In: Harris, L.M., .A. Goldin, and C. Sneddon (eds.) 2013. Contemporary Water Governance in the Global South. EarthScan from Routledge.

Chapter 3

HEGEMONIC CONCEPTS AND WATER GOVERNANCE FROM A SCIENTIFIC-ENGINEERING PERSPECTIVE

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Other authors of this book analyze core concepts important for water governance through the lenses of human geography, sociology, anthropology, history, and related social sciences. In this section, I examine the role of technology and the technocrats who often play a role, typically a lead part, in water governance. This is important because while a more inclusive culture of governance evolves, technocrats will not only play traditional roles such as construction of infrastructure, but also new roles, such as developing information technologies that can advance broader participation within water governance decisions.

In Chapter 2, Sneddon examines the concept of hegemony, focusing on power relations among countries, including the dominance of wealthier countries over poorer countries, accomplished historically through colonialism and in the present, through ongoing development efforts. Expanding on this discussion, an additional dimension of hegemony is the dominance of engineering practice in world water development. In other words, technical solutions to water-related problems through the application of engineering knowledge has achieved hegemonic status as a way to govern and manage water for human benefit.

Engineering has played an important part in water development for thousands of years – complex water engineering projects have been integral to human settlements across the globe. However, it was modern industrialization, fueled first by coal and later by oil that allowed exponential population growth in European and U.S. cities and created huge problems for water management. During the early years of industrial urbanization, engineers were often called upon to solve emerging water problems quickly, often with disastrous results. The problem of engineering hegemony in water management is illustrated by the conflict between engineers and public health officials in the U.S. regarding sewage disposal during the late 19th century (Tarr, 1996). At this time, towns and cities were developing public water supplies, but officials and the general citizenry debated the question of sewage disposal. By this time, use of the "water closet" was expanding throughout U.S. cities, resulting in overflowing cesspools and latrines, which had been designed for human wastes only, not large volumes of water. Disposal of sewage could have been dealt with in two ways: by constructing new "sanitary" sewers that would be used exclusively for human wastes, separate from storm sewers ("separate sewers") or by connecting household sewers to existing storm sewers, which had been designed for urban drainage, creating what came to be known as "combined sewers."

Linked to this debate was the decision of whether to treat sewage before it was discharged to rivers, or to discharge untreated sewage. In the latter scheme, it was expected that the "self-purification" process of rivers would cleanse the water. Downstream cities that withdrew the cleansed river water would treat it further (at that time, mainly through filtration), making it safe to drink. Treatment before discharge was feasible only for the smaller volumes of water conveyed by sanitary sewers, not for the much larger flows conveyed by combined sewers.

Public health officials argued for separate sewers and treatment before discharge. Engineers promoted the development of combined sewers, with no sewage treatment, arguing that it was a cheaper option for downstream cities to treat municipal water at the point of withdrawal. In most U.S. cities, the engineers prevailed, but the tragic outcome was the spread typhoid and other waterborne diseases downstream. Epidemics of typhoid and other waterborne diseases ended only when the technology of chlorination was adopted for water treatment (first in 1908), which combined with water filtration nearly eliminated typhoid by the 1940s. Yet, the legacy of combined sewers persisted: when it became necessary to treat sewage, upon passage of the Clean Water Act in 1972, hundreds of U.S. cities were compelled to separate their combined sewers into separate sanitary and storm sewers, costing tens of billions of dollars. As of 2001, combined sewer overflows remained in more than 700 communities and continue to pollute surface waters during storm events, a legacy of hegemonic decision-making by engineers more than 100 years ago (EPA, 2001).

I do not mean to castigate engineers: any profession left to its own devices will tend to develop "siloed" thinking, and all professions will argue for the supremacy of their own brand of thinking. In the U.S., many hegemonic mistakes made by engineering could be overcome by the wealth of the nation – society could afford to fix most errors of short sightedness because water infrastructure costs represent only about one percent of GDP (CBO, 2002). By contrast, countries in sub-Saharan Africa will need an investment of four percent of GDP (on average) to meet water-related Millennium Development Goals (Banerjee and Morella, 2011) and can hardly afford to repeat the mistakes of industrialized countries.

A related cultural hegemonic idea in our early U.S. history was the premise that nature was to be conquered by technology (Adas, 2006). Water development in the western U.S. had religious overtones, the idea of "reclaiming" desert "wasteland" into gardens of Eden (Reisner, 1986). In a stunning photographic narrative of the construction of the Hoover Dam, the largest engineering project of its time, Arrigo (2010) presents headlines "boosting" the dam prior to its construction: "Mammoth Dam at Boulder Canyon Promises Vast Wealth and Unrivaled Electric Power for Los Angeles" (*Los Angeles Examiner*, 1921) a map of the dam site in *Popular Mechanics* (1932) was labeled "White Gold! Harnessing a River to Reclaim a Desert." At the onset of construction, a set of photos in the *San Francisco Examiner* (1931) was titled "Men Move Mountains, Make Way for Greatest U.S. Project." Total dam storage in the U.S. increased rapidly from the 1930s to the 1970s.

Construction of major dams in the U.S. virtually ceased by 1980 largely due to pressure from the growing environmental movement (Graf, 1999), but large dams continue to be built in developing countries, often with negative consequences (World Commission on Dams, 2000). This development-above-all mindset persists: Erensu (Chapter 6) quotes a Turkish Minister of Water and Forestry who said, in 2012, "my job is to build dams." The historical lesson is that hegemonic ideas of disciplinary supremacy, on one hand, or a blind ideology of human mastery over nature, on the other, have led to many ill-conceived water development projects.

The need for expanded participation in water governance is especially important in the context of extreme events, such as drought. Engineers and hydrologists have traditionally thought of drought as an entirely hydrologic phenomenon, defined, for example, on the basis of the percentage of precipitation within a given time period in relation to the long-term average. This narrow definition can contribute to a sense that these problems must be solved with engineering/hydrologic solutions, such as building more dams to store water or reducing leakage in municipal water systems. Recently, water experts have started to think of drought as a socio-ecological phenomenon, a product of both hydrologic conditions and the social system (Kallis, 2008). In this view, human systems are either more or less vulnerable to drought based on a host of political and economic factors. At one extreme, scarcity might be thought of as a human-induced drought caused by overuse of water, even in the absence of a meteorological drought. Mahayni (Chapter 5) illustrates this phenomenon for Damascus, presenting evidence of diminished flows in springs and dried up rivers caused by overuse of groundwater. An important component of the crisis in this case was the inability of governance mechanisms in Syria to respond to overuse.

In a parallel development, ecologists have developed the concept of "resilience," referring to the capacity of an ecosystem (human and otherwise) to respond, by adaptation, to perturbations (Gunderson and Holling, 2002). The essence of resilience is that *feedback* (for example, in a human system, collection of data and synthesis into useable information) is used to guide an *adaptive response*. A theory of drought resilience would predict that two cities facing identical hydrologic droughts might have very different outcomes: the less resilient city (with ineffective governance) would collapse or at least become severely weakened, whereas the city with effective governance would recover quickly (Baker, forthcoming). There is some evidence for this hypothesis from the archeological literature. Historical settlements that have collapsed during periods of climate extremes (drought, often interspersed with flooding) include the Hohokum settlements in what is now Arizona (Bayman, 2001), the Mayan cities of Mexico (Haug, et al., 2003), the Akkadian Empire of the Middle East (Cullen and deMenocal, 2000), and Ankor, Cambodia (Buckley, et al., 2010). The consensus of these authors is that collapse of settlements during periods of extreme hydrologic variability (droughts and flood) is often caused by the failure of sclerotic governments to respond effectively. In this view, droughts and flooding creates a tipping point for an already weakened social system.

Developing a theory of water resilience (resilience to both droughts and flooding) is important because such a theory would give us the capacity to *anticipate and react to* potential tipping points caused by hydrologic stress. This is a critical need, because droughts are likely to become more devastating in the future. Drivers include (1) climate change, which will likely produce hotter, drier, more variable climate regime s in areas of the world that are already hot; (2) rapid growth in the world's urbanized population, and especially in unorganized peri-urban areas; (3) pollution of groundwater; and (4) increasing per capita water use, paralleling increasing prosperity (Baker, forthcoming).

The discussion of resilience leads directly to the theme of participation in water governance (Goldin, Chaper 16). A key aspect of resilience is the ability to adapt on the basis of feedback. For the case of incipient drought, this feedback might include measurements of groundwater levels, reservoir storage, leakage losses in water systems, and household water use – information that could be used to adapt to changing conditions and thereby avoid the impact of a drought. For example, feedback on leakage from water pipes (sometimes 50 percent in developing countries) might lead to the adaptive measure of fixing the pipes, thereby conserving water, well before a drought occurs.

Broad participation —in this case multiple paths of information flow whereby citizens can communicate with each other and with decision makers at various levels of government—is therefore critical with regard to the development of resilient water systems. Some elements of participation that would influence resilience to droughts and floods would include incorporation of indigenous/local knowledge, the acquisition of hydrologic data for decision-making, transparency and accessibility of this data, and the ability of citizens to communicate through both formal and informal networks. The case study of drought in Southern Rhodesia presented by Musemwa (Chapter 7) illustrates how decision-making in an earlier era (1960s) was severely hampered by lack of hydrologic data: even the notion of scarcity, in the middle of an extreme drought, was contested! In today's information age, we have the ability to develop regional water balances based on multiple sources of data, and the ability to communicate this information to citizens. Questions about how to appropriately engage citizens remain open for debate, as several authors in this volume appropriately query. What the previous examples suggest is that resilience is a characteristic of social-ecological systems that cannot be engineered exclusively through technological innovation; rather, attention to institutions and power relations is equally important in promoting resilience.

Today, information technologies can play a huge role in increasing participation in water management. Our ability to acquire, store, manipulate, and disseminate data has increased exponentially over several decades, and the cost of using this technology has decreased. Ten years ago, a gigabyte of storage on a desktop was state-of-the art; today's computers often have a terabyte of storage – a thousand times more. This means that digital operations – such as manipulation of geographic information system (GIS) files, which in the past could be done only on centralized computer systems located at universities and corporations, can now be done by a small nongovernmental organization on a personal computer, and the outcomes can be transmitted via the internet to a cell phone in a remote village. A creative "app" could readily allow a rural villager with a mobile phone to upload information on the depth of her well; this information, along with information compiled by neighbors, could be processed and transmitted back to her in the form of a map of groundwater depths in his region. Ordinary people can now be empowered with hydrologic information; moreover, through analysis by governments and informal networks, this information can be used to develop actionable knowledge regarding water resources. Added to this is the capacity of first world satellites, which enable detailed mapping (< 1 m^2 resolution), in multiple spectra, of crops, forests, and cities, anywhere in the world, which can also be readily shared to increase local knowledge.

While information technologies have the potential to increase participation, this potential will not be realizeable unless the information is made both accessible and transparent to the population. By accessibility I mean that the relevant data must be offered in a way that ordinary citizens can acquire it. Transparent refers to the idea that the data must be useable without high-level skills. For example, mapped information must be provided in ways that don't require expensive GIS software or specialized GIS training. Moreover, governments and water development agencies must be committed to the idea that local knowledge of water resources can be a valid and crucial input point for decisions regarding water governance.

A personal experience illustrates these ideas. A few years ago, at the depth of the U.S. recession (ca. 2009) a major power company proposed to build a very large power plant in east-central Minnesota. At the time, I was chair of an informal watershed group that was fighting the proposal. Because the type of power plant being proposed would have used large quantities of water, I dug into a technical database on water consumption in the U.S., developed by the U.S. Geological Survey. As a water expert, I quickly concluded that the power plant would consume as much water as all other uses of water in the county combined (which included several small cities). This kernel of knowledge, combined with the indigenous knowledge that many nearby residents who had private wells were already experiencing water shortages, resulted in widespread concern, even among boosters of the plant. The county board, bent on approval of the idea, nevertheless inserted a condition in the development agreement that prohibited the withdrawal of groundwater for cooling, effectively preventing the plant from being built (at least until they figure out another way to cool it!). The point here is that although hundreds of people would have benefited from this information, I was the only one in a position to access and interpret the data. The data were accessible in that anyone could download the information for free, yet it was not readily accessible, or transparent, given that almost no one could find it, and even if they did, it would have been difficult to understand and interpret. For participation to be effective, legal and technical accessibility is not sufficient: hydrologic data must also be transparent for meaningful engagement to occur. Public officials and citizens need be no more than a few "clicks" away from the information they need for decision-making. How to get that information, and what to do with it, are key for constructive and engaged dialogue and participation on a host of water management issues.

An excellent example of where information technologies have been used to provide sophisticated tools to local populations is the Arizona Meteorological Network (AZMET). AZMET is a meteorological network that collects data and processes this information using a model of crop water requirements to make week-by-week irrigation recommendations to efficiently use water for various crops and at various locations throughout the state, available to farmers via the Internet (AZMET, 2012). Importantly, the state shares not only raw data, but also processes data into recommended irrigation rates, in inches per week. Such technological advances can help to overcome some of the challenges of meaningful local participation (e.g. Kadirbeyoglu and Kurtic, Chapter 18). With technological tools in their hands, local farmers, even if not well educated, can become efficient irrigators. They also will be able to engage, or even challenge, governmental or other institutions to make the case for other water uses, as they deem appropriate.

Information technologies are rapidly spreading, increasing the potential for utilizing them to improve participation in water governance. Even in Sub-Saharan Africa, one of the poorest regions of the world, information technologies have arrived: among 17 countries, 57 percent of respondents had a mobile phone and 14 percent had both mobile phone and Internet access (Tortora and Rheault, 2011). Participation via the Internet has the potential to counteract all four "flaws" proposed by Goldin (Chapter 16): it defies rigidity of government structures and is genuinely "authentic"; it is always demand driven; it tends to reduce the "vagueness" of participation, and it defies isomorphism, the tendency to become "cemented in form." Of course, the potential benefits of information technology can only be realized if governments, citizens, and other entities embrace their use, or at least, do not actively seek to limit them.

With respect to the third theme of this book, privatization and markets (Harris, Chapter 10), research in the U.S. has shown no consistent gain in efficiency resulting from privatization of water or wastewater operations (Wolff and Hallstein, 2005). Some of the engineering and finance issues associated with privatization include: loss of control of a public service, little recourse if a privatization contract does not work, loss of transparency when a utility is turned over to a private operator, potential for loss of jobs, the need to prepare very detailed contracts, including a detailed inventory of infrastructure assets (Jacobs and How, 2005). In Atlanta, a privatization scheme failed in part over a dispute on the condition of the subterranean water infrastructure; in the end, both sides agreed to cancel a long-term contract. Because of these concerns, in 1997 only about 10 percent of the U.S. population were served by privately operated water systems, and only six percent was served by privately operated wastewater systems. Van der Berg (1997) found that nine years after privatization in Britain and Wales it was still too early to determine whether the privatized system was more efficient than the prior public system.

Extrapolating to poorer countries, the technical and engineering problems of privatization would seem to be overwhelming. Effective privatization requires extensive engineering and management expertise in the public sector in order to maintain oversight, transparent accounting, and fair contracting processes, all of which are likely to be problematic. In her discussion of water privatization in Zambia, Waters (Chapter 12) notes that the simple task of water metering – essential for billing – could not be accomplished. Inserting the technological issues into debates about privatization is essential for understanding why privatization might succeed in some situations and fail in another.

A final point: developing new theories of water governance will require substantial transdisciplinary research efforts, that is, research that requires "mutual interpenetration of disciplinary epistemologies" (Gibbons, et al., 1994). This research cannot be dominated by any one discipline: engineers, political scientists, hydrologists, geographers, sociologists, historians, anthropologists, economists and others must be involved. Working in such highly interdisciplinary teams presents formidable obstacles (Baker, 2006) that need to be interrogated and overcome. Tools such as intergroup dialogue (to allow researchers to understand each others cultures), a common set of heuristics (Nicholson, et al., 2002), and modeling approaches that help to integrate findings from various disciplines, such as systems dynamics modeling (Sterman, 2001; Welling, 2011) are steps that can be taken to allow researchers from disparate disciplines to work together.

In summary, while the technocratic hegemony has failed the developing world in many ways, the problem is not the technology itself, but the way it was used. Hence, castigating the technocrats is not the solution. Instead, those seeking to improve water governance in the developing world should embrace the potential of technology to support their efforts, guided by broader social considerations.

REFERENCES

Adas, M., 2006. *Dominance by design: technological imperatives and America's civilizing mission*. Cambridge, MA: The Belknap Press.

Arrigo, A., 2010. *Imagining The Dam: The Visual Rhetoric Of Hoover (Boulder) Dam In Popular And Public Print Media, 1920-1975*. Ph.D. University Of Minnesota.

Arizona Meteorological Network (The) (AZMET), 2012. [online] Available at: http://ag.arizona.edu/azmet/ [Accessed 7 November 2012].

Baker, L.A., 2006. Perils and pleasures of multidisciplinary research. *Urban Ecosystems*, 9, pp.45-47.

Baker, L.A. (forthcoming). Urban drought resilience, in Situating Sustainability. In: A. Rademacher, ed., *An Unequal World*. New York: NYU Press.

Banerjee, S.G. and Morella, E.E., 2011. *Africa's water and sanitation infrastructure access, affordability, and alternatives*. Washington, DC: The World Bank.

Bayman, J.M., 2001. The Hohokam of Southwest North America. *Journal of World Prehistory*, 15(3), pp.257-311.

Buckley, B.M. Anchukaitis, K.J., Penny, D., Fletcher, R., Cook, E.R., Sano, M., Nam, L.C., Wichienkeeo, A., Minh, T.T. and Hong, T.M., 2010. Climate as a contributing factor in the demise of Angkor, Cambodia. *Proceedings of the National Academy of Sciences of the United States of America*, 107(15), pp.6748-52.

Congressional Budget Office (CBO), 2002. *Future investment in drinking water and wastewater infrastructure*. Washington, DC: Congressional Budget Office.

Cullen, H.M. and deMenocal, P.B., 2000. Climate change and the collapse of the Akkadian Empire: evidence from the deep sea. *Geology*, 28(4), pp.379-382.

Environment Protection Agency (EPA), 2001. *Report to Congress: implementation and enforcement of the combined sewer overflow control policy*. Washington, DC: U.S. Environmental Protection Agency.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M., 1994. *The new production of knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Graf, W.L., 1999. Dam nation: A geographic census of american dams and their large-scale hydrologic impacts. *Water Resources Research*, 35(4), pp.1305-11.

Gunderson, L.H. and Holling, C.S., 2002. *Panarchy: understanding transformations in human and natural systems*. Washington: Island Press.

Haug, G.H., Günther, D., Peterson, L.C., Sigman, D.M., Hughen, K.A. and Aeschlimann, B., 2003. Climate and the collapse of Maya civilization. *Science*, 299(5613), pp.1731-1735.

Jacobs, L. and Howe, C.W., 2005. Key issues and experiecne in U.S. water services privitization. *Water Resources Development*, 21, pp.89-98.

Kallis, G., 2008. Droughts. *Annual Review of Environment and Resources,* 33(1), pp.85-118.

Los Angles examiner, 1921. Mammoth Dam at Boulder Canyon Promises Vast Wealth and Unrivaled Electric Power for Los Angeles. *Los Angeles Examiner*, 24 July.

Nicholson, C.R., Starfield, A., Kofinas, G., and Kruse, J., 2002. Ten heuristics for interdisciplinary modeling projects. *Ecosystems* ,5, pp. 376-384.

Popular Mechanics, 1932. Area affected by Hoover Dam project. In: *White Gold! Harnessing a River to Reclaim a Desert*. Popular Mechanics, June.

Reisner, M. 1986. *Cadillac desert: the American west and its disapearing water*. New York: Viking Penguin.

San Francisco Examiner, 1931. Men Move Mountains, Make Way for Greatest U.S. Project. *San Francisco Examiner*, 9 June.

Sterman, J.D., 2001. System dynamics modeling: tools for learning in a complex world. *Calilfornia Management Review*, 43(1), pp.8-25.

Tarr, J.A., 1996. *The search for the ultimate sink: urban pollution in historical perspective*. Akron, OH: University of Akron Press.

Tortora, B. and Rheault, M., 2011. Mobile Phone Access Varies Widely in Sub-Saharan Africa: Average phone owner is more likely to be male, educated, and urban. *Gallup World* [online] 16 September. Available at: http://www.gallup.com/poll/149519/mobile-phone-access-varies-widely-sub-saharan-africa.aspx [Accessed 12 November 2012].

van der Berg, C., 1997. *Water privatization and regulation in England and Wales. Public policy for the private sector*. Washington, D.C.: The World Bank.

Welling, K.N., 2011. *Modeling the water consumption of singapore using system dynamics*. S.M. Massachusetts Institute of Technology.

Wolff, G. and Hallstein, E., 2005. *Beyond Privatization: Restructuring Water Systems to Improve Performance*. Oakland, CA: Pacific Institute.