EPICENTERS OF CLIMATE AND SECURITY: THE NEW GEOSTRATEGIC LANDSCAPE OF THE ANTHROPOCENE

June 2017

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THE CENTER FOR CLIMATE AND SECURITY

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Water Towers: Security Risks in a Changing Climate

Troy Sternberg[1]

Since the Boutros Boutros Ghali, then Secretary General of the United Nations stated that the next war in the Middle East will be over water, not politics, the global community has focused on water flashpoints, particularly in the Middle East.[2] But examining micro- to meso-scale dynamics has confined thinking to rivers, aquifers and watersheds at national levels. While important, discussion has often ignored the mega-scale threat of human and climate changes[3] to the world's mountain 'water towers' [4] and the resultant implications to security and human well-being. For example: two billion people depend on water originating on the Tibetan Plateau[5]. Hundreds of millions more drink from global water towers, including the massive Andes, Rockies, Tien Shan, Caucasus and Alps to the more modest Ethiopian and Guinean Highlands. In each, climate change affects glaciers, water resources and runoff[6]. If it were only a matter of harnessing water from a nation's territorial mountain, the issue would be structural; the complication comes when water flows through several states. Riparian nations stress natural, human and economic rights to water that crosses their realm, yet without physical control, states remain vulnerable to upstream users. This gives a hegemonic dynamic to control of water towers with significant implications for national and regional security.

Water Towers as regional and global risks

The key link between water towers and security lies in their transboundary nature. In most instances massive mountain systems stretch beyond national borders. Thus factors affecting water dynamics have a cascading effect on riparian states that rivers traverse.[7] Any change upstream has a potential corresponding impact downstream. This global

phenomenon affects 4 billion people across the continents (Table 1)[8]. Consider the countries that share mountain water resources – many riverine environments are today's conflict flashpoints[9]. Think of the sources of the Euphrates, Tigris and Jordan rivers in the Middle East, the Nile and Himalayan rivers flowing through India and China and the potential for clashes over water rights. Contrast this with the International Commission for the Protection of the Danube River where 14 signatory nations have agreed to share and protect the river.

Table 1: [10, 11]
Mountain contribution to total water discharge; relative size of mountain area

River	Discharge %	Area %	Countries
Orange	100	42	Lesotho, South Africa
Colorado	100	46	US, Mexico
Rio Negro	100	60	Colombia, Venezuela, Brazil
Amu Darya	98	68	Tajikistan, Afghanistan, Turkmenistan, Uzbekistan
Nile	93	44	Ethiopia, Sudan, Egypt, Uganda, South Sudan, etc.
Euphrates	85	22	Turkey, Syria, Iraq
Tigris	80	41	Turkey, Syria, Iraq
Indus	76	31	China, Pakistan
Niger	58	11	Guinea, Mali, Niger, Benin, Nigeria
Rhine	49	22	Switzerland, Austria, Germany, France, Netherlands
Mekong	34	48	China, Myanmar, Laos, Thailand, Cambodia, Vietnam
Danube	32	16	Germany, Austria, Hungary, Serbia, Romania, etc.

The table emphasizes how water tower dynamics and issues are shared around the world. Mountain glaciers are the source of major rivers[12], have geographical distribution, diverse political contexts, and confront similar challenges. Foremost are climate change, population, human action and extreme events. Processes are linked by cause, impact and outcome in both environmental and social spheres as water towers serve half of humanity (Table 2). These forces mean that changes to water towers affect well-being and security at regional and continental levels, not just at national scales.

Table 2: [13, 14] **Water Tower Facts**

Serves 50% global population
>80+% runoff in river basins
>50% area supplies downstream water
Mountains cover 25% land surface
Provides hydropower, domestic, industry,
Source of crops - potatoes, maize, barley, etc.

As with so many climate and security issues today, a discussion of water towers starts in China as the *de facto* potentate of the Tibetan plateau[15]. Its thirsty population (22% of the world's population, 7% of the water) needs increasing water supply for domestic, agriculture and industrial growth. The country's major rivers are heavily tapped; at times the Yellow River no longer reaches the sea. The South to North Water Transfer projects come at great cost ($77-plus billion)[16] and uncertain effectiveness. Chinese scientists have considered a Lake Baikal to Beijing water pipeline as well as inter-basin water transfer schemes, dams, diversions and desalination to increase water supply. No wonder that the Politburo seeks to maximize water resources on the Tibetan Plateau[17]. In keeping with their communist-era tradition, the government focuses on domestic exigencies rather than cross-border concerns or regional relationships. When in 2013 the Chinese mentioned diverting the Yarlung Tsangpo/Brahamputra from the Tibetan border region, India was apoplectic[18]. The idea was presented as an innocent refill for the Yangtze (imagine the physical implications there). The statement that nuclear explosions could be used to blast a passageway through the Himalayas conveys a threatening security message to the sub-continent downstream.

This issue reflects the anger, volatility and folly a discussion of manipulating water towers can generate. India's unsurprising response was that any diversion would be an act of aggression. The potential for the two most populous and nuclear-equipped nations going to war dwarfs anything the Middle East can present. However, when in 2016 India announced its plans to divert parts of the Brahmaputra there was no concern for downstream users in Bangladesh[19] – apparently the country was too small, and without nuclear weapons, to be of much concern. In this way the future of water towers very much reflects a power game, both in terms of who is able to control and manipulate the water, and whether or not this actor can rebuff any challenge from downstream users.

Elusive Control of Water

The sheer power of water carves a path through landscapes leaving several practical issues for societies to contend with. Maps may show clear lines of national control but mountain territory is, by definition, notoriously rugged and a difficult geography in which to place "boots on the ground" Consider Pakistan and India's multi-decade skirmish over Kashmiri lines of control at 6,000 meters. While the Ganges, Irrawaddy, Salween and Mekong are sourced on the Tibetan Plateau, rivers have a way of meandering, bifurcating, joining and splitting on their journey to the ocean. This makes water hard to control and variable over time; consider that the Niger once flowed from the Guinea Highlands through Timbuktu. The very nature of water – fluid, heavy, unconfined, awkward to transport -- requires much infrastructure and great cost to move from source to end-user. These qualities and challenges mean that location is important for access and control. Upstream states have first-user advantage

on rivers, making downstream riparians subject to decisions and actions beyond their control. The process gives water a transboundary, political dynamic that can be cooperative (Danube) or contentious (Tigris, Mekong) and contributes to securitization and conflict. This can be exacerbated by major water projects that become "nation-building" exercises. Think of the significance Turkey attached to the Greater Anatolia Project[20] or China's self-importance about the 3 Gorges Dam when it was initiated in the 1980s. This leads to social and philosophical dimensions of water: can abstraction of water tower resources be justified physically, diplomatically, economically and to the long-term benefit of one or several state authorities?

Climate Change

So far the discussion has side-stepped the elephant in the water tower – climate change[21, 22]. Pandey (2017)[23] gives a sobering assessment of climate implications in the Himalayas where the recession of glaciers is part of a global trend. New techniques for assessment, such as the remote sensing, the Normalised Melt Index, cryospheric analysis and data-driven hydrological modelling, can identify changes in the world's water towers[24]. Climate impacts particularly affect water processes including glacial and snow melt, precipitation patterns, temperature and changing global weather dynamics[25] (Table 3). These factors will change downstream water availability, increase volatility and affect water resources and recharge along water basins both today and in the future as the volume of water stored in ice caps and permafrost decreases. The consequences for water access and food supply[26] are immense and a vital concern for poorer, agriculture-dependent societies as shifts in water resources affect populations, politics and security.

Dynamic water processes can become irreversible as climate and weather patterns are transformed. Decreased glacial mass, changes in albedo (surface reflection), timing and seasonality of precipitation, temperature variability, shifts in cloud cover and wind patterns may reinforce deleterious impacts[27]. For example, climate-influenced snow and ice cover has seen Glacier National Park (U.S.) decrease from 150 glaciers to today's remaining 25. This exemplifies the irreversibility of climate impacts on mountain systems. As frozen water sources are depleted they will not return on a human timescale. Such historically unprecedented change has corresponding impacts on living conditions and could threaten social stability and provoke state conflict over water resources.

Table 3: Climate Change Impact on Water Towers

Reduced glacial cover, mass
Affect weather patterns, seasonality
Temperature impacts streamflow
Decreases downstream runoff
Loss of water stored as permafrost
Increased glacial lakes
Increased extreme events - floods, debris flow, glacial lake outbursts
Impact soils, wetlands, water supply
Contributes to food shortages, loss of renewable energy, conflict
Disrupts transborder stability

Infrastructure

Mountain water towers and access to their transboundary rivers present a delicate balance between users. Water withdrawals from rivers are encouraged to serve local needs, predominantly for agriculture and domestic water supply. This is like sticking a straw in a glass and drawing out as much water as can be swallowed before others can drink. Until recently this had been hard to monitor, particularly if many straws were drinking from the river. Satellite data now provides new methods of identifying water flow and vegetation density, recording changes over time, and insight into national water regimes.

Infrastructure changes river patterns, flow, amount and access, benefiting upstream users to the detriment of downstream states. Most common are dams, including run-of-the-river dams that generate electricity but do not involve water retention. Large-scale dams have greater riverine impact in their ability to change and govern water amount and flow, provide vast storage, control discharge, timing, flooding and regularity. At the same time dams reduce or remove sediments from rivers as they are trapped in reservoirs, diminishing the natural benefit of nutrient replenishment downstream. River channelization is another impact, often involving straightening or deepening waterways for human convenience and profit – to increase boat and barge transport capacity and speed while neglecting potential detrimental effects as natural barriers to rapid water flow. Curves, meanders, fields and plants are eliminated in the name of efficiency. The problem, highlighted by 2005's Hurricane Katrina, is that in extreme events the astonishing power of great volumes of water overwhelms feeble man-made defenses to great human and economic cost. In transboundary environments water infrastructure exemplifies assertion of hegemonic rights and control.

Likelihood of Conflict

Variegated circumstances flowing from water towers draw together physical, social and environmental dynamics in such a way that if water resources are compromised, societies are at risk[28]. At this point the specter of national security becomes a concern; when essential resources upon which a country depends are damaged, the threat to human and social survival can potentially lead to conflict.[29, 30] The scenario is basic: < water = < agriculture = < food = livelihood stress and then directly to protest and civil unrest. Responses reflect power relations: can a state persuade or force an upriver abstractor to let water flow? If political resolution is not feasible, are local and state actors prepared for confrontation? Can pressure be brought to bear from state-to-state relations, from the international community, through the auspices of the United Nations, African Union, ASEAN or other trans-national organizations? In the above context it is unlikely the Mekong Delta countries have the political, economic or military power to change Chinese action, yet China may recognize that there can be a breaking point in state water manipulation. Conversely, the China-India scenario is more problematic and asks the question, "will states go to war over water?"

The idea of Mexicans, Bulgarians, Sudanese or Laotians commandeering naval vessels and heading upriver to attack an exploitive water usufruct is rather preposterous. Already waterways are manipulated, altered and reconfigured as perceptions and use of water are transformed. Indeed, development changes water needs as conception and presentation of state power and industrialization moves away from mega-projects toward technology. Instead of the 3 Gorges Dam and vast infrastructure representing state advancement, China now stresses its astronauts and high-tech industry. The role of water for agriculture continues to evolve as economic progress transforms how and where a society uses water. Today farming consumes ~ 65% of China's water while in India the rate remains >90%[31]. Other options – reuse, desalination, taking advantage of "virtual" water and making water delivery systems more efficient are ways to reduce riverine pressures and flashpoints.

Today's awareness of the value of water can have a salutary impact on transboundary water cooperation[32]. The Middle East, of all places, offers an example of collaboration replacing conflict. Driven by new desalination capacity, Jordan and Israel trade water, in the south and north, to the benefit of both countries. The process reflects a willingness to overcome political barriers for mutual advantage, reflected in the Danube River coalition.

Can this be replicated across the world's water towers?[33] Shared interests, alarm over domestic unrest, political realities, costs and fear of regional hostilities need to be continually discussed and balanced. Positively, water towers in the Americas, Europe and much of Africa, while presenting challenges, are not conflict-prone. This

reflects the ability or resignation of states in resolving or accepting de facto mountain water regimes. On a geo-political scale, powerful states infrequently share key water resources; a Russian, U.S. or China confrontation is unlikely, though an Indian-Chinese water-driven clash is conceivable. More likely are confrontations between large and small states and conflicts driven by population, demand for food and economic/ infrastructure differences.

Present dynamics and potentially unknown future crises will be influenced by climate change disrupting water resources[34]. Climate impacts present a clear risk to long-term water supply, while the capacity for a global response that is commensurate to the risk is less clear. At stake are human and national well-being and threats to sovereignty and security, both real and perceived. This makes water towers one of the vulnerable pillars of regional and global security that will test the world's ability to adapt and respond to changing climates and water resources via peaceful means.

Notes

1 Researcher, University of Oxford, School of Geography and Environment.

2 J. Selby, "The geopolitics of water in the Middle East: fantasies and realities." *Third World Quarterly* 26, no. 2 (2005): 329-349.

3 UNESCO, Our global water towers. (2014). Accessed at unesdoc.unesco.org/images/0023/ 002308/ 230850e.pdf

4 D. Viviroli, B. Messerli, B. Schädler and R. Weingartner. "Water towers in a changing world," *Mountains and climate change: From understanding to action* (2009). Accessed at www.fao. org/docrep/017/i2869e/i2869e00.pdf

5 UNESCO, "Mountains as the water towers of the world," Accessed at www.unesco.org/fileadmin/ MULTI MEDIA/.../SDGs_and_mountains_water_EN.pdf

6 A. Sorg, T. Bolch, M. Stoffel, O. Solomina, and M. Beniston. "Climate change impacts on glaciers and runoff in Tien Shan (Central Asia)." *Nature Climate Change* 2, no. 10 (2012): 725-731.

7 D. Viviroli, H. Dürr, B. Messerli, M. Meybeck and R. Weingartner. "Mountains of the world, water towers for humanity: Typology, mapping, and global significance." Water resources research, 43(7) (2007).

8 UNESCO, Our global water towers. (2014). Accessed at unesdoc.unesco.org/images/0023/ 002308/ 230850e.pdf

9 UNESCO, "Mountains as the water towers of the world," Accessed at www.unesco.org/fileadmin/ MULTI MEDIA/.../SDGs_and_mountains_water_EN.pdf

10 D. Viviroli, B. Messerli, B. Schädler and R. Weingartner. "Water towers in a changing world," *Mountains and climate change: From understanding to action* (2009). Accessed at www.fao. org/docrep/017/i2869e/i2869e00.pdf

11 D. Viviroli, H. Dürr, B. Messerli, M. Meybeck and R. Weingartner. "Mountains of the world, water towers for humanity: Typology, mapping, and global significance." Water resources research, 43(7) (2007).

12 UNESCO, Our global water towers. (2014). Accessed at unesdoc.unesco.org/images/0023/ 002308/ 230850e.pdf

13 Ibid.

14 UNESCO, "Mountains as the water towers of the world," Accessed at www.unesco.org/fileadmin/ MULTI MEDIA/.../SDGs_and_mountains_water_EN.pdf

15 K. Pomeranz, "Asia's unstable water tower: the politics, economics and ecology of Himalayan water projects." Asia policy 16 (2013): 4-10.

16 T. Sternberg, "Water megaprojects in deserts and drylands." *International Journal of Water Resources Development* 32, no. 2 (2016): 301-320.

17 D. Viviroli, B. Messerli, B. Schädler and R. Weingartner. "Water towers in a changing world," *Mountains and climate change: From understanding to action* (2009). Accessed at www.fao. org/docrep/017/i2869e/i2869e00.pdf

18 Chinese dams in Tibet raise hackles in India.. Washington Post, February 7, 2013. Accessed at www. washingtonpost.com/.../chinese.../2013/.../ee39fc7a-7133-11e2-ac36-3d8

19 India set to start massive project to divert Ganges and Brahmaputra rivers, May 18, 2016, *Guardian*, Accessed at www.theguardian.com/global-development/2016/may/18/india-set-to-start-massive -project-to-divert-ganges-and-brahmaputra-rivers

20 T. Sternberg, "Water megaprojects in deserts and drylands." *International Journal of Water Resources Development* 32, no. 2 (2016): 301-320.

21 UNESCO, Our global water towers. (2014). Accessed at unesdoc.unesco.org/images/0023/ 002308/ 230850e.pdf

22 W. Immerzeel, L.Van Beek, and M. Bierkens. "Climate change will affect the Asian water towers." *Science*, 328(5984) (2010):1382-1385.

23 P. Pandey, "Climate hazards in the Himalayan Region," *Climate Hazard Crises in Asian Societies and Environment*, T. Sternberg (ed) (2017). Routledge, Abingdon.

24 W. Immerzeel, L.Van Beek, and M. Bierkens. "Climate change will affect the Asian water towers." *Science*, 328(5984) (2010):1382-1385.

25 D. Viviroli, H. Dürr, B. Messerli, M. Meybeck and R. Weingartner. "Mountains of the world, water towers for humanity: Typology, mapping, and global significance." Water resources research, 43(7) (2007).

26 W. Immerzeel, L.Van Beek, and M. Bierkens. "Climate change will affect the Asian water towers." Science, 328(5984) (2010):1382-1385.

27 A. Sorg, T. Bolch, M. Stoffel, O. Solomina, and M. Beniston. "Climate change impacts on glaciers and runoff in Tien Shan (Central Asia)." *Nature Climate Change* 2, no. 10 (2012): 725-731.

28 D. Viviroli, H. Dürr, B. Messerli, M. Meybeck and R. Weingartner. "Mountains of the world, water towers for humanity: Typology, mapping, and global significance." Water resources research, 43(7) (2007).

29 UNESCO, "Mountains as the water towers of the world," Accessed at www.unesco.org/fileadmin/ MULTI MEDIA/.../SDGs_and_mountains_water_EN.pdf

30 D. Viviroli, H. Dürr, B. Messerli, M. Meybeck and R. Weingartner. "Mountains of the world, water towers for humanity: Typology, mapping, and global significance." Water resources research, 43(7) (2007).

31 K. Pomeranz, "Asia's unstable water tower: the politics, economics and ecology of Himalayan water projects." Asia policy 16 (2013): 4-10.

32 Ibid.

33 D. Viviroli, H. Dürr, B. Messerli, M. Meybeck and R. Weingartner. "Mountains of the world, water towers for humanity: Typology, mapping, and global significance." Water resources research, 43(7) (2007).

34 UNESCO, Our global water towers. (2014). Accessed at unesdoc.unesco.org/images/0023/ 002308/ 230850e.pdf