and Agricultural Organization, *Aquastat Database*, 2008

Figure 4. Asia's Disappearing Glaciers[42]



Pamir (Tajikistan, Kyrgyzstan, Afghanistan, Pakistan and China): Total Area, 12,260 km^2

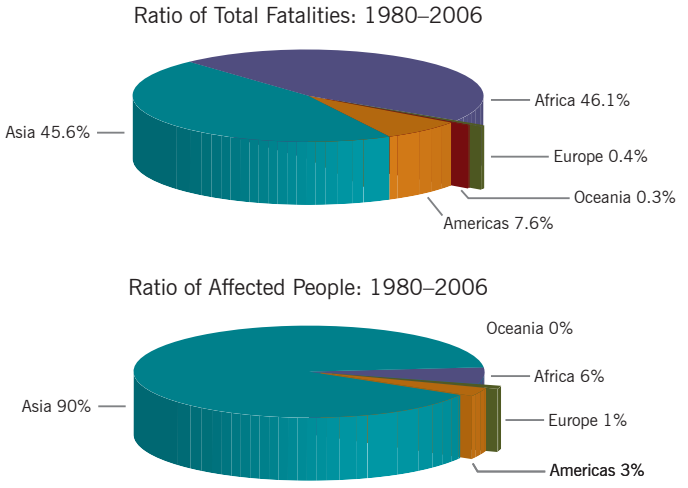
Tien Shan (China, Pakistan, India, Kazakhstan, Kyrgyzstan): Total Area, 15,417 km^2

Himalayas (Bhutan, Tibet, India, Nepal, Pakistan, Burma, Afghanistan): Total Area, 33,050 km^2

Asia (includes the Pamir, Tien Shan, Himalayas, Kun-Lun (Tibet) glaciers, and the smaller Dzungaria, Quilan, and Gongga glaciers in China)

[a] Cumulative mass balance (in meters) measures the average thickness gained (positive balance) or lost (negative balance) of glacier during the measured year.

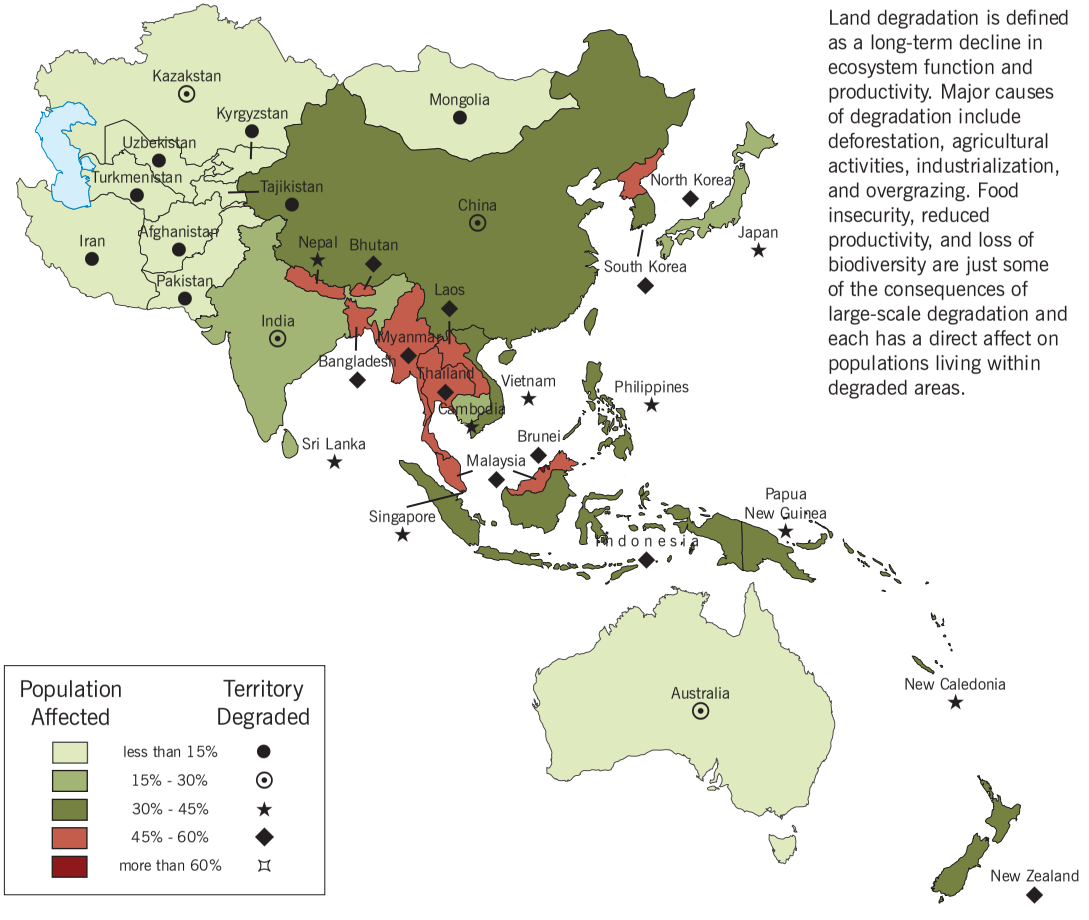
Figure 5. Water-related Fatalities and People Affected: 1980–2006[43]



[42] Mark B. Dyurgerov and Mark F. Meier, "Glaciers and the Changing Earth System: A 2004 Snapshot," *Occassional Paper No. 58*, Institute of Alpine and Arctic Research (Boulder, CO: University of Colorado, 2005).

[43] Adapted from Yoganath Adikari, Junichi Yoshitani, Norimichi Takemoto, and Ali Chavoshian, "Technical Report on the Trends of Global Water-related Disasters: A Revised and Updated Version of 2005 Report," *Technical Note of the Public Works Research Institute*: No. 4088 (2008): 30.

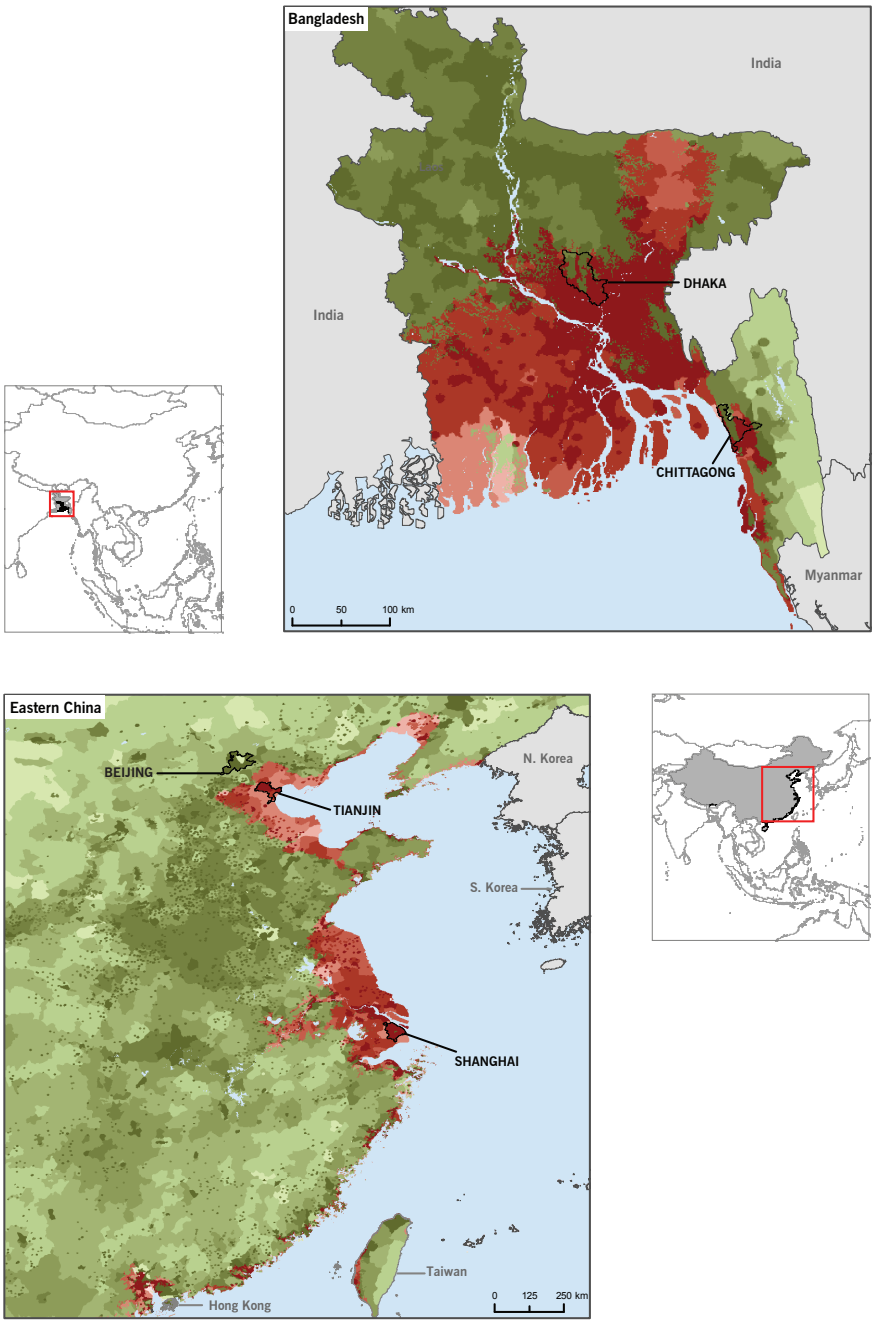
Map 1. Land Degradation in Asia and its Impacts[44]

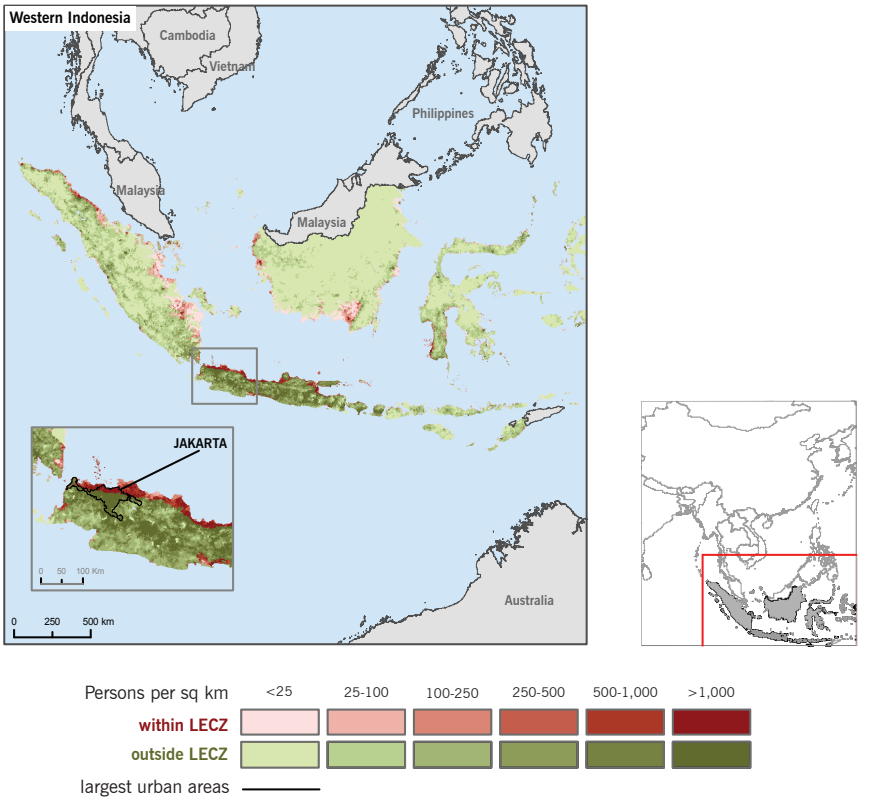


Land degradation is defined as a long-term decline in ecosystem function and productivity. Major causes of degradation include deforestation, agricultural activities, industrialization, and overgrazing. Food insecurity, reduced productivity, and loss of biodiversity are just some of the consequences of large-scale degradation and each has a direct affect on populations living within degraded areas.

[44] Derived from Zhanguo Bai, David Dent, Lennart Olsson and Michael E. Schaepman, "Global Assessment of Land Degradation and Improvement 1: Identification by Remote Sensing," *Report 2008/01* (Rome: Food and Agricultural Organization; Wageningen, Netherlands: International Soil Reference and Information Center, 2008).

Map 2: Population Density in Low-Lying Coastal Areas: within and outside a 10 meter low elevation coastal zone (LECZ), 2000[45]





[45] Reproduced from maps provided by: Center for International Earth Science Information Network (CIESIN), Columbia University, 2007 (http://sedac.ciesin.columbia.edu/gpw/lecz.jsp)

Appendix 1: Asia's International Freshwater-Related Agreements[46]

Name	River	Country	Year
Terms of agreement between Great Britain and Patiala, Jind, and Nabha regarding the Sirhind Canal	Indus	Great Britain, States of Patiala, Jind, and Nabha	February 18, 1873
Articles of agreement between the Edur Durbar and Great Britain	Indus	Great Britain, State of Edur	July 20, 1874
Amended terms of agreement between Great Britain and Jind, for regulating the supply of water for irrigation from the Western Jumana Canal	Indus	Great Britain, State of Jind	September 16, 1892
Agreement between Great Britain and Patiala regarding the Sirsa branch of the Western Jumna Canal	Ganges-Brahmaputra-Meghna	Great Britain, State of Patiala	August 29, 1893
Final working agreement relative to the Sirhind Canal between Great Britain and Patiala, Jind, and Nabha	Indus- Sirhind Canal	Great Britain, States of Patiala, Jind, and Nabha	February 23, 1904
Agreement between Great Britain and the Panna State respecting the Ken Canal	Ganges-Brahmaputra-Meghna	Great Britain, State of Panna	September 30, 1908
Treaty between the government of Afghanistan and Great Britain for the establishment of neighborly relations	Indus	Great Britain, Afghanistan	November 22, 1921
Inter-dominion agreement between India and Pakistan on the canal water dispute between East and West Punjab	Indus	India, Pakistan	May 4, 1948
Terms of reference of the Helmand River Delta Commission and an interpretive statement relative thereto, agreed by conferees of Afghanistan and Iran	Helmand	Afghanistan, Iran	September 7, 1950
Agreement between India and Nepal on the Kosi Project	Ganges-Brahmaputra-Meghna	India, Nepal	April 25, 1954
Agreement between the Union of Soviet Socialist Republics (USSR) and the People's Republic of China on joint research operations to determine the natural resources of the Amur River Basin and the prospects for development of its productive potentialities and on planning and survey operations to prepare a scheme for the multi-purpose exploitation of the operations to prepare a scheme for the multi-purpose exploitation of the Argun River and the Upper Amur River	Amur	People's Republic of China, Union of Soviet Socialist Republics (USSR)	August 18, 1956

Name	River	Country	Year
Treaty between the government of the USSR and the Iran concerning the regime of the Soviet–Iranian frontier and the procedure for the settlement of frontier disputes and incidents	Atrak	Iran, USSR	May 14, 1957
Agreement between Iran and the USSR for the joint utilization of the frontier parts of the rivers Aras and Atrak for irrigation and power generation	Atrak	Iran, USSR	August 11, 1957
Statute of the Committee for Co-ordination of Investigations of the Lower Mekong Basin established by Cambodia, Laos, Thailand, and Vietnam in response to the decisions taken by the United Nations Economic Commission for Asia and the Far East	Mekong	Cambodia, Laos, Thailand, Vietnam	October 31, 1957
Indo-Pakistan agreement (with appendices) on East Pakistan border disputes	Indus	East Pakistan, India	October 23, 1959
Agreement between Nepal and India on the Gandak Irrigation and Power Project	Ganges-Brahmaputra-Meghna	India, Nepal	December 4, 1959
Agreement between Pakistan and India on West Pakistan–India border disputes	Indus	India, Pakistan	January 11, 1960
Indus Waters Treaty between India, Pakistan, and the International Bank for Reconstruction and Development	Indus	India, Pakistan, International Bank for Reconstruction and Development	September 19, 1960
Convention between Laos and Thailand for the supply of power	Mekong	Laos, Thailand	August 12, 1965
Amended agreement between Nepal and India concerning the Kosi Project	Ganges-Brahmaputra-Meghna	India, Nepal	December 19, 1966
Statute of the Indo-Bangladesh Joint Rivers Commission	Ganges-Brahmaputra-Meghna	India, Bangladesh	November 24, 1972
Joint declaration of principles for utilization of the waters of the Lower Mekong Basin, signed by the representatives of the governments of Cambodia, Laos, Thailand, and Vietnam to the Committee for Coordination of Investigations of the Lower Mekong Basin	Mekong	Laos, Thailand, Vietnam	January 31, 1975
Provisional conclusion of the treaty of 18 April 1975 on the division of the waters of the Ganges	Ganges-Brahmaputra-Meghna	India, Bangladesh	April 18, 1975

Name	River	Country	Year
Treaty concerning the state frontier and neighborly relations between Iran and Iraq	Tigris-Euphrates-Shatt al Arab	Iran, Iraq	June 13, 1975
Agreement between Iran and Iraq concerning the use of frontier watercourses	Tigris-Euphrates-Shatt al Arab	Iran, Iraq	December 26, 1975
Agreement between Bangladesh and India on sharing of the Ganges waters at Farakka and on augmenting its flows	Ganges-Brahmaputra-Meghna	Bangladesh, India	November 5, 1977
Declaration concerning the Interim Committee for Coordination of Investigation of the Lower Mekong Basin	Mekong	Laos, Thailand, Vietnam	January 5, 1978
Agreement between Nepal and India on the renovation and extension of Chandra Canal, Pumped Canal, and distribution of the Western Kosi Canal	Ganges-Brahmaputra-Meghna	India, Nepal	April 7, 1978
Indo-Bangladesh memorandum of understanding on the sharing of Ganga waters at Farakka	Ganges-Brahmaputra-Meghna	India, Bangladesh	October 7, 1982
Meeting of the Joint Rivers Commission	Ganges-Brahmaputra-Meghna	India, Bangladesh	July 20, 1983
Agreement on ad hoc sharing of the Teesta waters between India and Bangladesh reached during the 25th meeting of the Indo-Bangladesh Joint Rivers Commission held in July 1983 at Dhaka	Ganges-Brahmaputra-Meghna	India, Bangladesh	July 20, 1983
Agreement between Kazakhstan and the Russian Federation concerning the joint use and protection of transboundary waters	Ob	Kazakhstan, Russia	August 27, 1992
Agreement on joint activities in addressing the Aral Sea and the zone around the Sea crisis, improving the environment, and ensuring the social and economic development of the Aral Sea region	Aral Sea	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan	March 26, 1993
Agreement between China and Mongolia on the protection and utilization of transboundary waters	Amur	China, Mongolia	April 29, 1994

Name	River	Country	Year
Agreement between Mongolia and Russia on the protection and use of transboundary waters	Amur	Mongolia, Russia	February 11, 1995
Resolution of the Heads of States of the Central Asia on work of the Executive Committee of the Interstate Council for the Aral Sea on implementation of Action Plan on improvement of ecological situation in the Aral Sea Basin for the 3–5 years to come with consideration of social and economic development of the region	Aral Sea	Kazakhstan, Kyrgyzstan, Tajikistan Turkmenistan, Uzbekistan	March 3, 1995
Agreement on the cooperation for the sustainable development of the Mekong River Basin	Mekong	Cambodia, Laos, Thailand, Vietnam	April 5, 1995
Treaty between Nepal and India concerning the integrated development of the Mahakali River including Sarada Barrage, Tanakpur Barrage, and Pancheshwar Project	Ganges-Brahmaputra-Meghna	India, Nepal	February 12, 1996
Treaty between India and Bangladesh on sharing of the Ganga/Ganges waters at Farakka	Ganges-Brahmaputra-Meghna	Bangladesh, India	December 12, 1996
Agreement between Russia and China on guiding principles of the joint economic activity on some islands and adjacent defined areas of water of the borderline rivers	Frontier or shared waters	Russia, China	November 10, 1997
Agreement between Kazakhstan, Kyrgyzstan, and Uzbekistan on joint and complex use water and energy resources of the Naryn Syr Darya cascade reservoirs	Aral Sea	Kazakhstan, Kyrgyzstan, Uzbekistan	March 17, 1998
Agreement between Kazakhstan, Kyrgyzstan, and Uzbekistan on cooperation in the area of environment and rational nature use	Aral Sea	Kazakhstan, Kyrgyzstan, Uzbekistan	March 17, 1998
Agreement between Kazakhstan, Kyrgyzstan, and Uzbekistan on the use of water and energy resources of the Syr Darya Basin	Aral Sea	Kazakhstan, Kyrgyzstan, Uzbekistan	March 17, 1998
Tashkent Declaration	Frontier or shared waters	Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan	March 26, 1998

Name	River	Country	Year
Protocol on inserting amendments and addenda in the agreement between Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan on the use of water and energy resources of the Syr Darya Basin	Aral Sea	Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan	May 7, 1999
Decision ratifying the plan on the control and use of flood water in Mekong River Delta Area for the period from now to the year 2010	Mekong	Laos, Thailand, Vietnam, Cambodia	June 21, 1999
Agreement between Kazakhstan and Kyrgyzstan on the utilization of the water facilities of interstate use on the Chu and Talas Rivers	Talas	Kazakhstan, Kyrgyzstan	January 21, 2000
Agreed items between Malaysia Prime Minister Dr. Mahathir Mohamed and Senior Minister Lee Kuan Yew at their "4-Eye" meeting at Putrajaya	Johore	Malaysia, Singapore	August 15, 2000
Decision adjusting and supplementing a number of mechanisms and policies in order to speed up the construction progress of population clusters and lines as well as dwelling houses in frequently flooded provinces in Mekong	Mekong	Laos, Thailand, Vietnam, Cambodia	May 7, 2004

[46] Source: International Freshwater Treaties Database (http://www.transboundarywaters.orst.edu/database/interfreshtreatdata.html).

Appendix 2: Asia-Pacific Water Summit Declaration 2007

Message from Beppu

We, the leaders of the Asia-Pacific, coming from all sectors of our societies and countries, meeting at the historic inaugural Asia-Pacific Water Summit, in the beautiful city of Beppu, in the hospitable Oita Prefecture of Japan, do hereby agree to:

- Recognize the people's right to safe drinking water and basic sanitation as a basic human right and a fundamental aspect of human security;
- Reduce by half the number of people who do not have access to safe drinking water by 2015 and aim to reduce that number to zero by 2025;
- Reduce by half the number of people who do not have access to basic sanitation in our region by 2015 and aim to reduce that number to zero by 2025, through the adoption of new and innovative sanitation systems that are not as water reliant as current methods;
- Accord the highest priority to water and sanitation in our economic and development plans and agendas and to increase substantially our allocation of resources to the water and sanitation sectors;
- Improve governance, efficiency, transparency and equity in all aspects related to the management of water, particularly as it impacts on poor communities. We recognize that while women are particularly vulnerable, they are also resilient and entrepreneurial, hence, should be empowered in all water-related activities;
- Take urgent and effective action to prevent and reduce the risks of flood, drought or other water-related disasters and to bring timely relief and assistance to their victims;
- Support the region's vulnerable small island states in their efforts to protect lives and livelihoods from the impacts of climate change;
- Exhort the Bali Conference to take into account the relationship between water and climate change, such as the melting of snowcaps and glaciers in the Himalayas and the Pamirs, and rising sea levels, which are already having an impact on some countries in the region;
- Establish concrete goals for the 2008 Toyako G8 Summit to:
  - commit to support the developing countries to achieve their MDG targets on water and sanitation; and
  - take immediate action to support adaptation to climate change by developing countries;
- Empower a high-level coordinating mechanism in our cabinets and where possible, appoint a minister in charge of water to ensure that all issues related to water and sanitation would be dealt with in a holistic manner;

- Respect and strengthen the region's rich history of water-centered community development, including the rehabilitation of urban waterways and protecting the environmental integrity of rural watersheds; and
- Work together with other like-minded institutions, entities and individuals in order to achieve our collective vision of water security in the Asia-Pacific region.

We will support the Policy Brief as prepared by the Asia-Pacific Water Forum family.

We encourage all governments to make all efforts to implement its recommendations.

We have the will and the courage to realize our vision.

The message from Beppu was unanimously endorsed by the participants of the 1st Asia-Pacific Water Summit, which was held in Beppu, Japan on 3–4th December 2007, attended by ten Heads of State and Government, 31 Ministers, and representatives from over 36 Asia-Pacific countries and regions.

Leadership Group Chairman and Members

Chairman

Tommy Koh is Ambassador-At-Large at the Ministry of Foreign Affairs of Singapore. He also serves as Chairman of the Asia-Pacific Water Forum, the Institute of Policy Studies and the National Heritage Board, and is a Professor of Law at the National University of Singapore. He was Singapore's Ambassador to the United States from 1984 to 1990, and served as Singapore's Permanent Representative to the United Nations from 1968 to 1971 and again from 1974 to 1984.

Andrew Benedek is the Founder, Chairman and CEO of ZENON Environmental Inc., a global leader in advanced membranes for water purification, wastewater treatment and water reuse to municipalities and industries worldwide. In June 2006, the company was sold to General Electric, becoming a subsidiary of GE Water & Process Technologies. Dr. Benedek is a research associate of the Scripps Institution of Oceanography in San Diego, California, and the first recipient of the prestigious Lee Kuan Yew Water Prize.

Gareth Evans is President of the Brussels-based International Crisis Group, a nongovernmental organization working to prevent and resolve deadly conflict. He also serves as the co-chair of the International Commission on Nuclear Non-Proliferation and Disarmament and is a member of the U.N. Secretary-General's Advisory Committee on Genocide Prevention. Prior to joining the Crisis Group, he served for 21 years in Australian politics, thirteen of them as a Cabinet Minister, and, from 1988 to 1996, he was Australia's Foreign Minister.

Ajit Gulabchand is the Chairman and Managing Director of Hindustan Construction Company (HCC), one of India's leading construction companies founded by industrialist Seth Walchand Hirachand in 1926. He is a founding member of the Geneva-based Disaster Resource Network (DRN), established in collaboration with the World Economic Forum, the United Nations and International Red Cross. HCC is a signatory to the U.N. CEO Water Mandate.

Han Sung-Joo is Chairman and Director of the Asan Institute for Policy Studies in Seoul. He served as Korea's Minister of Foreign Affairs (1993-94), the U.N. Secretary-General's Special Representative for Cyprus (1996-97), a member of the U.N. Inquiry Commission on the 1994 Rwanda Genocide (1999), Chairman of the East Asia Vision Group (2000-01), and Ambassador of the Republic of Korea to the United States (2003-05).

Yoriko Kawaguchi is a Member of the House of Councillors and Chair of the Liberal Democratic Party Research Commission on Environment in Japan. Ms. Kawaguchi serves as Co-Chair of the International Commission on Nuclear Non-Proliferation and Disarmament. She was Japan's Minister for the Environment (2000-2002) and Minister for Foreign Affairs (2002-2004).

Rajendra K. Pachauri is Director-General of The Energy and Resources Institute, a position he has held since April 2001. In 2002, he was elected the Chairman of the Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization and the United Nations Environment Programme in 1988. In 2007, under his leadership, the IPCC received the Nobel Peace Prize for its work on climate change.

Surin Pitsuwan is the Secretary-General of the Association of Southeast Asian Nations (ASEAN). As a Deputy Leader of the Democrat Party in Thailand, he served as a Member of Parliament in the National Legislative Assembly, where he was appointed Secretary to the Speaker of the House of Representatives. He was Secretary to the Deputy Minister of Interior, Deputy Minister of Foreign Affairs (1992-1995), and Minister of Foreign Affairs (1997-2001).

Jeffrey Sachs is the Director of The Earth Institute, Quetelet Professor of Sustainable Development, and Professor of Health Policy and Management at Columbia University. He also serves as Special Advisor to U.N. Secretary-General Ban Ki-moon. From 2002 to 2006, he was Director of the U.N. Millennium Project and Special Advisor to U.N. Secretary-General Kofi Annan on the Millennium Development Goals, the internationally agreed targets to reduce extreme poverty, disease, and hunger by the year 2015.

Nafis Sadik is Special Adviser to the U.N. Secretary-General and his Special Envoy for HIV/AIDS in Asia and the Pacific, with the rank of Under-Secretary-General. In 1971, she joined the United Nations Population Fund (UNFPA) serving in various capacities until her appointment as its Executive Director in 1987 until 2000. Dr. Sadik was Pakistan's Director-General of the Central Planning Council, where she was responsible for the country's health and family planning program.

N.G. Wickremeratne is Chairman and CEO of Hayleys, a Sri Lankan company with a portfolio of businesses in Global Markets and Manufacturing, Agriculture and Agri-business, Transportation and Infrastructure, and Consumer Products and Leisure. He previously served as Deputy Chairman, Group Executive Director, and a member of the Board of Hayleys.

Erna Witoelar is Chair of the Partnership for Governance Reform in Indonesia. She served as U.N. Special Ambassador for the Millennium Development Goals in Asia & the Pacific from 2003-07. She was the Minister of Human Settlements and Regional Development (1999-2001) and a former member of the National Assembly of Indonesia. She currently serves as Vice-Chair on the Governing Council of the Asia-Pacific Water Forum.

Xianbin Yao is the Director General of the Regional and Sustainable Development Department of the Asian Development Bank, and leads the Bank's environment, social and climate change program. He joined ADB in 1991 as a Young Professional and has worked in different functional areas of the Bank, including country operations, education and agriculture sector operations, and economic research.

Yuan Ming is Vice-Dean of the School of International Studies and Director of the Center for American Studies at Peking University. She is a member of the Chinese People's Political Consultative Conference and its Foreign Relations Committee. She served as a Trustee of the Asia Society from 1998-2004.

Saleem H. Ali is a Visiting Fellow at the Brookings Institution's research center in Doha, Qatar, on sabbatical from his position as an Associate Professor of Environmental Planning and Asian Studies at the University of Vermont. He is the editor of *Peace Parks: Conservation and Conflict Resolution* (MIT Press, 2007) and coeditor of *Earth Matters: The Extractive Industries, Indigenous People and Corporate Social Responsibility* (Greenleaf, 2008).

Suzanne DiMaggio joined the Asia Society in September 2007. As the Director of the Asian Social Issues Program, her work focuses on a range of political, economic and social challenges facing the region. She was the Vice President of Global Policy Programs at the United Nations Association of the USA (UNA-USA), where she directed the Association's "Track II" initiatives with partners in the Middle East and Asia on regional security, nuclear nonproliferation, multilateral peace operations, and global environmental governance.

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