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DISCUSSION PAPER

Water and U.S. National Security

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Introduction

Water and security are inextricably linked in every region of the world. While shared interests have historically facilitated cooperation in managing water, the future could be different. Climate change, combined with increased and more diverse demands for water, makes disputes more likely. Moreover, many of the security problems associated with water will occur in areas where the United States has strategic interests, including the Middle East and the Asia-Pacific. Yet water as an issue for U.S. national security lacks sustained visibility and sufficient funding.

To address global water issues, pragmatic steps are necessary. These include an enhanced priority for water and security at the highest levels in the U.S. government; more support for data collection, analysis, and early warning efforts; investments in institutions to manage transboundary rivers and domestic water supplies; and more public-private partnerships to increase water supplies, water conservation, and to waterproof at-risk infrastructure.

Water is essential for drinking, agriculture, and livestock. It is also used for electricity generation and industry. But around the world, hundreds of millions of people live without access to sufficient water for part or all of the year. The largest numbers of people who face constant water scarcity live in China and India, but high proportions of the populations of Libya, Pakistan, Saudi Arabia, Somalia, and Yemen also face severe year-round water stress. Acute droughts periodically put millions of lives and livelihoods at risk. In a world of climate change and increased population growth, challenges related to water scarcity will only grow.

A number of the states affected by chronic water scarcity also have weak governance, and some are already experiencing conflict. Where watersheds are shared across borders, governments may dispute control of those water resources, particularly where upstream dam construction diverts water from downstream countries. While violence is not inevitable, and history shows extensive water sharing between countries, conflicts over water are likely to become more severe in a world of nearly eight billion people experiencing increased demand for water, growing urbanization, and climate change.

Within states, the effects of water scarcity on lives and livelihoods can lead to economic downturns and migration. Too little water can lead to crop failure, starvation, and thirst. Water scarcity in countries dependent on hydropower can lead to electricity shortages that adversely affect economies and contribute to civil unrest. In extreme circumstances, those who control water can use it as a coercive tool.

Scarcity is not the only source of water-related security problems. Too much water can lead to flooding and large-scale loss of life, while irregular or volatile water supplies can upend planting cycles and prevent effective preparations and adaptations. Changes in rainfall patterns can also shift the geographic range of disease vectors, such as mosquitoes.

Institutions, both domestic and international, mediate how conflicts over water are handled. They provide frameworks for competing interests to peacefully resolve disputes and establish water sharing. They guide sustainable investments in conservation and water storage. Inadequate or absent institutions can contribute to poor planning and insufficient water supplies, potentially exacerbating social and political tensions.

The United States is not blind to the risks related to water security. A report on global water security, released by the U.S. National Intelligence Council (NIC) in March 2012, identified some of the main risks and areas of concern.¹ The State Department has a small office led by the special coordinator for water resources that oversees an Interagency Water Working Group to coordinate U.S. efforts on water across the executive branch. The U.S. Agency for International Development (USAID) has supported some analytical products and projects on water, though mostly relating to sanitation and hygiene. Beyond this, the United States is the leading producer of satellite information on water and the environment.

That said, the U.S. government has not sufficiently mobilized to prepare for water-related challenges. It has not fully utilized the capabilities of U.S. civil society, universities, and the private sector to anticipate and address water-related problems around the world. Improved data sources and methods, including satellite data collected by U.S. government assets, now make it possible to identify fragile states and river basins where water problems are most likely. The failure to invest in water and security now could mean that the United States and other international actors will pay billions later to respond to crises, whether they be humanitarian emergencies, disease outbreaks, or conflicts within or between states.

As the nexus between water and security gains attention, policymakers should keep in mind the need to “do no harm.” Outside countries and institutions should pay careful attention to the local context of a water dispute and its ripeness for resolution. In some instances, direct U.S. involvement could be appropriate. In others, the United States will be better served by working with partners to shore up its interests.

Linking Water and Security

Climate change has made natural water variability and scarcity more acute and will continue to do so. Periods of low rainfall and high temperatures are likely to last longer, be less predictable, and be punctuated by high rainfall events and rapid rises in sea level from storm surges.² Though some states may be able to compensate for decreased surface water by drawing from deeper groundwater, increased demand threatens to draw down groundwater to unsustainable levels.³

In May 2016, the World Bank released a report, *High and Dry: Climate Change, Water, and the Economy*. The report concluded that nearly 25 percent of the world's population, approximately 1.6 billion people, live with water scarcity—and that number could potentially double in two decades.⁴ South Asia, the Middle East, and North Africa currently face constant water stress. Another 2016 study found that two-thirds of the world's population face severe water scarcity for at least one month a year, with half of those people in India and China. The study found that, globally, five hundred million people face water scarcity year round.⁵ Although these studies used different methodologies, their common conclusion is clear: substantial portions of humanity do not have access to enough water.

Currently, nearly 70 percent of fresh water demand comes from agriculture.⁶ But over the next thirty years, the demand for water will increasingly come from urban areas and their related energy needs.⁷ As many as 2.5 billion more people may be living in cities by 2050, with 90 percent of that increase occurring in Africa and Asia, in countries with insufficient institutions or infrastructure to handle the rising demand for water.⁸

In addition to the urban planning and humanitarian concerns that these realities raise, they also have real security implications. It is rare for states to go to war over water, but conflicts over resources within states are common. Humanitarian emergencies and disease epidemics can also become security problems when civilian agencies are unprepared or unable to respond.

Local insecurity can spill over to neighboring states through migration, the spread of conflict across borders, or disease, triggering U.S. national security concerns. This is particularly true when the states involved are strategically important to the United States—for instance, because they provide important raw materials, are located along vital sea lanes, are important to the global economy, or coincide with active U.S. military operations.⁹

WATER AND SECURITY BETWEEN COUNTRIES

Analysts have periodically claimed that the world is poised for “water wars.”¹⁰ However, there are only a few historical examples of violent conflict between countries explicitly over water.¹¹ But the fact that it has rarely happened does not mean that it will not in the future, particularly when climate change threatens to make water problems more acute.

Historically, tensions between states over water have led to water-sharing agreements that have alleviated the risk of violent conflict.¹² More than 680 water treaties have been signed since 1820, more than half of which were agreed upon in the past half century.¹³ While these agreements are frequently far from fair, even governments that are otherwise politically opposed often find it possible to collaborate on water. As a 2014 Adelphi report on water diplomacy noted: “The 1960 Indus Waters Treaty

has thus survived three wars between India and Pakistan, cooperation on the Mekong persisted throughout the Indochinese wars, and water has served as a crucial means for strengthening cooperation in Southern Africa.”¹⁴

While it is possible to deal with water stress peacefully, transboundary water agreements are usually facilitated by robust institutions. River basins with stronger institutions—characterized by mechanisms to allocate water, manage water variability, resolve conflicts, and govern river basins—tend to have less conflict.

The most severe security challenges between states emerge when countries—such as China, Ethiopia, India, Pakistan, Thailand, and Turkey—have some domestic capacity to develop their water resources but insufficient institutional capacity to manage them properly. Along with sudden physical changes in the quantity or quality of water, tensions between or among states are often triggered by one party’s unilateral action to build a dam or water transfer project without consulting other affected states.¹⁵ These pressures could become increasingly difficult to manage without strong institutions, domestically and internationally.

Unfortunately, institutions often leave something to be desired. In early 2016, for example, the worst drought in a century threatened Vietnam’s rice harvest, fisheries, and electricity production. Thai farmers upstream on the Mekong River began diverting water, which left both Vietnam and Cambodia in a difficult situation, having already endured diminished flows from dam-building further upstream by China and Laos.¹⁶ The river basin authority, the Mekong River Commission, is increasingly incapable of managing these disputes. China is not a member, and the Commission lost credibility and foreign funding after Laos, the host country, unilaterally approved dam-building in its territory.¹⁷ Given U.S. interests in the South China Sea, conflict along the Mekong River adds to the security frictions in this region. Cooperation on the Mekong could be easier to achieve than in the contentious South China Sea, and could help pave the way for better relations on other issues.

New projects or events can even put reasonably robust institutions under strain. In September 2016, attacks on the Indian military by militants in Kashmir led the Indian government to threaten to withdraw from its water-sharing agreement with Pakistan over the Indus River.¹⁸ For the United States, tensions between India and Pakistan are undesirable, as would be actions that precipitated significant economic losses in the region, such as the unilateral diversion of upstream headwaters.

Asia is not the only region to suffer from weak water institutions. Turkey has long dominated the use of water from the Tigris and Euphrates, having built large upstream dams and planned a number of others that could hurt Syria and Iraq downstream. While there is a water-sharing agreement on the Euphrates, no such agreement exists for the Tigris, and political turmoil in the region has made pursuit of a region-wide water-sharing agreement difficult.¹⁹

Tensions have also emerged between Iran and Afghanistan over the Helmand River. While the countries have a water-sharing agreement dating back to 1973, turmoil has harmed the Hamoun wetlands that straddle the border. Moreover, U.S. efforts to help reconstruct Afghanistan’s agricultural economy and water systems undermined Iran’s water security and contributed to Iranian support for the Taliban.²⁰ Iran blames Afghanistan for the diversion of water and is opposed to Afghanistan’s completion of various dam projects in Nimruz Province, where there have been cross-border skirmishes over water.²¹

These episodes all underscore the need for strong institutions to facilitate water-sharing and conflict resolution. Strong institutions provide venues for data-sharing and consultation before major water projects are set in motion and affect other users. They can facilitate water allocation between parties,

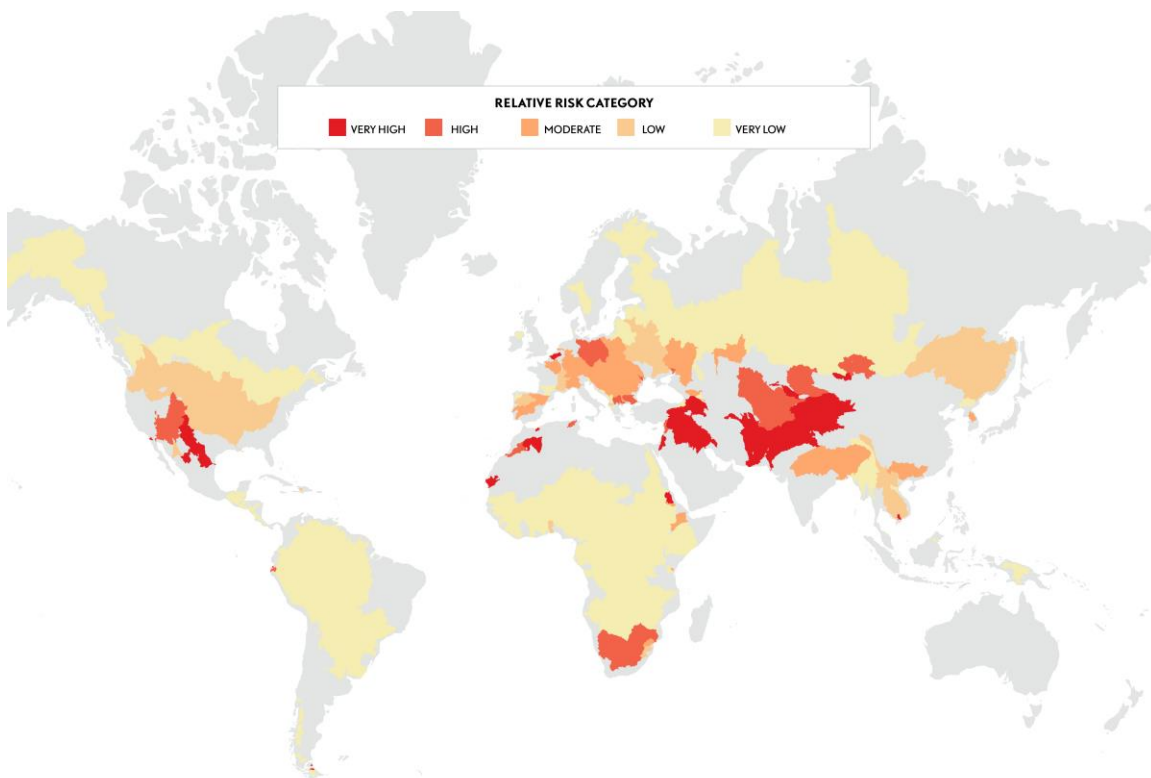
deal with unexpected drops in water levels, and help resolve disputes, all of which are preferable to crisis diplomacy or military intervention.

Regional Water Hotspots

Several different studies have noted places of concern for water stress. A 2012 NIC report on global water security identified Central Asia's Amu Darya and the Brahmaputra in South Asia as most worrisome, having "inadequate" river basin management. The concerns for the Amu Darya included drying of the Aral Sea, food security, and regional competition. For the Brahmaputra, the report cited regional food security (particularly related to fisheries), reduced hydropower, and unilateral water projects. As for other priority areas, the report rated river basin management capacities in the Mekong, Nile, and Tigris-Euphrates as "limited"—marginally better than "inadequate"—and the Indus and Jordan as "moderate."²²

The Transboundary Water Assessment Program has also analyzed the status of the world's most important river basins (see figure 1).²³ The core basins it rated at a very high risk of human water stress in 2010 included those in Central and East Asia (Indus, Tarim, Pu Lun T'o, Shu/Chu, and Song Vam Co Dong), several basins in Southwest Asia (Hamun-i-Mashkel/Rakshan, Murgab, Hari/Harirud, Kowl E Namaksar, and Dasht), some basins in the Middle East (Kura-Araks, Tigris-Euphrates/Shatt al Arab, and Jordan), several in northern Africa (Baraka, Guir, Tafna, Douara, and Atui), one in Europe (Schelde), and one in the Americas (Rio Grande).

FIGURE 1. RIVER BASINS AT RISK OF HUMAN WATER STRESS



Source: Transboundary Water Assessment Program, 2010.

Another study, based on Oregon State University's Transboundary Freshwater Dispute Database, estimated in 2012 that 24 of 276 international river basins were at high risk of political tensions due to scarce water and weak institutions. Many of those basins were in sub-Saharan Africa, including the heavily populated Congo, Lake Chad, and Niger River basins. In 2016, a follow up study by the Oregon State University research team focused on water issues that could affect U.S. national security. It identified rivers that originate in the Himalayas, basins in Afghanistan and Iran, and basins in the Caucasus and Central Asia to be of primary concern.²⁴

WATER AND SECURITY WITHIN COUNTRIES

Disputes over water within countries are more likely to create or exacerbate conflict than disputes between countries. While a direct cause/effect relationship between water and conflict is difficult to prove, water issues can indirectly contribute to conflict through their effects on food prices, migration, economic growth, and natural disasters. Humanitarian emergencies and health crises caused or influenced by water could also rise to the level of security concerns.

Direct Connections Between Water and Conflict

The evidence of a direct link between drought and violent conflict within states is contested.²⁵ Some studies find that when rains are much lower than normal, conflict is more likely.²⁶ Others, however, dispute those connections.²⁷ Some posit that drought makes it more likely for people to join rebel movements or participate in other kinds of social conflict like protests or riots, while others argue that hardship forces people to focus on survival. Several studies have found that rainfall variability is a more important driver of civil conflict than water scarcity.²⁸ Volatile rains make it harder for farmers to plan and could force sudden, unforeseen efforts to secure water, leading to conflict.

Some scholars even argue that rainfall abundance, rather than scarcity, drives conflict. Abundant rainfall could enhance communal conflict (such as between herders and farmers) by leading to further competition over more plentiful resources.²⁹

Beyond these connections, there is increasing awareness of the strategic use of water as a weapon or source of leverage within existing conflicts.³⁰ As the 2012 NIC report on global water security noted, dams or other water infrastructure such as desalination plants or canals could be important targets for insurgent or terrorist activity.³¹ In 2014, the self-proclaimed Islamic State briefly controlled Iraq's Mosul Dam and tried to exert its political will by threatening water cutoffs.³² With U.S. support, Kurdish and Iraqi forces were able to reclaim the territory, but U.S. engineers still fear the decrepit dam might fail and flood heavily populated cities downstream such as Baghdad, Samarra, and Tikrit.³³

Indirect Connections Between Water and Conflict

Water scarcity, rainfall variability, and water-related natural hazards are more likely to indirectly contribute to conflict by stunting food production or driving up prices, forcing migration, stifling economic growth, or causing natural disasters.

For example, the role of drought in increasing global food prices has been frequently cited as a cause of the 2011 Arab Spring.³⁴ The assertion is that low harvests in Russia, Argentina, and Australia in 2010 led to higher grain prices and triggered public protests in North Africa and the Middle East.³⁵

Though many countries heavily subsidized food, thereby reducing the price hike to consumers, one study of African countries found that when lower than normal rains led to rising domestic food prices, it made social conflict, including riots and strikes, more likely.³⁶

Water can also contribute to conflict by sparking or exacerbating migration and population displacement. Dams and other large-scale engineering projects to transfer water from water-rich to water-scarce regions (as both China and India envision) can undermine domestic stability, particularly when they require the resettlement of large populations. Groups opposed to such projects have mobilized to protest relocation, and resettled populations sometimes harbor grievances about their new surroundings and economic fortunes.³⁷

Persistent water stress can encourage rural to urban migration or even migration across borders. Natural disasters such as cyclones can lead to large temporary shifts in migration. And research on refugees suggests that newcomer and local populations can come into conflict over scarce resources—so insufficient water can trigger migration from one location, and then become a source of dispute in another.³⁸

One of the most clear-cut findings on conflict is that poor countries and countries with low economic growth are more prone to conflict.³⁹ Thus, if changes in rainfall and access to water lead to low economic growth or even declines in GDP through their effects on agriculture (such as declining harvests) or industry (such as electricity blackouts or insufficient water for industrial cooling), then conflict might become more likely.⁴⁰ One way slow growth or a shrinking economy potentially contributes to conflict is by undermining a state's capacity for managing violence. Deprived of revenues necessary for security and the provision of essential services, a poorer and less capable state loses its capability to dampen violence and respond to grievances.

Another potential pathway to conflict and social upheaval can happen through natural disasters. If governments fail to respond adequately to water-related emergencies, they could find themselves facing protests and political challenges at home.⁴¹ In the Middle East, analysts have frequently invoked drought and water mismanagement as sources of grievance and as drivers of the urban migration that precipitated the Syrian civil war.⁴²

Whether disasters ultimately cause more violence is a bit more uncertain, with mixed findings and variation by disaster type and region. In some cases, conflict declines because rebel movements find human deprivation too severe to continue the fight. The devastating effects of the 2004 tsunami in Indonesia are said to have weakened rebel movements' resolve and capability to fight.⁴³

On the other hand, when domestic needs for water quantity and quality are not met, populations often mobilize to express their grievances: sometimes through peaceful protest, and sometimes through theft, looting, or even violence. In 2016, an already weakened Venezuelan economy faced a water crisis brought on by a strong El Niño.⁴⁴ Scarce drinking water led to ambushes on water trucks and raids on swimming pools and public buildings' water supplies. Low water levels also disrupted the output of the main hydroelectric power station and caused crippling blackouts. These developments, combined with the collapse of the Venezuelan economy, led to fears of a wider humanitarian and political crisis.⁴⁵

Other Security Consequences: Humanitarian Emergencies and Disease

Even when they do not contribute to civil unrest, natural disasters such as cyclones, floods, and droughts can create water-related humanitarian emergencies and lead to disease outbreaks. In some

cases, political conflict and natural disasters can combine—for example in 2008, when cyclone Nargis killed 140,000 in Myanmar.

Authoritarian regimes or weak states with active conflicts could be especially prone to these kinds of problems. In July 2010, floods in the Indus River basin affected as many as twenty million in Pakistan. Two thousand people died, and eleven million were left homeless. Pakistanis criticized the government's slow response, and many blamed the president for proceeding with an overseas European trip amidst the flooding.⁴⁶

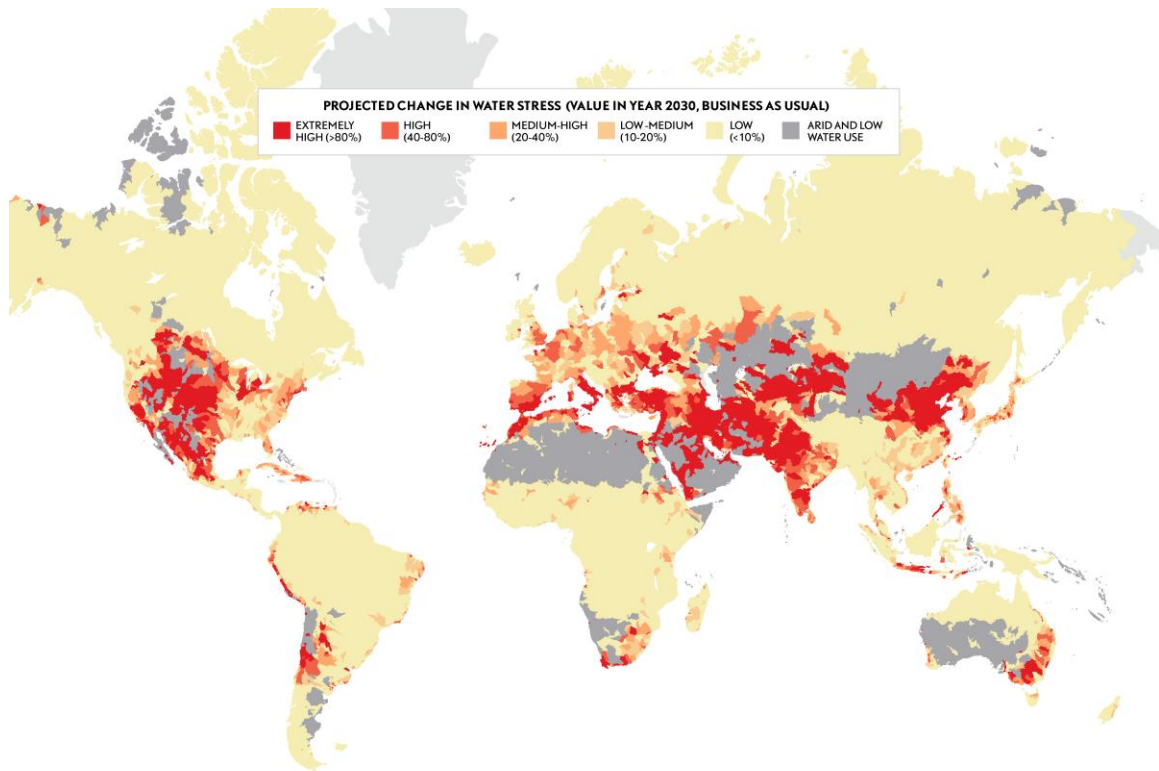
Similarly, in 2011, a devastating drought in Somalia led to famine when aid worker interventions were disrupted by al-Shabab militants, resulting in the preventable deaths of some 250,000 people.⁴⁷ By contrast, neighboring Ethiopia has a more capable state that can withstand and respond to humanitarian challenges. In 2016, twenty million Ethiopians were at risk of starvation due to the worst drought in decades. But unlike the 1984 famine, which killed 600,000 people, a more confident and competent Ethiopian government was better prepared with new food and cash assistance programs, water collection programs, and more extensive rural health clinics.⁴⁸

Climate change is another factor with security consequences. Changes in rainfall patterns, for instance, are likely to alter the geographic range of disease vectors like mosquitoes, making it more likely that diseases such as malaria spread to new locations or become reestablished where they had been eliminated.⁴⁹ Newer diseases such as the Zika virus may also be advantaged by these changes.⁵⁰ In addition, water scarcity can lead to other health problems associated with inadequate sanitation, facilitating the emergence of diseases such as the cholera outbreak that affected Haiti after the devastating 2010 earthquake.⁵¹

HOTSPOTS OF CONCERN FOR WATER SCARCITY WITHIN COUNTRIES

Efforts to identify places at risk tend to focus on water scarcity. For example, the World Resources Institute's online atlas, *Aqueduct*, tracks current and projected water risk. As shown in figure 2, large parts of the southwestern United States, North Africa, the Middle East, India, Pakistan, and northeast China are likely to face extremely high water stress by 2030.

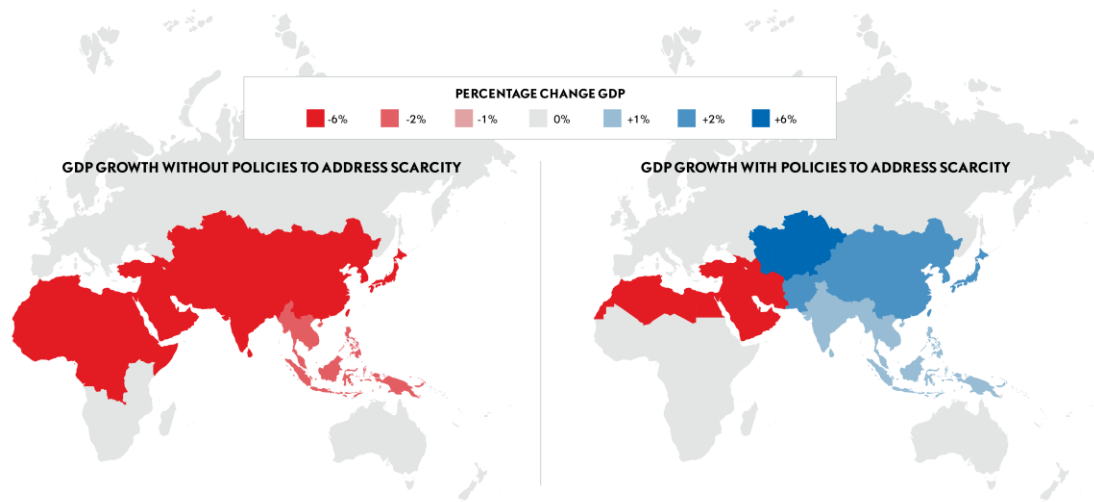
FIGURE 2. CHANGES IN WATER STRESS BY 2030



Source: World Resources Institute, 2013.

Areas under water stress could experience significant economic downturns. The 2016 World Bank report identified a band extending from West Africa across the Middle East to Asia that could see significant declines in GDP—as much as 6 percent—by 2050 as a result of the effects of water scarcity on agriculture, human health, income, and property (see figure 3).⁵²

FIGURE 3. THE IMPACT OF WATER SCARCITY ON GDP BY 2050



Source: World Bank, 2016.

The effects of climate change on agriculture are particularly worrisome. Under high emissions scenarios, changes in rainfall patterns are projected to reduce crop yields globally by up to 10 percent by 2030, and up to nearly 35 percent by 2080.⁵³ The effects are likely to be most severe in river basins such as the Yangtze, Ganges, and Indus that depend heavily upon seasonal meltwater from snowpacks and glaciers.⁵⁴ Where these risks intersect with demographic and development challenges, the odds of conflict rise. The NIC has highlighted North Africa, the Middle East, and South Asia as likely to face major challenges.

In 2008, Columbia University's Center for International Earth Science Information prepared a study examining the intersection of climate change and political instability.⁵⁵ The report identified countries that had two or more risk factors for political instability and were also predicted to see increased water scarcity by 2030. The ten countries identified as most at-risk were China, Ethiopia, Guatemala, Iraq, Ivory Coast, Mozambique, Nigeria, Somalia, Syria, and Zimbabwe. The report also identified countries that had risk factors for political instability as well as large numbers of people living within one meter of sea level. The top five countries by that metric were China, Egypt, Indonesia, the Philippines, and Russia.⁵⁶

Water scarcity and other water-related problems pose a risk to countries in all regions of the world, but South Asia, the Middle East, China, and northern Africa stand out across different studies.

What Is Being Done

The U.S. government, the private sector, nongovernmental organizations, and universities have all dedicated substantial efforts to understanding climate change broadly and global water security in particular.⁵⁷ But while the links between climate and security have received ample attention, the specific challenges associated with water have not.

In 2009, then President Barack Obama issued an executive order directing government agencies to integrate climate change into their planning. In 2016, he issued a similar memorandum focused more narrowly on climate change and national security.⁵⁸ The United States also championed the Paris Agreement, which coordinates efforts around the world on climate mitigation and will serve as a platform for discussion on how to adapt to climate change, where water concerns will loom large.

Climate change and related water issues have been incorporated into a variety of strategic documents produced by the intelligence community and the U.S. Department of Defense.⁵⁹ Prompted by a request from then Secretary of State Hillary Clinton, the March 2012 NIC report provides the most prominent analysis of the links between water and U.S. national security.⁶⁰ Water also featured prominently in a 2015 intelligence community report on food security.⁶¹ However, the responsibility for global water programs is fragmented across twenty U.S. government agencies, with most emphasis and resources dedicated to sanitation and hygiene. There have only been limited efforts dedicated to the wider strategic and institutional context that can affect the provision of and contestation over water.

Between 2007 and 2016, the State Department and USAID dedicated more than \$6 billion to water and sanitation issues in more than fifty countries.⁶² The Millennium Challenge Corporation, another development-focused institution, has invested \$2.2 billion in water, sanitation, and natural resource improvements in partner countries since 2004.⁶³ Most of this funding, however, is geared toward the provision of clean water and sanitation services, with limited attention and resources dedicated to water and security.⁶⁴

The State Department has a special coordinator for water resources in the Bureau of Oceans, Environment, and Science Affairs. Aaron Salzberg has held the position since it was created under the authority of the 2005 Senator Paul Simon Water for the Poor Act.⁶⁵ Salzberg coordinates a small team of seven and leads the Interagency Water Working Group that convenes once a month. The group has existed since 2001, waxing and waning in activity, and mostly serves as an information-sharing platform.⁶⁶ In the absence of a clear presidential signal that the relationship between water and security is important, individual agencies struggle to justify budgeting resources for such purposes, limiting the capacity for coordinated action. This was true for the Obama administration and could even be more relevant in the Donald J. Trump administration.

In 2016, USAID released a request for proposals for a new Sustainable Water Partnership with funding of \$65 million over five years, and the first of those partnerships was funded in fall 2016. Assuming the program continues during the Trump administration, this new partnership, geared around shoring up resilience to water security risks, could have more scope to invest in early warning and conflict resolution in important watersheds at risk around the world.⁶⁷

The Famine Early Warnings Systems Network (FEWSNET), which USAID has supported since 1985, already produces such forecasts for famine risk for a select number of countries, mostly but not exclusively in sub-Saharan Africa. FEWSNET forecasts changes in rainfall, agricultural production, markets and trade, and sociopolitical issues such as conflict and humanitarian response.⁶⁸ Data from this network and similar initiatives has helped anticipate and defuse humanitarian crises and potential conflicts.

The State Department's flagship food security initiative, Feed the Future, is also relevant, given the importance of water for irrigation. Launched in 2010, the \$3.5 billion initiative has supported climate-smart development, including experimentation with drought-resistant crops as well as efficient irrigation.⁶⁹

The Department of Defense has a variety of assets and capabilities relating to water and has assessed the implications of climate change, including water issues, for its operations. In addition, the Army Corps of Engineers provides technical assistance internationally.⁷⁰ The military is frequently called upon to provide humanitarian relief in the event of water-related emergencies, as in Operation Restore Hope in Somalia in 1992, after the 2010 floods in Pakistan, and after Typhoon Haiyan in the Philippines in 2013.⁷¹ The Pentagon and USAID also collaborated on rebuilding and extending water supply and purification infrastructure through Provincial Reconstruction Teams in Afghanistan and Iraq, though the security situation made it difficult to succeed with that mission.⁷²

The intelligence community has actively considered the implications of climate and water for security. In 2008, the NIC released a national intelligence assessment on climate and security.⁷³ The intelligence community also produced the 2012 NIC global water security report and the 2015 food security report, both of which were designed to shape U.S. government security planning in the coming decades.

One of the U.S. government's most important roles has been supporting academic and private sector institutions in developing data on the quality of water management institutions and on water scarcity. The Transboundary Freshwater Dispute Database (TFDD), a dataset on institutional strength in river basins, was supported by the U.S. Geological Survey, USAID, and other donors.⁷⁴ In addition, the U.S. government has also supported the consultancy firm ISciences in its development of models of global water scarcity. Since 2011, ISciences, through its Water Security Indicator Model, has monitored and offered periodic maps to forecast water anomalies on a global basis.⁷⁵ ISciences' work has informed external evaluations of climate and security including the 2008 study from Columbia University. In addition, ISciences has collaborated with the World Resources Institute to develop Aque-duct, the online atlas of global water risks. These and other resources can inform government planning and investment in the United States and abroad, making them a critical foundation on which to build subsequent efforts.

While the U.S. government has exerted ample energy and resources in prioritizing the wider threat of climate change, the specific and particular challenges associated with water and security lack sustained, coherent focus and funding. When water has received attention, the emphasis has focused narrowly on sanitation and hygiene. The U.S. government has not fully taken advantage of the capabilities of universities and the private sector to contribute to prevention, early-warning, and problem-solving efforts.

Recommendations

Global water security issues lack the visibility and resources needed to bring coherence to the diverse efforts of the U.S. government and wider civil society. The 2012 NIC report on water security provided high-level U.S. government attention to this issue, but that was only a beginning. While the agenda of water, sanitation, and hygiene (WASH) is well supported, the wider strategic opportunities for conflict prevention and protection of U.S. strategic interests related to water are not. To this end, the United States should consider the following policy options.

ENHANCE THE PRIORITY OF WATER AND SECURITY

Issue a National Security Decision Directive. The mandate for global water security issues could be strengthened with a paragraph in the National Security Strategy highlighting the importance of inter-agency coordination on water security.⁷⁶ More important would be a stand-alone national security decision directive on water and security. Like the 2016 presidential memorandum on climate change and national security, that decision directive could guide executive agency actions and be more prominent than a single paragraph in a wider text that covers many issues. This language would give executive branch agencies the mandate to dedicate resources to water and security that they currently lack.

Develop a World Water Security Strategy. A world water security strategy should be drafted that reflects on water risks, investment opportunities, and hotspots. It should be informed by outside analytical work from ISciences, TFDD, and other experts, analysis from the NIC, as well as State Department and USAID project implementers who can offer lessons from previous projects.

The 2012 NIC report was an important undertaking, but it lacked policy follow-through and will require periodic updating. The 2014 Water for the World Act mandated that the U.S. government develop a global water strategy by no later than October 2017 to evaluate how the administration intends to meet objectives for WASH, water management, and preventing and resolving water conflicts between and within states.⁷⁷ The Trump administration will inherit that task, but whether the strategy generally and water and security specifically receive sufficient attention hinges crucially on high-level presidential involvement.

In addition to an assessment of where assistance is most needed from a strategic perspective, the world water security strategy should evaluate the potential efficacy of different programs to increase the likelihood of success and minimize the possibility of doing more harm than good.⁷⁸

Devote More Resources to Water Issues. If this initiative is to receive the attention it deserves, additional financial and personnel resources are needed. The U.S. government has invested some funding toward understanding the security challenges associated with water, but it still lacks sufficient capabilities to monitor and analyze problems on a continuous basis or to coordinate an effective response.

The Interagency Water Working Group could potentially be a more visible and important vehicle for addressing water and security, but seven people in the State Department water office are not enough to coordinate the interagency system. The climate team at the State Department has thirty

people, not including negotiators, while one hundred thirty people work on energy. If water issues are to receive the priority they deserve, additional staff will be necessary. A substantial pool of resources—around \$100 million—should also be earmarked to enable productive cooperation among the twenty U.S. government agencies working on water issues and the many external organizations that can contribute to their efforts.

SUPPORT DATA COLLECTION, ANALYSIS, AND EARLY WARNING SYSTEMS

Expand Earth Science Data Collection. With the increasing availability of satellite data and other technologies, more is known about rainfall and groundwater levels across the world than ever before. However, countries affected by water and security problems often do not have access to that data or the trained staff to interpret it. Many countries lack adequate information about water supply, demand, and weather-related phenomena that can contribute to seasonal risks. Even the U.S. government lacks sufficient capabilities to make sense of the vast amounts of information that are increasingly available. As the World Bank concluded, “To protect the world’s poor against natural hazards, developing countries need to be better able to predict when they will occur. This means investing more in hydro-meteorological and early-warning systems, and putting the institutions in place which are capable of transforming a forecast into an actionable warning.”⁷⁹

The U.S. government has a variety of capabilities in this regard, such as satellite monitoring from the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and integrated famine assessments such as FEWSNET. The U.S. government has also supported private sector monitoring and forecasting such as the work by ISciences. Other units across the government periodically support complementary efforts. Early reports suggest the incoming administration might cut NASA’s monitoring capabilities related to earth sciences.⁸⁰ If anything, investments in those capabilities should be expanded, both in terms of data collection and dissemination, so that other countries can benefit from the information that the United States collects.

Increase Production of Dynamic Water Risk Maps. ISciences currently generates its forecasts on global water risks maps as a public service. It is unclear whether ISciences can continue to provide this service for free over the long-term from revenue from its other contracts. The U.S. government helped fund the creation of the model and could continue to support it for a modest amount of resources. One approach would be to endow the effort with grant resources to allow ISciences to update the risk maps and develop training modules indefinitely, following models such as U.S. government support for the United States Institute of Peace, Freedom House, and other organizations. A program to produce monthly maps of emergent risks would cost between \$300,000 and \$400,000 per year to be sustainable.

Crowdsource Stream Gauge Monitoring. While satellite monitoring can provide data on rainfall and model-driven forecasts can provide a measure of water balance and deficits, these often need to be paired with on-the-ground observations for accuracy. Unfortunately, in many developing countries, the number of stream gauges (devices that measure water volumes) has declined since the 1970s. However, the internet, cell phones, and GPS devices can make crowdsourcing information from citizen scientists possible.

Citizens with a cell phone and a stick can send photo evidence that can be used as rudimentary stream gauges. Whereas a World Meteorological Organization approved meteorological station might cost between \$70,000 and \$80,000, those for high-end hobbyists could cost between \$200 and \$500. This is an area where bulk buys and public-private partnerships could potentially generate equipment and training to facilitate collective action. One can envision on-the-ground testing equipment that plugs into a smartphone and enables evaluation of both water quantity and quality. Beverage and food companies, Silicon Valley companies, and other firms could generate positive public relations by supporting these activities.⁸¹ The United States should explore and encourage such partnerships.

INVEST IN INSTITUTION-BUILDING

Maintain Data on River Basins at Risk. Robust institutions are at the heart of conflict mitigation and resolution both within and between countries. Like the global risk maps for water deficits, it would be useful to identify the hotspots of concern where conflicts over transboundary rivers might escalate. According to the Transboundary Freshwater Dispute Database project, the two main criteria for identifying basins at risk include: whether there have been large or rapid changes in the physical or political setting (such as dam construction, an irrigation scheme, or territorial realignment) and whether the institutions to manage disputes are adequate.⁸² TFDD has periodically been updated as funding has allowed, but with more sustained U.S. government support, they could update their risk maps regularly and with increased frequency. Updating the maps semi-annually would cost approximately \$50,000 a year.

A similar assessment should also regularly be conducted for waterways and groundwater that do not cross borders, particularly for countries of strategic concern to the United States.

Invest in Capacity Building. Once the at-risk basins are identified, the State Department, USAID, and other entities should integrate that knowledge into their training and institution-building in at-risk regions and countries. A number of past U.S. efforts to support regional initiatives have succeeded. For example, between 2009 and 2013, USAID supported the Southern African Regional Environmental Program, which worked with the Okavango River Basin Water Commission to develop better geospatial awareness of potential water conflict flashpoints.⁸³ Despite the challenging political environment in the early 2000s, USAID also supported national and transboundary water management capabilities in the South Caucasus countries of Armenia, Azerbaijan, and Georgia.⁸⁴

In some cases, bilateral funding from other countries or multilateral finance could be more effective than direct U.S. funding, particularly in river basins where U.S. leadership and support might incur diplomatic backlash. In other situations, financial assistance could be channeled through NGOs.

The 1997 UN Convention on the Law of Non-Navigational Uses of International Watercourses, which entered into force in 2014, helps establish best practices for transboundary water management.⁸⁵ Unfortunately, it lacks enforcement powers and has limited buy-in from important countries; China, India, Russia, Turkey, and the United States have not ratified it.⁸⁶ Whether U.S. accession to the treaty would enhance the water and security agenda should be evaluated as part of the world water strategy.

The U.S. government should also take advantage of the expertise of multilateral organizations. The World Bank is a particularly important organization to support initiatives given the size of its lending

capacity and its operational expertise. The Global Environment Facility (GEF) is another organization with depth and experience in institution-building related to water. International water issues, one of GEF's six priority areas, includes topics such as transboundary water management. GEF dedicated about \$440 million in funding for international water issues between 2010 and 2014.⁸⁷

Support Standby Water Mediators and Develop an International Water Mediation Force. Periodically, water conflicts might appear to be headed toward violence. In identified areas at risk, the U.S. government should support standby water mediators—people with experience in water diplomacy who are available at short notice to travel to mediate disputes. USAID has supported capacity building through its Fostering Resolution of Water Resource Disputes project. However, since the United States will not be a welcome mediator in all conflicts, it should help create a visible international institutional home for such mediation. UN-Water is a possibility, though its resources and mandate are limited and would have to be expanded.

Another option is to support an informal network of water professionals, perhaps loosely affiliated with the Group of Seven, Group of Twenty, or European Union, who are ready and willing to serve in that capacity.⁸⁸ The United States could support such a network financially, through a multilateral effort or an initiative housed in a neutral location such as Stockholm.

Attempts by external mediators to support the resolution of water conflicts should recognize the history of previous attempts, not all of which have been successful. The United States should take care to support such endeavors only when situations are ripe for resolution.

SUPPORT PUBLIC-PRIVATE PARTNERSHIPS

Supply Partnerships. In a world of increased water scarcity and variability, new technologies will be required to increase water supplies, improve water conservation, and waterproof infrastructure from extreme events. The United States Water Partnership, a U.S.-led public-private partnership with more than one hundred members, is an important development, but its small staff means that it mostly serves a convening role. More operational public-private partnerships that benefit from significant public matching resources should be developed.⁸⁹

Dams that provide power and reservoirs for drinking water, irrigation, and other uses have come back into vogue among middle-income countries, but their downsides—high costs, siltation, evaporation, and political protest from resettlement—could reemerge as problems in coming years. The U.S. government, along with its partners, should work to minimize these risks where possible.

Other solutions to insufficient water supplies, such as desalinization, are expensive and energy-intensive. Technology partnerships with private sector actors to make desalinization cheaper and less energy-intensive could yield technical breakthroughs. The U.S. government, along with the World Bank and other institutions, can offer prizes and procurement contracts to developers that build better desalinization technology.

Support More Efficient Water Management. Water is often highly subsidized or delivered free to end users. Though this is popular among poor customers, wealthier beneficiaries often capture the lion's share of these benefits. Water trading and pricing are two strategies to incentivize conservation. Trading of water usage rights promotes more efficient use of water for more valuable ends but requires capable administration. Moreover, sustained access to water by the poor is a vital consideration. The

United States should work to avoid repeating the problems seen in the late 1990s, when the agenda to privatize water resources triggered a sometimes-violent backlash because equity concerns were not sufficiently addressed.

Increased use and support for technology standards in irrigation and drought-resistant crops might nudge farmers to adopt seeds and practices suited to a changing climate. The U.S. government can support the diffusion of more water-resistant varieties and efficient irrigation through research money, prizes, and procurement offers. Support for integrating these and other climate-focused agriculture efforts into domestic agricultural extension services should be considered through Feed the Future. Beyond this, the United States should seek to influence the World Bank to ensure that water management pricing systems are coupled with mechanisms to protect the poor's access to water, such as cash transfers and vouchers.

Waterproof Infrastructure. In the wake of Hurricane Sandy in 2012, the New York City government enacted a raft of building regulation reforms. Buildings in harm's way were required to make waterproofing improvements to prepare for future floods that might inundate ground floor structures. Around the world, cities should set similar standards to waterproof infrastructure. While physical impediments such as seawalls and dikes are popular, they are expensive and may not be sustainable. Restoration of marshes, wetlands, and other natural shock absorbers would be a cheaper and more sustainable strategy in many places. In addition, countries should discourage development of housing in vulnerable areas such as along riverbeds and creeks.

To this end, much as it has started to do at home, the United States should support efforts abroad to encourage risk reduction, particularly along coasts and flood plains. Through channels like the World Bank, governments around the world can be encouraged to adopt land management policies that discourage building in vulnerable areas. All U.S. government-supported investment finance or insurance for large infrastructure projects should anticipate future flood and storm risks and avoid the destruction of natural shock absorbers and invest in their restoration. The U.S. government can also work with private companies and groups such as the Nature Conservancy to support international conservation in support of flood and cyclone protection. Both bilateral and multilateral foreign assistance should support capacity building of regulatory systems at the national and municipal levels, as well as sister city exchange programs between urban areas that face similar risks.

Conclusion

Water will play an increasingly important and visible role in international security in the coming years. While conflict between and within countries is not inevitable, disputes among users of water will become more severe in a world of increased demand and diminished or variable supply. Domestic institutions that can effectively manage, allocate, and price water will be critical for efficient and fair water security within countries. Institutions that can effectively perform similar functions and resolve disputes internationally will be essential for transboundary waters. Situational awareness of emergent risks and hotspots for water stress is foundational for building sound institutions.

The provision of water can also be an important issue for countries coming out of conflict. Countries that have experienced civil wars have typically had major disruptions in basic services including water. Restoration of those services can be an important source of confidence and peace-building in war-torn societies as state institutions seek legitimacy. Moreover, progress on providing water for human consumption and agriculture can be a significant driver of economic growth and, in turn, prevent the reoccurrence of conflict.⁹⁰

The United States should be a leader in this arena, given its capabilities in water monitoring and river basin assessments as well as its significant investments in extending water access, improving sanitation, and assuring food security. However, success will require enhancing the capacity for and priority of the water security agenda inside the U.S. government. At the same time, the United States should incorporate a “do no harm” ethos of conflict sensitivity, lest this pulse of resources and attention bring about the exact problems interventions were designed to prevent.⁹¹

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