Environmental Issues of Indus River Basin: 
An Analysis

Abdul Rauf Iqbal

Abstract

Water, an important resource, is today threatened by extensive demographic growth, disordered urbanization, political actions and climatic changes etc and same is the case with Indus River Basin (IRB). Continuing population growth is significantly reducing per capita water availability and increasing industrialization and urbanization are bringing important shifts in water use. Climate change is exerting additional, chronic strains on water resources, potentially shifting the seasonal timing or shuffling the geographical distribution of available supplies. This changing pattern of water usage compels the scientists and the policy makers, to better apprehend, assess, and act on the links between water resources management, global and regional environmental change, sustainable development, and social welfare in order to meet these emerging challenges.

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Introduction

“Water, like religion and ideology, has the power to move millions of people. Since the very birth of human civilization, people have moved to settle close to it. People move when there is too little of it. People move when there is too much of it. People journey down it. People write, sing and dance about it. People fight over it. All people, everywhere and every day, need it”.

—Mikhail Gorbachev

Water is such a unique resource, for which there is no substitute. Fresh water is the world’s most essential commodity, because of its life-sustaining nature, and historically, “adequate water supplies provide a basis for the growth and development of human social, economic, cultural and political systems.” Alternatively, water crises increasingly limit economic development and impact inter-dependent infrastructure such as energy and agriculture. On the other hand, quality and quantity of water is today threatened because of extensive demographic growth, disordered urbanization, political actions and climatic changes etc and same is the case with Indus River Basin (IRB). With this premise, this paper is an endevour to highlight the environmental issues in the IRB and their likely impacts. The factual data from reliable international agencies’ reports have been used to project the central idea of the paper that socio-economic, environmental and political pressures will significantly reduce per capita water availability over the coming decades.
Indus River Basin – A Prelude

The Indus River is one of the most important water systems in Asia. The Indus River originates near Kailash Range in Tibet and, thereafter, it flows to the west, eventually falling into Arabian Sea.\(^3\) The main river Indus is about 2,000 miles long.\(^4\) The total area of Indus basin, the area draining the Himalayan water into the Arabian Sea, is about 365,000 square miles.\(^5\) Indus system consists of 27 major tributaries, the six most significant branches are: Chenab, Ravi, Sutlej, Jhelum, Beas, and the Indus itself which flow westwards through India before crossing into Pakistan. The seventh major tributary, the Kabul River, originating from Afghanistan, flows eastward into Pakistan. All told, the Indus River Basin encompasses 1.12 million square kilometers (km\(^2\)), with 47 percent of this area falling in Pakistan, 39 percent in India, eight percent in China, and six percent in Afghanistan. In turn, 65 percent of the total area of Pakistan, 14 percent of the Indian land mass, 11 percent of Afghanistan, and one percent of China’s land area lie within the Indus Basin.\(^6\) In this backdrop, Indus is considered as the life-blood of Pakistan, “which could not function without the support of this mighty river.”\(^7\)

Climate and precipitation conditions vary considerably over the basin. Most of the precipitation occurs in winter and spring. The Upper Indus Basin, in the north, covers a high mountain region with alpine and highland climates. Much of precipitation falls as snow, particularly at higher elevations. To the south, the Lower Basin extends over plains exhibiting sub-tropical arid and semi-arid to temperate sub-humid climates. Here, most of the precipitation falls during the monsoon from July to September. Across the entire Indus Basin, annual average precipitation ranges between 100-500
millimeters (mm) in the lowlands to 2,000 mm and above in the Himalayan foothills and the higher mountains.

In the upper sub-basins, flows derive largely from local run-off from the surrounding catchment. In the lower sub-basins, discharges descending from up-stream catchments increasingly predominate in the local river flow. On the whole, the high-altitude catchments comprise net contributors to the basin's water supplies and the lowland catchments constitute net consumers. Even so, all the basin catchments show substantial seasonal fluctuations, with river flows peaking during June-September, when the monsoon brings intense rainfall to the Lower Basin and higher temperatures increase snow and glacier melt in the Upper Basin. Observed monthly flows in individual sub-basins can be ten times greater at the height of the summer wet season than during the lean winter months. Large year-to-year variations in annual precipitation induce corresponding variability in the Indus' annual flow.8

**Indus River – A Lifeline for Pakistan**

Today, the Indus supplies the needs of some 300 million people living throughout the basin. Together, India and Pakistan represent almost all of the demand on the river’s resources, with Pakistan drawing 63 percent of water used in the basin and India drawing 36 percent. Pakistan depends critically on the Indus, as the country’s other rivers run only seasonally and their total flows equal less than two percent of the mean annual inflow entering Pakistan through the Indus system. For India, meanwhile, the Indus furnishes about seven percent of the annual utilizable surface water available nation-wide. Crucially, the basin's freshwater resources nourish the agricultural breadbaskets of both countries. Agriculture accounts for 93 percent of water withdrawn from the Indus, while industrial
and domestic demands combined make up just seven percent of total use. Pakistan annually abstracts three-quarters of the river’s flow into canal systems, supporting the world’s largest contiguous system of irrigated agriculture, and 95 percent of all the country’s irrigation occurs within the basin.

In addition to sharing the Indus’ surface waters, India and Pakistan also share important — though inadequately mapped and characterized — transboundary aquifers in the basin. Groundwater constitutes an essential additional source of freshwater for the region. Groundwater and surface water resources in the Indus Basin are closely linked, both hydrologically and socio-economically. Hydrologically, seepage from surface sources — such as rivers and irrigation canals — contributes to re-charging subterranean aquifers, while groundwater flows similarly enter and augment surface streams. By some assessments, 45 percent of Pakistan’s renewable groundwater supply originates in leakage from the canal system, 26 percent comes from irrigation return flows, and six percent derives from river re-charge. In India, an estimated one-fifth of the surface water withdrawn from the Indus for irrigation subsequently drains into groundwater aquifers as return flow. Socio-economically, many water users in the basin rely on groundwater to supplement or supplant surface water supplies where these prove inadequate, intermittent or unavailable. Over 40 percent of the irrigated land area in Pakistan, for example, is irrigated from mixed surface water and groundwater. For many cities in the basin, groundwater is the principal or unique source for municipal water supplies. In India, groundwater abstractions in those states situated wholly or partially within the Indus Basin — Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, and...
Rajasthan — amount to 62.7 km$^3$. Pakistan’s annual groundwater withdrawals from the basin totaled 61.6 km$^3$ in 2008, or one-third of all national water use. Across the Indus Basin, groundwater accounts for 48 percent of total water withdrawals.$^{12}$

**Environmental Pressures on Indus River Basin**

Growing populations and increasing development are placing mounting pressures on the Indus Basin’s water supplies. In Pakistan, total annual water withdrawals have risen from 153.4 km$^3$ in 1975 to 183.5 km$^3$ in 2008, while total annual renewable water resources per capita have plunged from 3,385 cubic meters (m$^3$) in 1977 to 1,396 m$^3$ in 2011. Over the same period, total annual water withdrawals in India have doubled, leaping from 380 km$^3$ in 1975 to 761 km$^3$ in 2010, while annual renewable water resources per capita have tumbled from 2,930 m$^3$ in 1977 to 1,539 m$^3$ in 2011.$^{13}$ To place these numbers in perspective, hydrologists commonly consider 1,700 m$^3$ per year the national threshold for filling each person’s water requirements for domestic needs, agriculture, industry, energy, and the environment. Annual availability under 1700 m$^3$ per capita constitutes conditions of “water stress,” and less than 1,000 m$^3$ per capita represents “water scarcity.”$^{14}$ For the Indus Basin as a whole, the United Nations Environment Programme (UNEP) calculates that per capita annual renewable water availability stands at 1,329 m$^3$. Another analysis by the International Centre for Integrated Mountain Development (ICIMOD) estimated yearly water supplies in the basin at 978 m$^3$ per person. Both figures indicate that the basin’s inhabitants face severe water stress.$^{15}$
<table>
<thead>
<tr>
<th>Country</th>
<th>India</th>
<th>Pakistan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average long-term available renewable water supplies in the IRB</td>
<td>97 km³/year</td>
<td>190 km³/year</td>
<td>287 km³/year</td>
</tr>
<tr>
<td>Estimated renewable surface water supplies in the IRB</td>
<td>73 km³/year</td>
<td>160-175 km³/year</td>
<td>239-258 km³/year</td>
</tr>
<tr>
<td>Estimated renewable groundwater supplies in the IRB</td>
<td>27 km³/year</td>
<td>63 km³/year</td>
<td>90 km³/year</td>
</tr>
<tr>
<td>Estimated total water withdrawals in the IRB</td>
<td>98 km³/year</td>
<td>180-184 km³/year</td>
<td>257-299 km³/year</td>
</tr>
<tr>
<td>Estimated total surface water withdrawals in the IRB</td>
<td>39 km³/year</td>
<td>128 km³/year</td>
<td></td>
</tr>
<tr>
<td>Estimated total groundwater withdrawals in the IRB</td>
<td>55 km³/year</td>
<td>52-62 km³/year</td>
<td></td>
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</tbody>
</table>

Note: Figures for surface and groundwater supplies may not sum evenly to figures for total renewable water resources because a
A large fraction of groundwater and surface water resources overlap, so that separate supplies cannot be absolutely distinguished.


The intensifying strains on the Indus can be read in diminishing river flows and dropping water tables. Water is a renewable resource, but also a finite one. Rainfall, snow and ice melt, seepage between surface waters and groundwater, and return flows from irrigation and other uses ultimately drain to the Indus River and recharge aquifers to varying degrees. For any given source, however, renewals vary over time and place. Natural processes may only recharge underground aquifers over tens, hundreds, or even thousands of years, and the glaciers that nourish many water courses have accumulated over millennia. Every watershed is only replenished by a certain amount of renewable water every year.

**Diminishing River Flows**

According to various studies, long-term available renewable water supplies in the Indus Basin average 287 km$^3$ per year, representing 190 km$^3$ of annual renewable water resources in Pakistan and 97 km$^3$ in India. Of this total, surface water accounts for around 239-258 km$^3$, comprising 73 km$^3$ from India and 160-175 km$^3$ in Pakistan. Annual renewable groundwater supplies have been estimated at 90 km$^3$, reflecting resources of 27 km$^3$ in India and 63 km$^3$ in Pakistan. Against the basin’s renewable freshwater resources, estimates of total annual water demand range from 257-299 km$^3$. India withdraws about 98 km$^3$ yearly, with around 55 km$^3$ of withdrawals coming from groundwater stocks and 39 km$^3$ from surface sources. Pakistan’s annual water demands from the Indus
add up to 180-184 km$^3$, with 128 km$^3$ from surface water and 52-62 km$^3$ pumped from groundwater aquifers.$^{16}$ Annual averages can camouflage important year-to-year fluctuations in water availability. An assessment of supply and demand on the Indus River by experts at the International Water Management Institute (IWMI) helps frame the importance of such variations. In recent decades (1957-1997), annual flow in the Indus ranged from 120-230 km$^3$, with a long-term average of 187 km$^3$. Meanwhile, combined Indian and Pakistani withdrawals from the river now amount to 176.5 km$^3$.\textsuperscript{17}

As the riparians’ resource requirements have grown, water removals from the Indus are outpacing natural rates of renewal. Total withdrawals nearly equal or even surpass long-term flow balances and eco-system needs. Increasingly, the Indus is a “closed” basin. A basin is considered closed, when all of its water resources are already allocated to meet various societal and environmental needs, with little to no spare capacity left over, such that supply falls short of demand during part or all of the year.$^{18}$ Claims on the Indus have reached the point that some sub-basins, and even the river as a whole, may generate no net runoff (i.e. mean annual discharge from the river is zero percent of mean annual precipitation). In fact, at times the Indus no longer reaches the sea year round.$^{19}$

With human water demands effectively absorbing available supplies, little flow remains to support the natural environment. Hydrologists and environmental scientists recognize that river systems require base “environmental flows” to sustain riverine habitats and eco-systems and maintain ecological functions such as diluting pollution, flushing sediment and nutrients downstream, controlling salinity intrusion, and replenishing wetlands and
estuaries. No fixed formula has been found to determine appropriate environmental flows, which will vary from river to river. One preliminary assessment, however, has suggested that environmental water requirements for the Indus River should equal 25 percent of mean annual runoff, or about 46.75 km$^3$ per year based on the reported long-term average annual flow of 187 km$^3$. Indus is not meeting this target. Within Pakistan, the 1991 Water Apportionment Accord between the provinces committed to ensure that annual environmental flows to the Indus Delta below the Kotri barrage would not descend below 12.3 km$^3$ — so as to check seawater intrusion, maintain the river channel and sediment transport, and support fisheries — but flows since the 1990s indicate the terms of the Accord are not being fulfilled and run-off to the delta has been notably less than 12 km$^3$ per year.\(^{21}\)

**Dropping Water Table**

India and Pakistan are likewise rapidly depleting the basin’s groundwater resources. Indeed, abstractions from the Indus aquifers reflect both the most intensive and the most unsustainable levels of groundwater exploitation on Earth.\(^{22}\) Studies in Pakistan reveal water tables plummeting by two to three meters a year, with groundwater levels falling to inaccessible depths in many wells. Because groundwater salinity in these aquifers typically increases with depth, dropping water tables lead farmers to irrigate with ever more saline water, salinizing the soils and degrading their production potential. Salt-affected soils now afflict 4.5 million hectares, amounting to over 22 percent of Pakistan’s irrigated lands.\(^{23}\) Similarly, a review by India’s Central Ground Water Board determined that over-drafts exceeded rates of re-charge in 59 percent of the administrative units monitored in Haryana state, 80
percent of units in Punjab, and 69 percent of units in Rajasthan. Around the region, yearly groundwater withdrawals equaled 127 percent of the total renewable supply in Haryana, 170 percent in Punjab, and 135 percent in Rajasthan. As a result, the Indus Basin is literally losing water. Estimates based on satellite data indicate that the basin aquifers lost groundwater at a rate of 10 km$^3$ per year between April 2002 and June 2008, an annual debit representing more than half the combined capacity of India’s six large dams in the Indus system, or almost half the available water storage in all the reservoirs of Pakistan.

Water Pollution

Increasing water pollution also burdens the Indus Basin. Natural processes can contaminate water supplies, but poor water quality more often results from human factors. Agriculture, industry, mining, and other activities charge surface and groundwater resources with synthetic chemicals, fertilizers, pesticides, toxic metals, and microbial pathogens that can compromise human health.

Pressures on water quantity and quality interact. Decreasing water quality ultimately can lower available water quantities, as some sources become too degraded for certain uses. Likewise, diminishing water quantities increase the concentration of any pollutants present, eroding water quality. Water quantity and water quality stresses frequently occur together, as demand centers requiring large withdrawals — such as zones of intensive agriculture, urban agglomerations, and industrial concentrations — also generate substantial pollution.

Surface water quality in the upper Indus is high on certain measures, but progressively deteriorates downstream, as farms and
towns dump untreated agricultural effluents, human waste, and industrial pollutants into the river, canals, and drains. Nitrogen loading, phosphorous loading, pesticide loading, organic loading, and mercury deposition exhibit alarming levels throughout the river’s course, and agricultural and industrial pollutants taint almost all shallow groundwater. According to UNEP, farms, cities, industries, and households pour 54.7 km$^3$ of wastewater into the Indus every year, with 90 percent of these effluents coming from the agricultural sector.

**Re-shaping the Basin: Population Growth, Urbanization, and Climate Change**

Water managers in the Indus Basin will have to overcome a host of overlapping socio-economic, environmental, and policy pressures as they strive to fulfill their countries’ future water needs. Historically, demographic pressures constitute the most powerful driver of regional water stress; the influence of population growth on water shortage has proven about four times more important than the effect of long-term shifts in available water resources due to climate factors. Even absence of any other stresses, demographic changes alone will significantly trim per capita water availability over the coming decades. As populations expand, renewable water resources remain finite, reducing available shares per person. The UN expects that India’s population will increase by almost a quarter in the next 20 years, topping 1.5 billion in 2030 and approaching 1.7 billion by 2050. Pakistan will witness even more spectacular growth. From 174 million inhabitants in 2010, its population will surge to 234 million in 2030 and near 275 million in 2050. Within the confines of the Indus, one assessment projects that 383 million people will be living in the basin — including populations in
Afghanistan and China — by 2050. Annual renewable water availability across the basin would then be under 750 m$^3$ per capita. Another model evaluation by the International Water Management Institute (IWMI) calculates that total annual availability of renewable water on the Indian portion of the Indus Basin will slip from 2,109 m$^3$ per capita (in 2000) to 1,732 m$^3$ in 2050. On the Pakistani portion of the basin, yearly per capita water availability is expected to slide from 1,332 m$^3$ to 545 m$^3$.

Economic growth and urbanization will also propel important shifts in water use. The Organisation for Economic Cooperation and Development (OECD) projects that Indian GDP will rise 5.1 percent per annum on average over the next 50 years — more rapidly than any other major economy — boosting per capita income more than sevenfold in 2060. Pakistan aspires to achieve seven percent annual GDP growth, quadrupling per capita income by 2030. Expanding economies will fuel growing industrial sectors, requiring increasing water inputs. By the same token, the UN anticipates that India’s urban population will swell a further 62 percent over the next two decades, and Pakistan’s will balloon by 83 percent. City dwellers use more water on average than their compatriots in the countryside, and over the past two decades, municipal water withdrawals have doubled in India and quadrupled in Pakistan. On the Indian side of the Indus, analyses by IWMI conclude that by 2025 both domestic and industrial water withdrawals will double from 2001 levels. Likewise, municipal and industrial demand in Pakistan is expected to grow more than two-and-a-half times over current use.

Larger, wealthier, and more urban populations will need sufficient sustainable water supplies to drink, wash, and cook. But it
is the water needed to produce the food that they will eat that will challenge policy-makers. International norms established by the World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF) hold that each person requires a minimum of 20 liters of water a day for drinking and basic hygiene. By contrast, to grow a kilogram of wheat — the primary crop cultivated in the Indus — requires 1,827 liters of water on average, while a kilogram of rice takes 1,673 liters. Producing dairy, meat, poultry, and other animal products can be even more water intensive, necessitating appreciable amounts of freshwater to grow feed, provide drinking water, and care for the animals. Raising a kilogram of lamb, for example, demands 10,412 liters of water; a kilogram of eggs uses 3,265 liters; and a kilogram of milk, 1,020 liters. All freshwater inputs considered, it takes 2,000 to 5,000 liters of water per person per day to grow the food to support diets of 2,800 kilocalories daily that the FAO deems the threshold for ensuring food security.

The growing danger of climate change compounds the water resource challenges confronting the region. Continuing global warming may shift the seasonal timing or the geographical distribution of water supplies. Extreme weather events are predicted to increase in frequency and degree, with stronger storms, higher floods, and deeper droughts becoming more numerous and severe. Such impacts could significantly alter water availability and damage or degrade the water supply and sanitation infrastructure on which Indians and Pakistanis depend. Regional-scale climate change projections remain clouded by many uncertainties. Nevertheless, ensemble analyses of multiple models suggest that the Indus Basin region will experience increasingly variable
precipitation. Winter precipitation is projected to decrease, implying less availability and higher water stress during the lean season. Summer precipitation is expected to increase overall, but with enhanced year-to-year variability in daily rainfall during the monsoon. An anticipated rise in intense precipitation presages more severe monsoon flooding. With more rainwater coming in short sudden downpours, less will be absorbed by saturated soils and more lost as direct runoff, correspondingly reducing the potential for re-charging groundwater.\textsuperscript{39}

<table>
<thead>
<tr>
<th>Glaciers in the Major Basins of the Hindu Kush Himalaya Region</th>
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<tr>
<td><strong>Basins</strong></td>
</tr>
<tr>
<td>Amu Darya</td>
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<td>Indus</td>
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<td>Ganges</td>
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<td>Brahmaputra</td>
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<td>Yellow</td>
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<tr>
<td>Tarim</td>
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<tr>
<td>Qinghai-Tibetan Interior</td>
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<tr>
<td><strong>Total, HKH</strong></td>
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</table>

**Source:** SR Bajracharya, Status of Glaciers in the Indus Basin, (Kathmandu: ICIMOD, 2012)
Climate change will exert additional, chronic pressures on key sources of fresh water supplies in the Indus Basin. The headwaters of the Indus rise in the glaciers of the Himalaya Hindu Kush (HKH). Often called the continent’s “water towers,” the glaciers of the greater Himalayan range constitute the world’s largest body of ice outside the polar ice caps. The glaciers act as massive regional freshwater repositories, seasonally accumulating snow and ice at high elevations and releasing melt water that feeds 10 large river systems across Asia. According to a recent inventory, the Indus is by far the most heavily glaciated of the region’s major basins. It counts 18,495 glaciers covering 21,193 km² and containing an estimated 2,696 km³ of ice, representing 44 percent of the total ice reserves in the entire HKH region. Snow and glacial melt contribute more than 50 percent of the total flow of the Indus, forming an especially critical source of water during the summer shoulder seasons (before and after the rains from the summer monsoon), when melt water comprises 70 percent of the river’s summer flow. In years of feeble or failed monsoons, melt water can avert or alleviate otherwise calamitous drought. As global warming drives up temperatures and shifts precipitation patterns worldwide, however, glaciers in the Himalayas are generally retreating.

Initially, increased glacier melting could boost river flows. This trend however could pose risks of its own. Rising runoff can heighten the danger of “glacial lake outburst floods” (GLOF) as melt water collects behind natural barriers of ice or debris. Seismic activity, avalanches, landslides, or other triggers can weaken or collapse these retaining barriers, sending sudden waves of water rushing downstream.
The Challenge and the Opportunity

Left unaddressed, such pressures could sow increasing competition over dwindling water supplies, fueling potentially destabilizing international tensions. Historically, the international boundary that set India and Pakistan apart at independence also set them at odds over water. As the downstream neighbor, Pakistan feared Indian withdrawals or diversions could deprive it of its water supply, posing an existential threat to its agriculture and economy, and undermining its food security. As the upper riparian, India worried that according all of the Indus’ flow to Pakistan would curtail possibilities for developing the river for its own benefit. Since 1960, the Indus Waters Treaty (IWT) between the two countries has governed water resource development on the river and its main tributaries. Unlike other water agreements that typically distribute water allowances between riparians — either as absolute amounts or percentages of the river flow — the IWT physically divided the river, allocating use of the three western tributaries that contribute to the main river entirely to Pakistan, and allotting the three eastern tributaries to India. The treaty also controls the type and features of projects that India can establish on its portion of the Indus.

Since its inception, the IWT has stood through three wars and countless lesser clashes. But the accord has no provisions for how the parties should respond to the variations in water flow that climate change could engender. Nor does the agreement contain effectively binding provisions to address water quality or pollution. Similarly, while the two countries share trans-boundary aquifers as well as surface waters, there are no provisions for managing this key resource, or even for sharing data on groundwater supplies. Yet consumers across the Indus Basin rely on groundwater to
supplement or substitute for surface water. As pressures on one source of supply grow, users will of necessity turn to the other.\textsuperscript{42}

South Asia’s earliest civilizations arose on the banks of the Indus, encompassing sites in both modern day Pakistan and India. Recent archaeological evidence suggests that climatic shifts dried the rivers that once watered the irrigated agriculture on which those Bronze Age cities depended, precipitating the ultimate collapse of Harappan civilization.\textsuperscript{43} Today, India and Pakistan again face significant water resource challenges. In 2005, a World Bank assessment judged that India’s clashing water supply and demand trajectories offered “a stark and unequivocal portrayal of a country about to enter an era of severe water scarcity.” A parallel 2005 World Bank analysis of Pakistan warned that while development of the Indus had transformed one of the world’s most arid nations — providing the platform for the country’s economy — “the survival of a modern and growing Pakistan is threatened by water.”\textsuperscript{44} Yet contemporary Indus civilization is by no means destined to suffer the fate of its Bronze Age predecessors. Effective management of the basin’s water resources — built on sound scientific data, guided by an integrated knowledge base, and anchored by capacity building and confidence building measures — can promote a sustainable future for both India and Pakistan in the Indus Basin.

\textbf{Conclusion}

Decision-makers in India and Pakistan will have to overcome a host of overlapping socio-economic, environmental, and political pressures, as they endeavor to ensure their countries’ future water needs and to sustainably manage the resources of the Indus River Basin that both nations share. Continuing population growth will significantly reduce per capita water availability over the coming
decades. Increasing industrialization and urbanization are bringing important shifts in water use. Climate change will exert additional, chronic strains on water resources, potentially shifting the seasonal timing or shuffling the geographical distribution of available supplies. Increasingly subject to soaring demand, unsustainable consumption patterns, and mounting environmental stresses, the Indus is swiftly becoming a “closed” basin; almost all of the river's available renewable water is already allocated for various uses — with little to no spare capacity.

Scientists, policy-makers, and the general public in both Pakistan and India will need to better comprehend, assess, and act on the links between water resources management, global and regional environmental change, sustainable development, and social welfare in the Indus Basin, in order to meet these emerging challenges. Existing analyses and projections, however, are often fraught with important uncertainties and unknowns. The dearth of consistent information at the relevant regional, national, and sub-national scales has, in turn, impeded efforts to conduct integrated evaluations that would better connect “upstream” assessment of environmental and socio-economic impacts on water resources with “downstream” implications for agricultural production and livelihoods, drinking water supplies and sanitation infrastructure, and hydropower development and industry. Coordination and exchange across national and disciplinary boundaries will be essential to overcoming this science/policy gap and to providing decision-makers with holistic perspectives on the multiple risks, weighing on the Indus Basin and the consequent policy choices and possibilities facing the riparian nations.
End Notes

16 Mukand S. Babel and Shahriar M. Wahid, Freshwater Under Threat: South Asia, p.15; Laghari et al., 1064-1066.


Central Ground Water Board, 38-39, 41-42.


Geneviève M. Carr et al., Water Quality for Ecosystem and Human Health, 2nd ed. (Burlington, Canada: UNEP Global Environmental Monitoring System/Water Programme, 2008).


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