Asia Society

Water: Asia's Next Challenge

Country Briefings
April 2009

Australia

Overview

Despite its highly variable rainfall and climate, Australia is the driest inhabited continent on Earth in terms of average precipitation. Climate change, increasing drought frequency and intensity, and high demand are increasing water scarcity. High agricultural consumption, increased salinity, and underdeveloped conservation technologies compound the pressures on the nation's water supply. Among the challenges ahead, the southeastern Murray-Darling Basin, which provides water to more than two-thirds of Australia's population, is facing severe stress to both its groundwater and surface water sources.

Water Security

Australia's water consumption distribution is extremely disproportionate. The sparsely populated tropical north receives more than 65 percent of the nation's rainfall, while the large urban areas to the south receive proportionally less water. For example, only 6 percent of the nation's runoff occurs in the Murray-Darling Basin.

Approximately 70 percent of Australia's irrigated agriculture is also located in the Murray-Darling Basin. Increased drought in the basin in recent years has had a detrimental impact on Australia's agricultural output. One of the world's largest grain exporters, Australia saw its wheat exports drop by 60 percent and rice exports by 90 percent between 2007 and 2008 as a result of protracted drought. Moreover, water use efficiency for irrigation in the Murray-Darling Basin is commonly very low—much of the water is lost through storage, transfer, and application to crops. Water conservation techniques are used in only 18.1 percent of the cultivated area. Growth in Australia's agricultural sector will put an even larger strain on the resource in years to come.

Extreme Events

Australia is naturally susceptible to wide fluctuations in rainfall, largely as a result of the Southern Oscillation Index, known as El Niño and La Niña. El Niño periods bring increased chances of drought, while La Niña events tend to foster a wetter than average season. However, scientists predict that climate change will make Australia hotter and drier in the future, and there may be increases in potential evaporation and decreases in rainfall between June and November over the continent's southern half. Ultimately, climate change is likely to have a negative impact on the country and make it increasingly difficult to meet urban and agricultural water needs.

Potential Outcomes

Reduced grain exports from Australia contributed to price hikes in the global food market in 2008, particularly for rice. In an effort to improve water resources management in the country and shore up the agricultural sector, in 2008, the Australian government invested nearly US$9 billion in modernization of irrigation systems and practices, environmental restoration, and desalination. Asia can learn much by examining the challenges that Australia has faced and—most importantly—how the country has addressed them. Australia is addressing concerns such as increasing salinity, more severe droughts, interstate basin conflicts, and population growth with innovative and effective solutions. Good governance and organizational cooperation have been used to resolve many water problems, thus avoiding water access disputes experienced elsewhere.

Bangladesh

Overview

Already challenged by a confounding physical landscape, Bangladesh is faced with unique obstacles to growth and stability because of rising population, urbanization, and poverty. Bangladesh currently houses the third-largest population of poor people in any single country, following China and India. According to the United Nations Development Programme, four out of five Bangladeshis live below the poverty line (less than $2/day), and one out of three lives in extreme poverty (less than $1/day). Despite improvements in health, mortality, and poverty rates, significant portions of the population lack access to clean drinking water and sanitation. Accelerating urbanization will perpetuate these development challenges.

Water Security

Poor water quality robs many residents of access to safe drinking water. Bangladesh sits in the delta of three major rivers. The surface water is full of sediment, heavily polluted, and slow moving, making the water expensive and difficult to treat for human consumption. Compounding water quality issues, the groundwater contains high levels of natural arsenic. One-quarter of the population is exposed to arsenic contamination from natural and industrial sources that exceed Bangladesh's standards, and almost a quarter more use water that exceeds more stringent World Health Organization pollution standards. In addition, only 14 percent of slum households in metropolitan cities have access to sanitary latrines, and nearly 50 percent of all urban populations lived in marginal or informal settlements without access to public services in 1999.

Extreme Events

Because 80 percent of the land in Bangladesh lies in the floodplains of the Ganges, Brahmaputra, and Meghna rivers, significant portions of the country are inundated with water every year. Approximately 21 percent of the country's land is covered by more than 3 feet of water because of seasonal flooding each year. This natural phenomenon limits land availability for settlement, agricultural production, and industry. Continued population growth and urban migration are forcing the settlement of floodplains around large cities. Poor migrants inhabit slums that are already threatened by seasonal flooding and extreme events. Future climate change projections warn of increased seasonal water flows, intensified cyclones, and sea-level rise—further decreasing the availability of stable, "safe" land. A 1-meter sea-level rise would inundate 18 percent of the land area and directly threaten 11 percent of the population.

Potential Outcomes

From the entangled forces influencing water availability and quality, two key areas emerge as primary threats to Bangladesh's water security. First, floods, lack of access to safe drinking water, and lack of sanitation will continue to endanger lives and livelihoods in urban areas. Second, climate change will amplify the threat of extreme events, disrupting livelihoods and the economy. Solutions may be impeded by the absence of funds and robust institutional capacities. While gains could be realized through greater coordination among some of the diverse but disparate institutions that are involved in addressing these challenges in Bangladesh, rising political and social tensions throughout the country may impede such coordination.

China

Overview

China's massive population—which is expected to grow from 1.33 billion in 2008 to 1.42 billion by 2050—produces significant water resource challenges, and the country's diverse landscape and large landmass make water problems distinct from the arid north to the more water-rich south. In the north, desertification is affecting agricultural production, and water scarcity is becoming more pronounced as demand and pollution increase. In the southern regions of China, the melt water of the Himalayan glaciers feeds Asia's most important rivers, but the quality and quantity of water from these rivers are threatened by pollution, over-withdrawal, and climate change. Just over one-third of China lies in 19 different river basins shared with 14 countries. As the upstream source of the majority of these rivers, China's river outflows are nearly 40 times greater than its inflows. Yet internal river flow management and cross-border coordination have been minimal, presenting challenges to downstream communities.

Water Security

Northern China—which is characterized primarily by desert and grasslands—is experiencing drastic population growth that is accelerating the exploitation of scarce water resources. Severe desertification is further eating up land that once was used for agricultural production and "choking" heavily relied-upon rivers. The North China Plain, which is home to almost 40 percent of China's cultivated land area and 40 percent of the population, holds only 7.6 percent of the country's water resources. Yet agricultural and industrial water demands are growing by more than 10 percent a year and are expected to increase by 40 percent by 2020. Officials have generally failed to curtail industrial dumping and sewage discharge into the plain's three major river basins—the Huai, Hai, and Huang (Yellow) Rivers. Compounding scarcity issues in the north, a quarter of the Yellow River is now piped to distant cities.

In southern China, melt water from the Himalayan glaciers bordering the Tibetan Plateau feeds some of Asia's greatest water sources—including the Yangtze, Yellow, Ganges, Brahmaputra, and Mekong rivers. Climate change is projected to decrease China's glacial coverage by 27 percent by 2050, seriously diminishing water availability for communities throughout China and Southeast Asia. At the same time, regional development may strain plateau communities' water supplies and raise equity and ethnic concerns. Southeastern China is a major site of global manufacturing, resulting in agricultural and industrial pollution of its water. This pollution-driven loss of water access and the threats to human health and fisheries have provoked social unrest and resulted in bans on certain Chinese fish exports.

For the communities and countries living downstream from the transboundary rivers of China, water access is becoming more salient as domestic, agricultural, and industrial water

demands have surged in northwestern China as a result of the development of water-usurping oil and gas fields; glacial melting, which could cause drying of rivers during nonrainy seasons; and industrial waste and chemical spills.

Extreme Events

Rising global temperatures, drought, and human activity are driving massive desertification in the arid northern regions of China. Since the marked desertification of the 1990s, billions of dollars have been spent to reverse the trend. One initiative, the Green Wall of China project, is intended to halt the encroachment of the Gobi Desert with planted forest strips. More than 25 percent of China's landmass currently consists of desert.

While increased glacial melting could cause severe short-term flooding, flow is expected to decrease as glaciers shrink. Winter and spring months are projected to be increasingly arid, which could exacerbate current strains on water resources. The resulting soil erosion, loss of biodiversity, and decreased water capacity could severely inhibit regional life sources, productivity, and stability.

The dense coastal population of Southeast China is particularly vulnerable to forecasted sea-level rise. Of immediate concern, the rising sea level drives salinity changes in the freshwater rivers that feed the ocean, thus affecting water access and quality. If urban infrastructure proves incapable of handling the encroaching sea, the epicenter of China's manufacturing region could be destroyed.

Potential Outcomes

Water availability in China is only one-quarter of the global average. Without effective national and international measures aimed at eradicating pollution, delivering proper infrastructure, and addressing climate change, water scarcity will intensify and serious social, economic, and environmental repercussions will reverberate throughout China and threaten livelihoods. For example, continued desertification could fuel regional migration to towns and cities. Additionally, the abandonment of once-fertile land could contribute to food insecurity problems and potential social unrest. Social and political tensions that are attributable to water pollution have already emerged in China, as evidenced by 50,000 pollution and health-related protests in 2007 alone.

Additionally, the 19 transboundary rivers that cut through China pose potential international tensions. For example, as a result of increased water demand, China has begun to divert water from the Irtysh and Ili rivers away from Kazakhstan and Russia, both of which rely on these rivers for drinking water, irrigation, hydroelectric power, and fishing. Moreover, the absence of China and Myanmar as committed stakeholders in the Mekong River Commission—a cooperative agreement among the Lower Mekong states of Cambodia, Laos, Thailand, and Vietnam to address the governance of the river—presents a significant obstacle to cooperative action. Because the Mekong originates in China, all of China's actions along the river system have a direct impact on downstream livelihoods.

India

Overview

Rapid population and economic growth in India in the last 50 years have placed significant pressure on the country's fragile environment and water resources. India's population is expected to grow further, from 1.14 billion in 2008 to 1.4 billion by 2024. Increasing urban and industrial demands for water now compete with the already high water requirements of the agricultural sector, while deteriorating quality constrains stretched water supplies. There is fierce competition for water at many levels in India—between and within regions, between and among sectors of the economy, and permutations of the two.

A second set of dynamics—linking water to poverty—is also in play. Despite progress in the last 50 years, India is still home to the world's highest absolute number of poor people. One out of three people in India currently lives in extreme poverty (less than $1/day), and one-quarter of children under five years of age are malnourished. Lack of access to water and sanitation services and exposure to extreme events reinforce a cycle of vulnerability. Droughts and floods lead to massive human and economic losses, which have been increasing in recent years. Climate change will only intensify the cycles and magnify the consequences.

Water Security

Access to safe drinking water and sanitation in India follows a pattern that is similar to other developing countries: urban areas are better off than rural areas, and indicators for water are better than those for sanitation. The scale of India's problems, however, sets it apart. According to a 2001 government census, 40.6 million people lived in the slums of 607 cities as a result of decades of uninhibited migration from rural areas. Although local governments are responsible for providing water and sanitation services, these services do not reach every household and are unreliable. Water supply systems are inefficient, leaving high-cost private vendors to meet the demand. Slum households are not connected to the sewage system, and many cannot afford proper sanitation facilities. Options are reduced to *in situ* pit latrines and open defecation. Moreover, improper wastewater disposal and poor urban drainage create water pools and rainy-season overflows that contribute to the spread of disease.

India's drive to boost food production in order to feed its large population has been largely successful, but increased intensity in the agricultural sector has sapped groundwater resources. The so-called green revolution has been based on fertilizer use, improved seeds, extension of arable land, and intensive irrigation. Production tripled from 1965 to 2000, and the poverty level dropped to 31.9 percent in 2000. However, the overexploitation of groundwater resources in states along the Indo-Gangetic Plains—Punjab, Haryana, northeastern Rajasthan, Gujarat, and portions of Uttar Pradesh—has led to serious scarcity

challenges. An estimated 60 percent of India's irrigation systems depend on groundwater.

Pollution of India's water resources is also prevalent throughout the country. Water quality is the primary concern along many of India's rivers, as rapid urbanization and industrialization outpace waste treatment mechanisms. Pollution directly compromises the health of inhabitants around these rivers, as well as the health of ecosystems and river-irrigated crops. The Ganges and Sabarmati basins are two of the absolute worst in terms of water quality. Massive populations depend on these rivers for agricultural, domestic, recreational, and religious purposes. Furthermore, India's management of the Ganges has direct implications on neighboring states, particularly Bangladesh. In 1974, India began construction of the Farakka Barrage approximately 11 miles from the Bangladesh border. The completed barrage has improved navigability and port access and provided irrigation and drinking water to adjacent Indian states. However, the barrage has also increased Indian control over the Ganges River's water flow into Bangladesh. In 1996, the two countries signed the 30-year Ganges Water Treaty to divide water flows. Its longevity is uncertain in light of mounting socioeconomic pressures in India.

Extreme Events

The frequency and intensity of extreme events are of great concern in India, and both have increased as a result of human activities and climate change. For instance, poor regulation of land use and construction, massive surface irrigation, and deforestation have exacerbated flooding in northeastern India. Despite India's Flood Management Program, 3,659 people and 114,140 heads of livestock were lost, infrastructure was destroyed, and 3.5 million houses were damaged by floods in 2007–2008. Flooding is endemic in northeastern India, and it is particularly acute in the low plain states, such as Orissa, Assam, and Andhra Pradesh.

India's control of water flow along the Ganges River further compromises Bangladesh's ability to monitor and predict floods. While the Joint Ganges River Commission facilitates information sharing between the two nations, Bangladesh continues to demand greater cooperation. More data—including rainfall data from farther upstream—would help Bangladesh prepare vulnerable downstream populations and improve models used to predict extreme events.

Potential Outcomes

Water scarcity, access to safe drinking water and sanitation, water quality, and extreme events will affect the economic performance of many sectors, political stability within and between states, and human development across the country. At the smallest scale, lack of access to safe drinking water and sanitation reinforces the poverty trap by usurping time from productive activities and promoting costly waterborne diseases. At an aggregate scale, the social and human health costs associated with water insecurity will intensify broader economic losses, and rural to urban migration is likely to exacerbate these problems.

Additionally, if India's states are unable to mediate disputes and expand water availability, frustrations among farmers will likely rise, and could escalate into demonstrations and unrest. Persistent droughts could increase farmers' vulnerability, and severe groundwater depletion may force poorer farmers out of agriculture, increasing migration and poverty, while declining crops could produce economic stagnation and widespread food insecurity throughout the country. Looking beyond India's national borders, the transboundary river systems that cut across India will drive hydropolitics in the region as India's water consumption rates continue to climb. For Bangladesh, the Ganges may be the largest and most critical source of water, but it is only one of more than 50 rivers entering the country from India.

Indonesia

Overview

Although Indonesia enjoys 21 percent of the total freshwater available in the Asia-Pacific region, many of the country's water security issues are tied to its rapid development, poor urban infrastructure, and stretched institutional capacity. Economic growth has not been accompanied by a corresponding expansion of infrastructure and institutional capacity. As a result, nearly one out of two Indonesians lacks access to safe water, and more than 70 percent of the nation's 220 million people rely on potentially contaminated sources. The country also has undergone significant land-use changes, and deforestation and extractive industries have polluted, altered the landscape, and left many areas more vulnerable to extreme events such as monsoon floods.

Water Security

Indonesia has become a pollution hotspot as a result of its rapid urbanization and economic development. Expanding waste streams are evident across the growing industrial, domestic, and agriculture sectors. Extractive industries account for much of the development, and waste from industrial and commercial processes is increasingly making its way into both surface water and groundwater supplies. The country—particularly its urban slums—sorely lacks wastewater treatment, and the basic sanitation infrastructure necessary to prevent human excrement from contaminating water supplies is virtually nonexistent. Roughly 53 percent of Indonesians obtain their water from sources that are contaminated by raw sewage, and this exposure greatly increases human susceptibility to water-related diseases.

Located along the equator, Indonesia is surrounded by warm waters that create relatively stable year-round temperatures. Monsoons drive seasonal variations. Yet climate change threatens to disrupt the regular, alternating periods of rain and arid dryness. The dry season may become more arid, driving water demand, while the rainy season may condense higher precipitation levels into shorter periods, increasing the possibility of heavy flooding while decreasing the ability to capture and store water. Increased rainfall and flood conditions facilitate the spread of disease in areas where the population lacks access to clean water and sanitation. Thus, managing water scarcity is a critical challenge for Indonesia and for many Southeast Asian nations with similar climates.

Extreme Events

The tsunami that struck Aceh Province in 2004 demonstrated the potentially devastating effects that weak infrastructure, poor planning, and inadequate governance can cre-

ate. In fact, environmental destruction associated with deforestation and unmanaged development has left many parts of the country extremely vulnerable to floods, landslides, and tsunamis. Indonesia has lost roughly 72% of its forest cover over the last 50 years. Large barren hillside areas and underlying soils, which are subject to heavy precipitation, greatly increase the likelihood and severity of floods and landslides. When flooding occurs, urban infrastructure is quickly overwhelmed, leading to sewage spillover and further contamination. In addition, post-event cleanup and repair costs can be immense.

Flood-related natural disasters may be connected to higher incidences of soft tissue, respiratory, diarrheal, and vector-borne diseases. In the aftermath of the 2004 tsunami, the World Health Organization warned of immediate, increased risk of waterborne diseases and strongly recommended uninterrupted provision of safe drinking water and implementation of standard treatment protocols in health facilities as a first line of defense against a potential epidemic. The difficulty of carrying out precautionary measures following another major natural disaster puts the health of both survivors and emergency response workers at high risk.

Potential Outcomes

The enormous challenge of environmental degradation directly feeds into many of Indonesia's water security problems. Vulnerability to extreme events and continued pollution of water supplies pose the greatest challenges. Pollution and compromised sanitary conditions in much of the country may lead to epidemics and severe health problems, testing institutional capacities. Rapid urban growth—combined with natural geographic and climatic conditions—will serve to compound social and political pressure.

Malaysia

Overview

By comparative standards, Malaysia has abundant freshwater resources, which are derived from an average 3,000 millimeters of rainfall per year and from more than 150 river systems that traverse the country. Roughly 95 percent of the nation's water resources come from inland rivers and streams, and thus there is little need to pump groundwater. Dams, canals, and pipelines throughout the country divert freshwater for domestic, industrial, and agricultural consumption. But as economic development has accelerated, so, too, have concerns about pollution and water quality.

Water Security

Malaysia's recent economic development has relied on a growing industrial sector, the expansion of irrigated agriculture, and an increasing urban population. This multidimensional growth is now placing a great deal of stress on water supplies. With approximately 22,000 cubic meters of water available to each person annually, Malaysia is not considered water stressed. However, pollution from industrial, agricultural, and domestic sources is a major source of concern. Rapid population growth has contributed to the increasing volume of domestic sewage discharged into rivers and drainage systems. Livestock breeding and indiscriminate use of pesticides has also negatively affected the quality of water supplies. Waste from rubber and palm oil factories continues to be a problem, although the adoption of effective treatment systems has reduced the volume of untreated waste from these industries in recent decades.

Much planned industrialization requires significant water inputs, thus increasing demand and requiring a growing number of diversion projects to bring surface flows toward commercial zones. These shifts in land use, coupled with growing commercial pollution and population growth, are increasingly having an impact on the quality of water supplies. Moreover, soil in Malaysia erodes quickly because of widespread deforestation and a large annual rainfall, and many drainage systems are inundated with high concentrations of suspended particles. Sedimentation in rivers may facilitate more frequent flooding, which is already a recurring problem during monsoon season.

Extreme Events

While floods are a common natural phenomenon in Malaysia, the severity of floods in the country may increase as a result of climate change. From December 2006 to January 2007, for example, torrential rains and flash floods in the southern part of the country left thousands of people homeless, with more than 300,000 people directly affected. This was the worst flood Malaysia had seen in 100 years.

Potential Outcomes

Despite vast freshwater resources in Malaysia, increasing concentrations of water demand around urban industrial centers as well as the expansion of irrigated agriculture are taxing local water supplies. Human engineering and ingenuity can certainly overcome these geographic barriers, but the cost to human health and well-being should also be considered. Water pollution is already a serious concern and can be expected to worsen without appropriate protection and management. High annual rainfall and deforestation magnify the severity of flooding, and persistent flooding could lead to mass migrations that would place a significant burden on the migrant-receiving areas.

Pakistan

Overview

Pakistan is already classified as water stressed. Total renewable water resources in the country declined from 2,961 cubic meters per person in 2000 to 1,420 cubic meters per person in 2005. The Indus River provides roughly 80 percent of all water consumed in Pakistan and supports the Indus River Basin Irrigation System—the largest gravity-fed, government-managed irrigation system in the world. Therefore, the Indus River is literally and figuratively the backbone of Pakistan's highly agrarian economy and society. Yet the Indus River—and the irrigation system that relies on it—are under enormous pressure.

Water Security

Long-term problems in the irrigation sector are complicated by trends in the upper reaches of the Indus River Basin. Deteriorating infrastructure has led to seepage from irrigation canals, and only 36% of the water drawn for irrigation actually reaches crops. This loss of water makes the system highly inefficient and requires great quantities of water to be withdrawn in order to grow crops. Moreover, an estimated 40% of irrigated land has been affected by poor maintenance and naturally poor drainage, which has led to water logging and increased salinity of irrigation water. As a result, arable land and agricultural productivity have declined, and in 2004, decreased agricultural output cost the Pakistani economy 0.9% of gross domestic product.

In the dry, mountainous region of the upper basin, rapid depletion of groundwater and deforestation—both linked to population growth—are causing more sediment to wash downstream. Sediment buildup diminishes the amount and quality of water stored in downstream reservoirs and irrigation canals. This buildup has also reduced Indus River Basin reservoir storage capacity by about 20%.

Extreme Events

The combined effects of water scarcity and quality limit the land and water available to grow crops. Declining river flows already are leading to seawater intrusion in the delta region. Quickly disappearing glaciers, which help regulate water flows across wet and dry seasons, will exacerbate these problems in the future. The Pakistani government expects a shortfall of 11 million tons of grain by 2010 and 16 million tons by 2020 as a direct result of water scarcity.

Potential Outcomes

Significant concerns about water access, quality, and scarcity exist within the boundaries of the Indus River Basin Irrigation System. As Pakistan's population continues to grow—it is expected to surpass 204 million by 2015—municipal facilities and other water resources will face even greater strain, particularly in urban areas, where the lack of sanitation and drainage facilities will further pollute freshwater drinking supplies. In the absence of water-quality monitoring and testing, the incidence of waterborne diseases will increase. In fact, guinea worm and other diseases believed to have been eradicated are resurfacing in the country.

Circumstances in the upper reaches and the delta region of the Indus River Basin are intricately linked. As a consequence, potential outcomes have broad national implications. This includes declining or stalled agricultural productivity, which could lead to widespread food shortages and stagnant national growth. Migration to urban areas could increase as the mountainous region experiences increased water scarcity, economic prospects decrease in rural areas, and delta regions face worsening land degradation. The agricultural sector accounts for 21% of gross domestic product and employs 44% of the labor force, and social unrest could increase if alternative sources of income and labor are not available. Moreover, tensions could rise between upstream and downstream provinces, and between rural and urban areas, over water supply and use. The traditional water distribution framework, called *warabandi,* inherently favors upstream users. Reforms and alterations of this system from the colonial period onward have exacerbated inequalities and undermined attempts to manage the system fairly and efficiently.

Sri Lanka

Overview

Although geography divides Sri Lanka into distinct wet, intermediate, and dry zones, water issues cannot be segregated so easily. Water scarcity is a growing challenge in the dry zone, but the increasing risks of extreme events and degradation of water quality by pollution are widespread. All of these factors are set against the backdrop of the potentially destabilizing separatist movement of the Liberation Tigers of Tamil Eelam (LTTE).

Water Security

Sri Lanka's dry zone covers the entire northern half of the country and extends along the eastern and southeastern coasts. Although water from rivers and reservoirs in the wet region can be transferred to adjacent areas in the dry zone—approximately 750 million cubic meters of water are diverted annually—the farther reaches rely on groundwater and a traditional system that captures rainwater in small tanks. The increasing use of wells for irrigation near these catchment tanks is decreasing groundwater levels and threatening the entire system's hydrologic balance. With less dry-season groundwater available, residents are forced to turn to unsafe or unreliable sources of drinking water. In the northern city of Jaffna, for example, well water contains unacceptable bacterial levels, a result of sewage effluent infiltration into groundwater.

In the western and northwestern regions, pollution from various sources is degrading surface water and groundwater quality, with epicenters located in the Colombo metropolitan area and the western Jaffna peninsula. Although the primary sources of pollution are linked to each region's unique geography and economic activity, the combination of high population density and lack of effective sanitation is amplifying human waste contamination. Industries discharge solid and liquid waste into surface drainage networks, particularly in the areas surrounding urban centers, while agricultural practices dispense sediments, pesticides, and nutrients into nearby water supplies.

Extreme Events

Changing precipitation patterns in Sri Lanka will likely intensify as global temperatures rise. Total precipitation is falling, meaning that dry spells are becoming longer and wet spells are becoming shorter. In addition, more rain is falling in fewer days during wet spells. Studies have found a correlation between similar changes in rainfall—particularly in intensity—and increased landslides. Such trends clearly put lives and livelihoods at risk.

Potential Outcomes

Local and national water resources management institutions in Sri Lanka are fairly robust. They are well connected to international organizations and nongovernmental organizations that can fill knowledge gaps and provide funding assistance. For this reason, water security challenges are unlikely to erupt into serious crises in the short or long term. Still, ongoing armed conflict between the LTTE and the Sinhalese-dominant government forces creates uncertainty. Tamil groups traditionally inhabit and control the regions of northeast—the same regions experiencing increasing drought and stressed groundwater supplies. Disputes over control of the Maavil Aru reservoir in 2006, for example, sparked a conflict that marked the end of a cease-fire between the government and the LTTE that began in 2002.

United States

Introduction

The United States has one of the safest water supplies in the world. The largest consumer of water is the industrial sector, which accounts for 46% of total water withdrawal in the United States. Agricultural and domestic use accounts for 41% and 13% percent nationwide, respectively, but in the semi-arid western United States, where a substantial portion of crops are grown, agricultural use accounts for at least 70% of water consumption. The country faces a daunting challenge in meeting the water demands of a growing population, particularly in the Intermountain West and Southwest. Compounding distribution issues, climate change is expected to raise temperatures, decrease snowpack, and reduce rainfall, thereby increasing the severity of droughts in much of the country. Drought in the southwestern region of the United States, which is already considered an arid zone, has been especially severe in recent years.

Water Security

The United States faces the prospect of a severe water shortage as a result of rising water demand and extreme weather events, such as intense drought. In the past five years alone, drought conditions have been recorded in nearly every region of the country. Hotter and drier conditions mean faster evaporation in reservoirs and on irrigated farmland, as well as increased water withdrawals for domestic and agricultural consumption. Many regions rely on groundwater withdrawals, but given the country's large consumption rates, the long-term sustainability of underground water resources will be undermined. Underground water withdrawals were 83.3 billion gallons per day during 2000—a 14 percent increase since 1985.

The arid regions of the western United States are especially vulnerable to water scarcity. Steady population growth, economic development, and droughts are resulting in rapid depletion of both surface water and groundwater. For example, Lakes Mead and Powell, both major providers of Nevada's water, stood at only 49% of capacity as of October 2007. Without Lake Mead, the region—which encompasses up to 36 million people, as well as the booming metropolis of Las Vegas— will be difficult, if not impossible, to live in.

Interstate disputes over water do exist in the United States. The most notable dispute is that between Georgia, Florida, and Alabama over the allocation of water from several key rivers in the region. Alabama and Florida are seeking a permanent injunction to limit excess water withdrawals in Georgia. In addition, interstate wrangling over the management of water resources has long been common in the arid West over the Colorado River, as well as in the Great Lakes region. Disputes over the Colorado River and the Great Lakes have also involved Mexico and Canada, respectively.

Extreme Events

If drought conditions become more prevalent and severe, agricultural production in the United States may decrease, contributing to a crisis in the global food markets. This is already happening in California's Central Valley, which produces approximately half of the fruits and vegetables grown in the country. Because the Central Valley is arid, its agriculture is completely dependent on irrigation. In 2009, rationing cut back the amount of water that could be irrigated from the Sacramento-San Jose Basin, cutting off the water supply for many farmers. This is expected to result in a steep increase in prices for many staple products.

Potential Outcomes

Climate change will exacerbate drought conditions all over the nation, but particularly in the arid Southwest, where population growth and drought have already strained water supplies. Drought can leave millions of people without a stable water supply and threaten the country's future with respect to both food and energy—specifically, it could raise the prices of both, which would, in the context of a recession, put a severe strain on those who may not be able to afford them. While water rationing and pricing schemes have led to more efficient and responsible use of water in American cities suffering from extreme drought, these stopgap measures must be reinforced by long-term, permanent improvements in water resources management.

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