Troubled Waters

Climate Change, Hydropolitics, and Transboundary Resources

David Michel
Amit Pandya
Editors

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The Henry L. Stimson Center
1111 19th Street, NW, 12th Floor
Washington, DC 20036
Telephone: 202.223.5956
Fax: 202.238.9604
www.stimson.org

A River Runs Through It: Climate Change, Security Challenges, and Shared Water Resources

David Michel

Global climate change threatens to significantly affect water resources worldwide. Continuing global warming will accelerate the Earth's hydrologic cycle, increasing both precipitation and evaporation and impinging on fundamental hydrometeorological mechanisms. Mounting global temperatures will augment melting of the polar and alpine glaciers that contain the bulk of the planet's fresh water. Elemental patterns and processes such as the seasonality of rainfall and snowfall, the onset of the monsoon, and the recurrence of El Niño–Southern Oscillation (ENSO) phenomena may shift or falter. Extreme climate events will increase in frequency and degree at both ends of the spectrum, with flash floods and deep droughts, intense storms, and searing heat waves becoming more numerous and more severe.

The world's river systems, crucial to global water supplies, will particularly bear the repercussions of growing climate pressures. Altered precipitation patterns and increased melting of mountain glaciers will disrupt the upstream sources that nourish river waters. Changing stream flows risk upsetting the timing, quantity, and quality of freshwater resources available to communities and ecosystems around the world. According to one recent study, by 2050, human-induced climate change will affect river discharge in every populated basin on the planet.[1] In much of the world, shifting freshwater availability will collide with increasing demand. The Organisation for Economic Co-operation and Development (OECD) calculates that by 2030 some 3.9 billion people—47 percent of the global population—will be living in areas with high water stress, mostly in developing countries.[2]

To many observers, such figures presage potentially serious shortfalls between rising demands and future water supplies, shortfalls that could spark dangerous conflicts. Water is life. It is essential for drinking and for growing food. If climate change alters the amount or distribution of this vital resource, water-dependent societies could suffer considerable consequences. Greenhouse-driven changes in river flows risk rippling through connected systems, touching farming, fisheries, and forestry, sanitation works, and hydropower generation.

Insufficient water supplies can impair agricultural production, endanger public health, strain established settlement patterns, and jeopardize livelihoods and social well-being. Where different countries (e.g., upstream and downstream) or different communities (e.g., rural and urban) share the same river, worsening climate pressures could engender sharpened competition or even violent confrontations to secure an increasingly scare resource. Policymakers, pundits, and the popular press alike have openly worried that the coming century could witness the eruption of outright "water wars."

Closer inspection of global hydropolitics, however, suggests that the more hyperbolic warnings of looming water wars are overblown. From local streams to international rivers, riparians seem more often to find opportunities for a cooperative *modus vivendi* than the seeds of a *casus belli* in shared water resources. No modern state has ever declared war on another solely over water. Indeed, by all historical accounts, the only such water war ever fought occurred over four millennia ago.

Nevertheless, open warfare between nation states is not the only threat to peace and prosperity posed by climate impacts on common waters. Rising stresses on freshwater supplies could fuel tensions within states as well as between them and will put new pressures on cooperative institutions from the local to the international. A reexamination of the human security issues arising at the intersection of global warming and global water can illuminate where the likely flashpoints lie and guide policymakers striving to keep the coming four millennia free of water wars.

Climate Impacts on River Systems

Climate-related changes in river flows stem principally from changes in the volume, timing, and form of precipitation (whether it falls as rain or snow). Globally, the Intergovernmental Panel on Climate Change (IPCC) projects that both annual mean precipitation and the number of heavy precipitation events will rise over the course of the 21st century. Glaciers and snow cover will contract as temperatures mount. Within these global tendencies, however, regional trends will vary considerably. Comparisons of multiple computer models suggest that precipitation will increase in the higher latitudes of both the northern and southern hemispheres, in Eastern Africa, and in much of Asia, but will decrease significantly across Central America and the Caribbean, as well as throughout the Mediterranean, Middle East, and North Africa. Even so, while precipitation will wax in some regions and wane in others, the total global land area subject to increasing water stress will double by midcentury. Extreme hydrological events, storms, floods, and droughts are also projected to increase. Ironically, because precipitation will be concentrated in more intense events, some basins could see both periods of heavy rainfall, high runoff, and increased flood risk interspersed with longer and more severe dry spells. Similarly, even where increased river

runoff from greater rainfalls or enhanced glacier melting will boost total water supply, the benefit may be offset by higher variability in seasonal availability and higher flood risks.[3]

The populations living along many major river systems in the developing world could prove especially vulnerable to such pressures on water supply. In the Nile Basin, Egypt receives 95 percent of its water resources from abroad and Sudan, 77 percent. Fully 86 percent of the Nile waters on which these countries rely originally flow from the Ethiopian Highlands, where the single June-to-September rainy season appears susceptible to potential changes in ENSO cycles. In South Asia, glacial melt from the Himalayan region comprises 9.1 percent of the Ganges river flow, 12.3 percent of the Brahmaputra, and 44.8 percent of the Indus. Himalayan glaciers, in turn, are retreating more rapidly than anywhere else in the world. Initially this melting will feed greater river runoff. As the glaciers recede, runoff will decline, with potentially dire consequences for riparians reliant on the previous levels of river flow. Around the world, major river deltas will be among the most exposed of all areas to climate change. Many exhibit high vulnerability both to river flooding and to sea-level rise and storm surges. Indeed, higher river flows can exacerbate the local impacts of sea-level rise and storm surges in the delta as incoming ocean water piles up over outflowing fresh water. By one calculation, perhaps 3 million people altogether could be displaced by climate-induced coastal flooding in the Nile, Ganges-Brahmaputra, and Mekong Deltas by 2050.[4]

Climate impacts on river basins will influence individual tributaries, communities, and water consumers at local scales as well. Within regions, climatic and geographic circumstance subject different countries along the same waterway to disparate hazards. One study prepared to inform preparation of India's national climate policy examined greenhouse scenarios for multiple subbasins of the Ganges River. It projected that precipitation might jump over 50 percent in some areas while falling 10 percent or more in neighboring zones. The number of anticipated drought events afflicting certain subbasins leapt fivefold in some places while plunging by the same order of magnitude in others.[5]

Even so, the specific ramifications of growing greenhouse warming for individual river basins remain difficult to discern. Existing studies concentrate heavily on North America, Europe, and Australasia. Only a handful of analyses have been brought to bear on key systems outside these regions such as the Mekong, the Ganges-Brahmaputra, the Indus, or the Nile. These efforts often deliver disparate results. An examination of the Nile Basin found that the present uncertainties surrounding future rainfall patterns and water management structures precluded any clear indication of climate change effects on Nile river flows. Similarly, current model forecasts of greenhouse repercussions for South Asian rivers disagree whether runoff will increase or decrease.[6] Uncertainty about future water resources as much as projections of potential variability and extremes complicate water managers' efforts to prepare for climate change.

Water Resources and Security Threats

Concerns that climate change could ultimately undermine global order have grown markedly in recent years, but they are not new. In the early 1970s, unusually difficult weather struck many parts of the globe. The Mediterranean Middle East suffered the severest drought of the century. In 1972 Moscow sweltered under its hottest summer ever recorded. As Russia's breadbasket east of the Urals struggled through the driest months in 100 years, the USSR bought 30 million tons of grain on the world markets, including 18 million tons from the United States, to make up the shortfalls. In Africa, 1973 delivered a fifth straight year of drought to the Sahel region, parching pasturelands, drying up rivers and wells, and leaving 100,000 dead.[7] This string of weather-related disasters raised fears that the world's food stocks could prove dangerously vulnerable to repeated climate catastrophes. A Central Intelligence Agency (CIA) analysis of the time suggested that, in the worst case, where climate change caused grave shortages of food despite US exports, hungry but militarily powerful nations could make desperate attempts to get more grain any way they could. Massive migration backed by force might spread, and nuclear blackmail was not inconceivable.[8]

Since that time, the worsening risk of global warming has engendered growing public and policy preoccupation with potential climate impacts on water security. In 1991, then–UN secretary general Boutros Boutros-Ghali famously pronounced that "the next war will be fought over water, not politics." His successors have evinced similar worries. In 2001, Kofi Annan warned that "fierce competition for fresh water may well become a source of conflict and wars in the future." And current secretary general Ban Ki-Moon has argued that the ongoing Darfur crisis "grew at least in part from desertification, ecological degradation, and a scarcity of resources, foremost among them water."[9] Accompanying this chorus of concern, numerous policy scholars as well have asserted that, as population growth and economic development raise pressures on demand and environmental pressures degrade supplies, resource scarcities could precipitate violent international conflicts, with shared rivers an especially dangerous flashpoint.[10]

From the speeches of international civil servants and the pages of academic journals, the argument that water and other resource conflicts, exacerbated by global warming, could undermine the international order has taken root in public policy and the public mind. The European Union explicitly invokes the danger that climate stresses could menace global security as a basis for European Community climate policies.[11] When the UN Security Council held its first-ever meeting on the greenhouse threat to international peace, 55 nations lined up to address the session.[12] Growing apprehension that unchecked global warming could potentially push environmental and social systems over a precipice is perhaps nowhere better illustrated than by the *Bulletin of the Atomic Scientists*. For six decades, throughout the Cold War and beyond, the bulletin's "Doomsday Clock" has served as an iconic indicator of modern society skirting the edge of momentous thresholds for global welfare.

Historically, it measured the danger of nuclear war. At the beginning of 2007, however, the clock advanced two minutes, closer to the fateful stroke of 12:00 than at any time since the height of the 1980s arms race, in large part due to the rising risk of climate change. In the eyes of the bulletin's directors and sponsors, including 18 Nobel laureates, it is now five minutes to midnight.[13]

Water Wars?

Responding to this rising tide of alarm, a number of water policy analysts have moved to evaluate the risk of prospective water wars against the historical evidence. Combing through data sets covering 124 countries and 122 of the world's 265 international river basins, a group of scholars surrounding Aaron Wolf at Oregon State University identified 1,831 interstate events between 1946 and 1999 that concerned water. Cooperation, they discovered, far outweighed confrontation, representing 67 percent of events. Of 507 incidents judged conflictual, 414 amounted to only rhetorical exchanges. In all, they found 37 instances of military or violent confrontation. In no case did disputes over water lead to formal declarations of war. On the contrary, riparians in transboundary basins signed fully 157 international freshwater treaties over the same period.[14]

In contrast to the often anecdotal or at best case study–based assertions advanced about impending international water conflict, Wolf et al. provide a more global and rigorously quantitative corrective. Their work is widely cited to deflate anxious claims that strains on water supplies will ignite future water wars and to highlight the predominantly collaborative character of interstate hydropolitics.[15] Yet, there are several reasons to fear that previous levels of international cooperation will not necessarily continue to prevail.

First, although when tallied as individual events, examples of cooperation considerably outnumber cases of conflict, this tote-board accounting may not accurately describe the dynamic degree of tension over water resources that riparians experience. In relations among nations, governments and publics may deem 1 exchange of gunshots much more telling than 10 exchanges of friendly communiqués. Indeed, that many hostile actions occurred in basins covered by official treaties bears out that even formal cooperative agreements by no means preclude states coming to blows. That no state formally declared war on another over water carries almost no probative value. The fact is that throughout the entire second half of the 20th century (1950–2000), there were only two formally declared wars for any reason anywhere in the world.[16] By the same token, security strategists and policy planners attempting to gauge the danger that rows about resources could escalate to war may judge the disclosure that water issues contributed to "only"[17] 37 violent incidents —including 21 examples of "Extensive war acts causing deaths, dislocation, or high strategic cost"[18]—to be less than reassuring. If this is already so, they might well wonder, what will happen if climate change aggravates existing strains on shared water supplies?

To be sure, students of water politics who emphasize the relative absence of violent encounters in the empirical record also clearly acknowledge that "The future of transboundary water conflict may not look like the past."[19] But there is also some question as to how much the past looks like the past. That is to say, the historical view recounted by Wolf and his colleagues may not fully reflect the role of water discord in interstate conflicts. Their assessment demonstrates that, across all water interactions among states inhabiting the same basin, cooperative instances predominated over clashes and riparians rattled sabers much more than they crossed swords. This approach shows states collaborate more *often* than they fight, but it does not address whether or not frictions over shared waters make the risk of violent confrontations more *likely*. Here, some other expeditions into the hydropolitical archives offer more troubling evidence. In an extensive statistical study, Gleditsch et al. examined every transboundary river in every one of the world's international river basins from 1880 to 2001. They determined that, even after accounting for other factors that trigger interstate conflict, countries that share a river face a higher probability of engaging in fatal military disputes. Though not conclusive, their results also suggested that competition stemming from water scarcity may help explain this propensity.[20] Similarly, Hensel and Brochmann reviewed the management of every shared river in the Americas, Western Europe, and the Middle East from 1900 to 2001. Their investigation indicated that growing water demands and greater scarcity both make explicit disagreements over rivers more likely and heighten the risk that these claims will become militarized.[21]

Other scholars have criticized historical arguments that divide transboundary water relations into so many discrete and static incidents, each instance then designated either collaborative or contentious. These analysts maintain that conflict and cooperation quite often coexist, embedded in more complex interactions. Qualifying international water politics by scoring events on a unidimensional conflict/cooperation axis misses the importance of this broader, multifaceted context. Crucially, it may obscure how many nominally collaborative acts can in fact serve to ignore, evade, exacerbate, or entrench contentious underlying issues. Rather than mitigate potential conflicts, such cooperation may sustain them. So, for example, focusing on small-bore scientific cooperation between Bangladesh and India sharing data on the Ganges masks the degree to which underpinning issues continue to fester unresolved, stoking enduring tensions. So too, formal legal instruments such as the 1929 and 1959 Nile Treaties represent the summit of international water cooperation. Yet those accords also enshrine an extraordinarily lopsided allocation of the river. Egypt and Sudan receive an absolute right to use 100 percent of the Nile waters, roughly 75 percent to Egypt and 25 percent to Sudan. The eight other basin states receive nothing, a distribution they increasingly contest.

"Not all cooperation is pretty" write Zeitoun and Mirumachi on the many visages of water politics.[22] Some is downright ugly. Some may affirm asymmetries of power among riparians. Some may codify coercion. Surveying the distribution of transboundary flows between

Israel and Palestine (giving 90 percent of the water to Israel), and the Israeli-Palestine Joint Water Committee procedures for licensing projects within Palestine (giving Israel an effective veto over works judged to threaten state interests), one observer labeled the arrangements not cooperation, but "domination dressed up as cooperation."[23] Hydropolitics is still politics. Thus, like all politics, it is, in the classic definition of Harold Lasswell, a question of who gets what, when, and how.[24] The simple quantity of transboundary water cooperation must not blind analysis to its quality, what exactly it entails, and how it comes about.

Civil War, Civic Unrest

Wolf and his fellows countered deterministic claims of impending water wars by delving into the chronicles of interstate hostilities. Many of the more recent analyses, concerned that climate pressures on water supplies and other resources could spark combustible conflicts among states, however, also worry that the same stresses could kindle potentially violent turmoil within them.[25] Civil conflicts can be as destructive as international ones. By one estimate, internal wars have killed three times more people than interstate conflict since World War II.[26] They are also far more common. By one count, 95 percent of all conflicts over the past decade have occurred within states, not between them.[27] And civil wars can be as destabilizing to global order as international ones. States racked by civil war are far more likely to become embroiled in militarized conflicts with their neighbors. Whether the fighting remains confined inside one state, the disruptive repercussions typically do not. All too often civil wars draw in combatants from surrounding countries to support one side or the other, protect endangered interests or compatriots, or take advantage of the neighbor's distress.[28]

Regrettably, swings in climatic conditions seem already to be contributing to such intrastate conflagrations. A 2004 study of 41 African nations determined that wherever drought precipitated a 5 percent drop in GDP growth one year, the likelihood that country would fall into civil war the next increased by more than half. Worrisomely, this relation held whether the countries in question were richer or poorer, democratically or undemocratically governed, ethnically divided or not.[29] More recently, an assessment of all civil wars since 1975 showed that, where rainfall deviates significantly below the normal in one year, the risk that a high-intensity internal war will break out the following year jumps substantially.[30]

Yet armed clashes to secure scarce resources, whether waged among states or between governments and insurgent groups, are not the only greenhouse threat to domestic order and international stability. Some climate impacts could kill or imperil large numbers of people, placing severe pressures on exposed populations and civil institutions. Droughts could weaken agricultural production, diminishing food supplies, raising prices, perhaps inciting hoarding or "bread" riots. Floods could destroy infrastructure and inundate settlements, depriving victims of sustenance, their homes, and their livelihoods. The weight of

such strains may exceed the ability of some societies to adapt, fostering civic disturbances and possible political unrest. "Many developing countries do not have the government and social infrastructures in place to cope with the types of stressors that could be brought on by climate change," concluded a review by former senior American military officers. And "When a government can no longer deliver services to its people…conditions are ripe for turmoil."[31] Here too, available evidence suggests the risks are real. A study of 187 states and territories covering the second half of the 20th century found that the danger of violent civil conflict increased markedly following climate-related disasters, the risk rising with the number of events suffered in a given year.[32]

In a globalizing world, such woes will not necessarily stay put. Potential climate catastrophes could both displace victims across borders and draw interventions from abroad. As the UN High Commissioner for Refugees points out, mobility and migration represent crucial coping and survival strategies for the victims of natural disasters and humanitarian crises.[33] On one oft-cited estimate, floods, droughts, and rising sea levels could generate 200 million climate refugees by 2050. At present, such projections represent no more than best-guess extrapolations, highly sensitive to underlying assumptions and classifications defining who counts as an "environmental" refugee. Multiple factors drive human migration, but empirical studies suggest climate pressures could play an increasing role. Fieldwork on flooding in the Mekong Delta, for instance, has found through questionnaires of Vietnamese migrants in Cambodia that half the respondents had decided to migrate in part because of environmental problems.[34]

While emigration may permit the victims some escape from environmental stresses, it can create new sources of conflict in the destination states.[35] Refugees displaced directly by environmental disaster can place heavy burdens on the natural resource base and the social and economic capacities of the host communities. Their presence may stir social tensions. In Bangladesh, for example, migrants from the flood-prone plains have been met by occasionally violent opposition both in the Chittagong Hill tracts and over the frontier in the northeast Indian region of Assam. Indeed, India continues to pursue a long-standing project of fencing off the border, erecting along the Brahmaputra a barrier itself constructed to withstand storms and floods.[36] Migrants dislocated by civil strife at home can pose additional challenges for receiving countries. Voluntarily or involuntarily, they may bring the conflict with them. They may be recruited into combatant factions; their settlements may become targets or bases for the contending parties.

While climate change may fire the engines of environmental migration, many outlets for such refugees are narrowing. As international migration of all kinds has surged in recent years, more than doubling from 75 million in 1960 to 191 million in 2005, governments around the world increasingly deem migration—particularly unauthorized or mass

population movements—a security issue. Many states now exhibit a growing willingness to "militarize" their responses, deploying military force to halt or control migratory flows.[37] Some analyses contend that developed countries may come under growing pressure to admit swelling numbers of environmental refugees. Most international refugees from natural disasters, though, move no further than neighboring countries. Developed countries worried about the potentially destabilizing effects of climate refugees, then, seem more likely to intervene with relief and reconstruction efforts on the ground than with asylum offered from afar. In the first instance, it will be the neighbors—the probable receiving states—and regional powers that will feel most compelled to step in to avert incipient humanitarian catastrophes or contain widening conflicts.

Unfortunately, ample indications testify to the social stresses global warming is already exerting. In the last 30 years, weather-related hydrometeorological disasters of all kinds—floods, droughts, windstorms, hurricanes, etc.—have quadrupled, surging from 428 in 1974–78, to 817 in 1984–88, to 1,707 in 1999–2003.[38] According to the reinsurance giant Munich Re, great natural catastrophes—those that overwhelm local recovery capacities, requiring interregional or international assistance—have almost tripled since the mid-20th century, jumping from 21 in 1950–59 to 57 in 1996–2005. Economic losses from these calamities have multiplied 12-fold, from US$48.1 billion (2005 values) in the 1950s to US$575.2 billion over the 10 years ending in 2005.[39] Worse has been the human toll. Between 1990 and 1999, an annual average of 188 million people worldwide lost their homes, livelihoods, health, crops, or livestock for some time due to natural disasters, six times the 31 million per year similarly harmed by armed conflicts.[40] In 1998 alone, the Red Cross calculates, 25 million people, or 58 percent of all the world's displaced persons, were refugees fleeing environmental catastrophes.[41]

Climate Pressures on Cooperative Water Management

History is filled with examples of water conflicts. Peter Gleick maintains a Water Conflict Chronology database detailing hundreds of incidents stretching back to 2500 BC.[42] Yet cooperation over shared water resources certainly holds an equally ancient pedigree. Though not traceable to Sumerian antiquity, the world's oldest international water agreement, a grant of freedom of navigation by Emperor Charlemagne to a monastery, appears to date from 805.[43] And where lethal clashes have occasionally erupted despite the existence of mutual agreements, cooperative relations have persisted even through open hostilities. India and Pakistan, for example, have fought two wars since concluding the Indus Waters Treaty in 1960, but have never once broken that accord.

Students of transboundary water resources have identified two key variables that define the likelihood and intensity of water conflict in a given river basin. The first is the amount

and rate of physical or institutional change in the water system covered. The second is the strength of the cooperative institutions linking the riparians.[44] Global warming will place unprecedented pressures on both.

Rising Physical Pressures

Climate change will contribute to dramatic alterations in the physical parameters of the water regime prevailing in many rivers. Almost a billion people now live in areas projected to experience a swing in river flow of 40 percent or more, and 365 million inhabit basins where river discharge could shift by upwards of 90 percent by midcentury.[45] Even where mean annual river flows remain closer to their current levels, seasonal variations could disrupt existing ecological patterns and upset socioeconomic structures reliant upon them. The Mekong River offers a case in point. Maximum monthly flows in the basin are expected to grow some 35 percent by 2038, while minimum monthly flows will shrink 17 percent. In other words, both flood risks in the wet season and water shortage in the dry season are projected to become more severe. One study of 16 large basins around the world found that, under one strong warming scenario, flood levels that previously occurred only once a century might recur as frequently as every two to five years. Droughts could similarly intensify. According to one model study, the proportion of the global land surface suffering extreme drought at any one time could jump 10- to 30-fold by 2090; the frequency of extreme drought events could double, and their mean duration increase sixfold. Another multimodel test projected that droughts in the mid-latitudes and northern subtropics could expand the land area experiencing extreme drought from 1 percent at any given time to 30 percent by 2100.

Climate pressures on water supplies may be even worse than projected. Forecast levels of water stress and water shortage build on projections of greenhouse gas (GHG) concentrations from greenhouse emissions and on calculations of the global warming that would then result. At present, the IPCC estimates that doubling the amount of carbon dioxide in the atmosphere—the customary yardstick for measuring climate sensitivity—would boost global average surface temperatures between 1.5°C and 4.5°C. If climate sensitivity to rising carbon dioxide levels is 1.5°C, then atmospheric carbon concentrations could almost double from today's amounts before global warming would cross 2°C above preindustrial levels, the threshold that many climatologists consider dangerous. But if climate sensitivity is 4.5°C, then carbon concentrations would have to be held to today's levels and all greenhouse emissions essentially eliminated by 2050 to keep humanity within the 2°C warming limit. Recent work, however, suggests the possibility that GHG concentrations could generate significantly more warming than previously believed. Although not likely, climate sensitivity may fall completely outside the IPCC estimate range and might reach as high as 10°C or more.[46] If so, the consequences for the global hydrological regime could

be catastrophic. Yet analyses of the emissions pathways that would be necessary to restrain GHG accumulations within the 2°C guardrail, even assuming lower climate sensitivity, show the increasing improbability of realizing such radical reductions in greenhouse pollution.[47]

Cooperative Institutions

By the same token, existing cooperative institutions may have difficulty grappling with the challenges posed by climate change. Addressing greenhouse pressures on common water resources, water policy experts commonly agree, calls for "integrated water management" techniques approaching river basins as a whole and encompassing all the demands on the river waters from human uses to maintaining natural ecosystems. Many current cooperative arrangements, however, are not particularly well adapted to such strategies. Policymakers must think across national and institutional boundaries if they are to think through growing relations of interdependence. Neither administrative jurisdictions nor bureaucratic remits correspond to ecological zones or environmental functions. Water policy in particular must appreciate that water resources are never fixed. Water is always part of the hydrological cycle and part of an ecosystem from which it is diverted or withdrawn. As such, policymakers must develop more holistic approaches to managing shared water resources, integrating the needs of different users—including ecosystems—evolving over time. This is now infrequently the case.

Decision-making power is asymmetric and information scattered among riparian states. Actions taken by countries upriver, such as constructing dams or drawing off water for irrigation, can hold significant ramifications for those downriver. Knowledge of water balances in specific tributaries or water demands in specific communities is spread unevenly among multiple entities across multiple countries. Within riparian states, responsibilities for different aspects of climate, water, and development policies are typically divided, with different institutions and authorities serving different constituencies and objectives. Different stakeholders perceive different problems and priorities.

Despite the possible rewards, international cooperation must surmount numerous political and institutional hurdles. Though transboundary water resource management offers positive cooperative opportunities, it also presents potential conflictual pitfalls. Collaboration aims to deliver mutual gains. A logic of "benefit sharing" could catalyze greater cooperation among riparian countries.[48] Many international agreements divide river waters into designated allotments for each party. As global warming threatens to upset transnational river flows, such quota systems risk spawning a zero-sum and potentially contentious dynamic. Benefit sharing strives to build cooperation around creating mutual advantages (e.g., food security, flood control, power generation) that profit all parties together or each in turn—sharing gains rather than sharing water. But most cooperative climate and water

policies necessitate substantial up-front costs that may only pay off over time. Before states can aspire to collective "benefit sharing" they must contrive to share out the price of collaboration that each will bear, a less appealing exercise.

The prospective fruits of cooperation can also prove problematic. Often, implicated stakeholders may feel that their interests do not figure in the ostensibly shared benefits. In the Mekong Basin, many riparian communities have long contested the construction of large dams intended to deliver the benefits of hydropower generation, arguing that the state pursues these projects without regard to the detrimental repercussions for the river environment and for their livelihoods.[49] Even the simple benefit of shared information can nurture mutual understanding, but it can also breed mutual antagonism. For downstream riparians, data detailing flows upriver can disclose how much water their more advantageously placed neighbors are diverting for their own use. Revealingly, while the ministries of the South Asian Association for Regional Cooperation (SAARC) recently agreed to share meteorological information, they declined to share hydrological data.

Intergovernmental organizations can bring shortcomings of their own to cooperative endeavors. Bilateral and multilateral institutions established to further cooperation can perpetuate the ingrained controversies and power imbalances that characterize their member states. The 1929 Nile Treaty which still governs aspects of water use in the Nile Basin is a colonial artifact dating from a period when Britain ruled most of the upstream riparians.[50] While river basin or regional associations may aspire to play the honest broker, ultimately they can only achieve as much or as little as their members allow. The existence of multiple institutional arenas can complicate as well as facilitate concerted policy formation. Domestically, different ministries often compete to take the lead on climate policy development in different international settings, hampering national coordination. Internationally, significant actors are often absent from important institutions. Though it is the upstream riparian, China holds only observer status in the Mekong River Commission. In the SAARC, foreign ministries overshadow generally feeble environmental agencies. To date, declarations, not deeds, dominate the association's environmental accomplishments. Institutional cultures as well as institutional structures may advance or confound international cooperation. Institutions have their own agendas, audiences, and objectives. They may succumb to bureaucratic overreach or bureaucratic inertia. They are not mere automata blankly awaiting government instruction.

Climate Security as Policy Outlook

Policy communities in the developed and developing nations alike perceive climate change as a prospective security threat. Yet developing country experts conceive the nature of this threat quite differently. Developed country policy analyses typically cast climate security as a question of *international* stability. In this view, greenhouse impacts striking one

country may spread risks to others, generating political frictions and possibly violent confrontation. Thus, global warming could diminish water supplies or food production, sharpening competition for scarce natural resources. Or refugees fleeing flooding or drought might spill into neighboring states, straining local capacities and sparking civil strife. Other countries might be drawn in, looking to avert destabilizing humanitarian catastrophes or contain widening conflicts.

For many developing states, however, climate change imperils their *national* security, even their national survival. Rather than reverberating from abroad, greenhouse impacts directly endanger their societies at home, threatening loss of life, loss of livelihoods, loss of property, and loss of territory (to sea-level rise). Serious climate security risks do not just emanate *from* developing countries, they happen *to* developing countries. Developed nations frame climate insecurity as a potential hazard exported from the developing world. In marked contrast, developing nations see climate insecurity as a present danger imposed upon them by decades of unabated greenhouse emissions in the developed world.

Similarly, focusing on the potential "hard" security threats posed by climate change detracts attention from the ongoing threat to "human" security experienced by millions of the poorest and most vulnerable in the developing world who lack adequate water supplies. Insufficient quantity and quality of freshwater resources strike much harder at the lives and livelihoods of developing country populations than any security reverberations from water wars that are likely to hit their developed neighbors. An estimated 2.6 billion people worldwide still lack improved sanitation facilities. And 3 million people in developing countries die each year from waterborne diseases, most of them children.[51] Climate change pressures on water supplies may make cutting these figures more difficult. Yet these very real water supply issues certainly pose a greater threat to the safety and well-being of more people than the as-yet-unrealized risk of future water wars.

Nevertheless, as a matter of political motivation, growing recognition of the potential security challenges presented by unchecked global warming gives policymakers powerful additional reason to enact effective greenhouse mitigation measures. Yet framing climate change as a looming risk to international stability holds important hazards of its own. First among these is the danger that focusing states' attention on the climate security risks to themselves could deflect energy and resources away from necessary cooperation with others. Countries concerned that climate stresses could ignite domestic strife may hoard relief supplies rather than assist stricken neighbors. States worried that climate migrants from abroad could cause civil turmoil at home may close their borders to refugees fleeing greenhouse impacts. Nations anxious that global warming could trigger struggles over scarce natural resources may move preemptively to control their supply. "How people define a problem," former diplomat Harold Saunders points out, "begins to determine what

they will do about it."[52] Without due care, emphasizing the very real security risks raised by climate change could lead fearful governments to take adversarial actions that would aggravate the very international antagonisms that both greenhouse and security policymakers hope to avoid.

Less likely but no less troublingly, excessive focus on climate security risks deforming not only the effective content of countries' particular policies but the very nature of some governments' response to the greenhouse problem. Numerous analyses of the climate security threat have noted the danger that global warming's impacts could simply overwhelm the coping abilities of many states. Dissatisfaction with government responses or disputes over distribution of disaster assistance could then spark potentially violent confrontations. For many of the most vulnerable states, the possible consequences for national stability could prove calamitous. At the same time, many of the countries most vulnerable to climate impacts have weak or troubled state and civil institutions. As a practical matter, these nations cannot rapidly or readily improve their governing capacities to deal with extreme climate stresses. Should they come to view global warming primarily through a security lens, when greenhouse impacts strike, these states may feel compelled first to deploy their military and security apparatus to head off dangerous civil conflict. The problem risks being all the more acute in ethnically or religiously divided societies where a drought, flood, or other natural disaster may afflict one group more than another. By the same token, these same considerations may lead neighboring countries to look upon these more greenhouse-vulnerable states principally as sources of regional instability—and so as candidates for military intervention or quarantine as much or more than for disaster relief and reconstruction. The increasing awareness of global warming's global security implications can provide a strong incentive for international cooperation to meet the climate change threat. But these issues must be carefully and collaboratively addressed if they are not to furnish instead a new inducement to international conflict.

Conclusion

Global climate change will significantly affect the hydrological cycles that nourish the world's major river systems. Potential shifts in the availability and distribution of shared freshwater supplies could engender conflicts among countries and communities over the management of this essential resource. Contrary to the claims of some commentators, these disputes will not likely spark open warfare over water. Rather than engage in battle to secure water sources, states have far more often engaged in negotiations to hash out cooperative agreements for managing common water supplies. Global warming heightens the need for such cooperation. Climate pressures ignore borders. In a warming world, water managers must similarly formulate integrated policies at ecosystemic and river basin levels that cross political boundaries.

Many water experts have rightly argued that riparian nations have very largely succeeded in controlling competition and conflict over shared resources by establishing cooperative international institutions. These institutions have already prevented or defused many potential water conflicts in transboundary basins. Many have survived and perhaps even helped alleviate extreme interstate hostilities. Yet as climate change renders basin-level water management increasingly important, many transboundary river systems lack the necessary institutional structures. In some cases, some riparians do not participate in the relevant accords. In others, some nations are reluctant to relinquish national policy prerogatives to "integrated" management. And some basins have no cooperative institutional mechanisms in place at all.

Identifying and acknowledging the wealth and resilience of cooperative arrangements governing transboundary rivers furnishes a valuable counterweight to undue apprehensions about looming water wars. Recognizing these successes, however, must not keep policymakers from identifying and acknowledging the potential dangers to international stability that climate-fueled pressures on water supplies still pose. These include natural catastrophes and civil conflicts within states that could both displace refugees into surrounding countries or draw in neighbors, or regional or global powers seeking to avert humanitarian disaster or contain conflict and prevent unrest from spreading.

Assessing the prospective security risks raised by climate change requires gauging the balance between cooperative opportunities and possible drivers of conflict. The potential stakes for global security could be considerable. The need to reach these judgments, however, must not push decision makers to overprivilege security concerns in formulating climate strategies or water policies. Just as transboundary water resource management increasingly requires holistic strategies, integrating competing demands across contending uses, so crafting effective climate policy will require broad collaboration engaging multiple parties in reconciling myriad pressures and perspectives for global greenhouse governance.

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