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Hydraulic Bureaucracies and the Hydraulic Mission: Flows of Water, Flows of Power

François Molle

Institut de Recherche pour le Développement (IRD), UR199, Montpellier, France; francois.molle@ird.fr

Peter P. Mollinga

Department of Political and Cultural Change, ZEF (Center for Development Research), Bonn University, Germany; pmollinga@hotmail.com

Philippus Wester

Irrigation and Water Engineering Group, Wageningen University, the Netherlands; flip.wester@wur.nl

ABSTRACT: Anchored in 19th century scientism and an ideology of the domination of nature, inspired by colonial hydraulic feats, and fuelled by technological improvements in high dam constructions and power generation and transmission, large-scale water resources development has been a defining feature of the 20th century. Whether out of a need to increase food production, raise rural incomes, or strengthen state building and the legitimacy of the state, governments – North and South, East and West – embraced the 'hydraulic mission' and entrusted it to powerful state water bureaucracies (hydrocracies). Engaged in the pursuit of iconic and symbolic projects, the massive damming of river systems, and the expansion of large-scale public irrigation these hydrocracies have long remained out of reach. While they have enormously contributed to actual welfare, including energy and food generation, flood protection and water supply to urban areas, infrastructural development has often become an end in itself, rather than a means to an end, fuelling rent-seeking and symbolising state power. In many places projects have been challenged on the basis of their economic, social or environmental impacts. Water bureaucracies have been challenged internally (within the state bureaucracies or through political changes) and externally (by critiques from civil society and academia, or by reduced funding). They have endeavoured to respond to these challenges by reinventing themselves or deflecting reforms. This paper analyses these transformations, from the emergence of the hydraulic mission and associated water bureaucracies to their adjustment and responses to changing conditions.

KEYWORDS: Irrigation, hydraulic mission, water resource development, iron triangle, interest groups, reform

INTRODUCTION: THE PROPHETS OF IRRIGATION

In the past 150 years, water resources development by the state was an emergent and, at times, intentional, political strategy for controlling space, water and people and an important part of everyday forms of state formation (Worster, 1985; Reisner, 1993; Wehr, 2004; Swyngedouw, 2007; Wester, 2008). A cadre of professionals, most frequently civil engineers staffing hydraulic bureaucracies (hydrocracies) led this process. While crucial for the economic development of the modern era, the role and power of hydrocracies have hardly been the focus of academic research. This issue of *Water Alternatives* contains a Themed Section on "Hydraulic Bureaucracies: Flows of Water, Flows of Power", presenting seven articles that address several central features of hydrocracies and their functioning. We hope this will lead to more studies on the history of hydrocracies, their dynamics and their scope for transformation to meet the water challenges of the 21st century.

Many of the most powerful and grand empires of ancient times, such as the Chinese, Mesopotamian, Egyptian, or Maya empires, are famous for their success in controlling river systems and developing large-scale irrigated areas and agricultural production, which supported and sustained their might and glory. The relationship between water control and the emergence of powerful despotic states formed the fulcrum of Wittfogel's (1957) inquiry into hydraulic societies, based on his long-time fascination "with the developmental lessons to be learned from the study of agrarian societies based on large scale and government-directed water works. These societies covered more territory, lasted for more years, and shaped more lives than any other stratified agrarian society".

Wittfogel argued that the necessity to muster the labour force necessary for huge flood-control works and irrigation systems was conducive to the development of a centralised bureaucratic-despotic type of state he called oriental despotism. According to Worster (1982) the control of water gave way to the emergence of a powerful elite that

included scientists and engineers who achieved sophisticated ability to manipulate the natural riverine environment, an expertise they willingly put to service of even more powerful authorities. There were priests who gave spiritual legitimacy to the regime. And there was an overclass of agro-managerial bureaucrats who took charge of directing that knowledge and spirituality, of directing the peasants, and of directing the rivers...

Wittfogel's thesis became the centre of heated scholarly debates, with many critiques¹ showing the limits of, and counterexamples to, the theory and the universal correlation between control over water and control over man (see Eisenstadt, 1958, discussed in Evers and Benedikter, this issue). Especially the linearity suggested by Wittfogel between irrigation development, state formation and centralised power, and whether this necessarily leads to a despotic state, have been debated (Adams, 1974; Steward, 1978; Bray, 1986). However, it is evident that water development by state water bureaucracies can play an important role in state formation and the centralisation of power, both in the distant and recent past.

With the demise of these early great empires, large-scale irrigation and hydraulic works virtually disappeared, with the exception of China. They reappeared in the 19th century, as a child of colonialism, with colonial powers in a position to mobilise massive *corvée* labour and the technical and scientific knowledge of enthusiastic engineers. This led to the transformation of local labour, land, water and sunlight into agricultural products grown in plantations or collected from local farmers. Historical figures associated with this form of colonial 'occidental despotism' and its feats – the diversion of great rivers to irrigate large and fertile alluvial plains and deltas – include Willcocks (Willcocks, 1935), Cotton (Hope, 1900) in India and Egypt, de Bruyn in Indonesia (Ravesteijn and Kop, 2008), van der Heide in Siam (ten Brummelhuis, 2007), Godard in Tonkin (Vésin, 1992), and Bélime in French Sudan (Mali) (Schreyger, 1984). As much as irrigation development was a colonial project pursued with vigour, it was a process of trial and error that happened at great social cost (e.g. in North India, where canal construction in the 19th century caused widespread malaria through blocking natural drainage ways; see Whitcombe, 1972).

The second half of the 19th century and the beginning of the 20th century witnessed a general craze for irrigation development. Inspiration came from both colonial works and experiences in different parts of the western world: the American West, California in particular (Ertsen, 2006), and places such

¹ As Barker and Molle (2004) note: "Critics have been prompt to point to situations where impressive hydraulic works were not necessarily the result of a powerful, centralized bureaucratic and despotic state (Bali: Lansing, 1991; Sri Lanka: Leach, 1961), while, on the other hand, there was no shortage of such states associated with modest hydraulic achievements (Wijewardene, 1971). However, the intensity of the intellectual debate on Asian despotism in the postwar period has sent many researchers in a quest of hydraulic societies in Asia which has not been always successful or convincing. (...) Even the paradigmatic case of the Khmer empire and irrigation around Groslier's (1979) "hydraulic city" of Angkor, which has spurred much fascination for ancient hydraulic feats (e.g. Stargardt, 1986, 1992 on Burma and southern Thailand), is now increasingly seen as owing much to imagination (Stott, 1992; de Bernon, 1997)".

as Spain or the Pô valley, in Italy. Irrigation and its purported benefits were hotly debated in many countries in the world – especially after the dramatic droughts witnessed in the 1870s and 1880s – including Mexico, (Northeast) Brazil, South Africa, Morocco or Australia. It had its prophets – like Smythe in the US, the Chaffey brothers and Alfred Deakin in Australia, J. de Caldas in Brazil, Joaquin Costa in Spain, or J.C. Brown in South Africa – who saw themselves as entrusted with the mission to preach, often in hyperbolic and lyrical style, the advent of an irrigated Eden.

During the second half of the 19th century most irrigation development was based on private enterprise, with the exception of India and Egypt where the British state invested heavily in irrigation and created Irrigation Departments. It was only in the beginning of the 20th century that public investments in irrigation became common, leading to the creation of state water bureaucracies. It is useful to dwell on the motivations, discourses and rationale that underpinned the popularisation of irrigation worldwide: indeed, the justifications brought up at that time embody many of the ingredients that would later shape – and still shape today to a large extent – the worldview and the work ethos of hydrocracies. These ingredients include an enthusiasm for "scientific irrigation", the associated view of the domination of nature, a view that many would now regard as hubris, the fascination conveyed by the "let the desert bloom" utopia, the moral ideal of farming, and the biblical/messianic overtone of the call for creating new Edens in deserts or arid places.

The enthusiasm for "scientific irrigation" must be seen in the context of the development of science during the 19th century. For Smythe (1905), the most noteworthy eulogist of irrigation in the US,

Irrigation is the foundation of truly scientific agriculture. Tilling the soil by dependence upon rainfall is, by comparison, like a stage-coach to the railroad, like the tallow dip to the electric light... This progress will continue until the agriculture and horticulture practised on the little farms of Arid America shall match the marvellous results won by research and inventive genius in every other field of human endeavour.

Undertaking irrigation is presented as being modern in a backward rural world, as an elite behaviour expected from the finest: for the Chaffey brothers in Australia it was obvious that the success of irrigation would be due to the calibre of the type of person that this venture would attract, "namely, the industrious, temperate, thrifty, intelligent, skilful, cleanly, and good living of all classes", in other words irrigation was "an industry suited to the most intelligent and refined people" (Hamilton-McKenzie, 2009). For Gustav Wex, a hydraulic engineer working in South Africa, the government should join "the more intelligent portion of the population" in the execution of dam and irrigation projects (Turton et al., 2004).

Not unrelated to scientism was a pervasive *hubristic view of the domination of nature*, with the glorification of man's conquest over "the perversity of nature", his "effort at the subjugation of the wilderness" (Smythe, 1905), and his "work of taming the wilderness with increasing fervor" (Hamilton-McKenzie, 2009). This view was widespread in semiarid regions such as South Africa, where scientists called for rivers to be "tamed and domesticated", so that "deserts [could be] turned into gardens" (Turton et al., 2004), the Brazilian Northeast, where the "*solução hidráulica*" was promoted (Guerra and Guerra, 1980), and Spain where nothing would be possible as long as "we are not the masters of the key to the rivers, which run loose, like untamed beasts, in a wild freedom... if in other countries it is sufficient for man to help Nature, here we need to do more: we need to create it!" (Costa, 1911). Similarly, in the US, President Theodore Roosevelt inaugurated the Boulder dam on the Colorado and proclaimed that "Pridefully, man acclaims his conquest of nature" (Stevens, 1988).

Proponents of irrigation invariably fell prey to the "*let the desert bloom*" utopia, the fascination conveyed by images of lush gardens in the desert, with California or the Middle East as frequent references and reminders of *Hammurabi's* inscription that claimed to "have transformed the desert plains into fertile fields, given their residents fertility and abundance, and I have made the country an abode of delight" (Costa, 1911). In the US, Smythe (1905) viewed irrigation as "nothing less than the

progenitor of civilization in an otherwise inhospitable land – the key to making the desert bloom" and envisioned "scenes of intensely cultivated land, rich with its bloom and fruitage, with its spires and roofs, and with its carpets of green and gold stretching away to the mountains".

Another strand of argument was the frequent association of irrigated farming with civilisation and a *moral ideal of farming*. In Brazil, analysts enthusiastically reported success with irrigation in California and emphatically predicted that in the dry northeast of the country it would "transform the semi-nomad man in someone fixed to earth", emphasising the solidarity and "spirit of submission" associated with a "civilisation of the canal" (de Caldas, 1939). According to Smythe (1905), in the US, this ideal embodied both a romantic view and idealisation of life in the countryside and a Jeffersonian conviction that irrigation would allow the establishment of a

...class of small landed proprietors resting upon a foundation of economic independence... A large farm under irrigation is a misfortune; a great farm, a calamity. Only the small farm pays. But this small farm blesses its proprietor with industrial independence and crowns him with social equality. That is democracy.

Smythe saw as "a blessing of aridity" not only the fertility of the soil revealed by the application of water but also the cooperative and stable social organization and the civic and moral attitudes that were instilled by a common dependence on collective works and resources. This ideal was shared by Powell, the Director of the US Geological Survey and promoter of a colonisation of the West based on its natural resources, who stressed the necessity to establish a small rural commonwealth that would be independent from both capitalist corporations and the distant federal government (Worster, 1985).

In Australia too, the early pattern of land settlement (and land grabbing) in Victoria contributed to the attraction of the yeoman ideal. The concept of the civilised nature of irrigated and intensive agriculture was reiterated, "using the image of people from all classes and age groups living side-by-side in gentle harmony" (Hamilton-McKenzie, 2009).

Not surprisingly such moral ideals and grand visions of the "march of civilisation" were associated with *biblical/messianic overtones* and the call for creating new Edens in desert places. Similarities between the Holy Land and Utah or California were underlined, both in terms of climate and of the divine mission allegedly vested in its people: the glories of the Garden of Eden itself, according to the Bible, were products of irrigation and making "the desert bloom as a rose" was seen as a biblical mission, a theme that would later also become central in the formation of the state of Israel (Lipchin, 2003). In Spain, Costa (1911) urged "fruitful engagements against the blind forces of Nature, taming and constraining/channelling [rivers], and making them sources of goods and wealth, as partners in God's plan of creation". It was frequently remembered that according to the Bible "A river rose in Eden to water the garden" and deduced that "the glories of the Garden of Eden itself, were products of irrigation" (Smythe, 1905).² While farmers in the Snake river valley were exhorted to establish a "Garden of the Gods" (Lovin, 2002), nowhere was the mission to follow God's example better embodied than in Utah, where Mormon leader Brigham Young, "the American Moses", and his followers would find a "new Palestine... and build the new Jerusalem!" (Smythe, 1905).

THE EMERGENCE AND APOGEE OF THE 'HYDRAULIC MISSION'

Politicians and decision-makers met the spread of the irrigation gospel with mixed enthusiasm. Debates included arguments on whether irrigation was profitable or not, whether it befit regions with scarce population and labour (like in Australia), and whether it should be preferred to investments in railways (discussions on the respective economic merits of investments in irrigation and railways could be found

² Genesis 2: 10: "A river rose in Eden to water the garden, and from there it divided and became four rivers", from which an engineer in South Africa deduced that "Thus, God's intention was to irrigate the Garden of Eden".

not only in the US but also in India,³ Siam or Australia). In most cases, however, the irrigation prophets were able to convert high-level decision-makers and technocrats.⁴ But the most disputed issue was whether irrigation development was to be supported by the government and public investment or through private investment.

As early as 1843 in France, Nadault de Buffon – a famous engineer with the *Corps des Ponts et Chaussées* – made the case that the state should shoulder the financial burden of constructing irrigation canal networks because such systems were not profitable for private companies (Haghe and Barraqué, 2001). In Australia, the Chaffey brothers were forced to file for bankruptcy by 1894 and Elwood Mead, appointed Head of the State Rivers and Water Supply Commission of Victoria in 1907, argued that the initial failure of irrigation arose from insufficient intervention by the state and the necessity for even greater engineering expertise (see Crase et al., this issue). In India, the Madras Irrigation and Canal Company was an effort at irrigation development by a private company. It lasted about 10 years in the 1860s period, started to construct one canal, went bankrupt and was taken over by the state (Atchi Reddy, 1990). In the western US, most of the investors who had believed they would thrive on selling water to farmers eventually failed around the 1870s, while the subsequent self-funded irrigation districts and companies also often ended up in bankruptcy (Pisani, 1992; Reisner, 1993).

The rationale and calls for public intervention in irrigation development gradually met with political interest at the national level. This is well illustrated in the case of Spain where, at the turn of the century, the *regeneracionismo* movement was actively promoting "inner colonisation" as a means of instilling a moral and economic revival after the loss of Spain's colonies (see Swyngedouw, 1999; Lopez-Gunn, this issue). For various reasons, depending on the country, land development and settlement came to be seen as major national priorities towards economic progress. The following quote (First progress report 1885; cited in Ward, 2000) from Australia, dating back to 1885, epitomises the new rationale:

If Victoria is to continue to progress in the settlement of her people upon the lands and multiplication of her resources by the conquest of those areas hitherto regarded as worthless; if she is to utilise her abundant natural advantages, bring her productiveness to the highest point and secure to the agricultural population of her arid districts a permanent prosperity, it must be by means of irrigation. No price, it may be said is too high, indeed, it implies the sapping of the spirit of independence and that of self-reliant energy and enterprise which have one (sic) her present position; for by these, and these alone, can she maintain it.

Because of the financial failure of private enterprises and various national objectives, the states thus stepped in and endorsed the role of (large-scale) developer of water resources. Imbued with the fresh legitimacy of technical marvels (high dams, electricity, etc) and the presumably unlimited power of science, inspired by the mission to tame nature and make the deserts bloom, hydraulic bureaucracies were created to take up the challenges of flood protection, hydropower generation and large-scale public irrigation. These bureaucracies had their secular priesthoods, acting in the name of the common good and in tandem with politicians and national leaders. Not a single drop of water should reach the sea without being put to work for the benefit of Man: the 'hydraulic mission' was born (Molle, 2009; Wester, 2009).

The beginning of the 20th century was therefore marked by the creation of many hydraulic bureaucracies in different parts of the world: foremost is the US Bureau of Reclamation, established in

³ The canals envisaged in India were initially also conceived as navigation canals. Cotton's 1860s plan to link all Indian rivers was to improve navigation, which was where the debate with the railways originated, with many canals also being irrigation canals. The habit of constructing irrigation canals that were also suitable for navigation (by constructing locks and elevated bridges for instance) continued till the 1950s in India in at least one case as part of the standard paradigm of canal irrigation, well beyond the period that some irrigation canals were actually used for navigation.

⁴ Such as Powell or Newell in the US or Mead and Deakin in Australia.

1902 as the Reclamation Service in the US, along with many other organisations that were to become powerful in the century to come: these include, for example, the National Irrigation Commission in Mexico (1926), the Department of Canals in Siam (1902; which was to become the Royal Irrigation Department), the General Directorate of Public Works in Turkey (1914; now DSI), and the *Inspetoria de Obras Contra as Secas* in Brazil (1909; later DNOCS: *Departamento Nacional de Obras Contra as Secas*). In European countries where Corps of Engineers had been created much earlier (in 1717 in France, in 1799 in Spain, and in 1798 in the Netherlands), water works acquired greater significance.

But in addition to this quest for irrigation, this period was also marked by an even larger thirst for electricity that was to radically change conditions of life in cities and the economy. Controlling water was not only a way of reducing flood damage or irrigating fields, but was also the source of hydropower. The progress in technology in high dam construction, turbines, and high-voltage transmission lines was soon to fuel private and state investments in dams, and attendant State Power Boards (Sweden) and other water bureaucracies.

These technological innovations made large-scale water resources development possible and desirable. With the advent of the Tennessee Valley Authority (TVA) in the 1930s, launched by Roosevelt in the aftermath of the economic crisis, river basin development was taken to new heights by combining the concept of unified development (the damming of all the streams of a given river basin to bring the river under total control), the benefits of multipurpose dams (hydropower, flood protection, transportation, irrigation and other users), and the idea of regional development (associating water development with other interventions such as reforestation, production of fertilisers, industrial development, etc). These ideas were soon expanded to the Colombia basin in the US which was to become the 'battery' of the western coast, with the first concrete for the grandiose Grand Coulee dam poured in December 1935.

Similar appeals for large-scale projects and planned development had arisen in Russia, where "the Soviet fascination with technology as a panacea for social and economic problems mirror[ed] that in the West" (Josephson, 1995). Technology, mechanisation, and large-scale centralised planning and production processes were part and parcel of a vision of a "supremely rational society". In the late 1920s, Stalin's "bulldozer technology" planned massive hydropower plants, domestication of rivers, and hydraulic works, including the damming of the Volga river (that was to be realised after World War II) and the infamous White Sea-Baltic canal built in the 1930s by hundreds of thousands of slave labourers under the slogan "we will instruct nature and we will receive freedom" (Josephson, 1995).

For the western Indian region called the Bombay Deccan, a historically famine-prone region, Attwood (2007) shows the impact on human welfare of a combination of the construction of railways (from the 1850s-1860s), rural employment/food-for-work programmes, and the triggering of farmers interest in canal irrigation (in the first decades of the 20th century). The former led to a stabilisation of food prices, the second to improved purchasing power of impoverished landless labour, and the latter to increases in local food and particularly cash crop production, leading to economic and population growth. Together they made rural famines a thing of the past. Before 1921 life expectancy at birth was usually less than 24 years; seven out of ten children died before maturity. At present life expectancy is 63 years; child mortality a quarter of what it was a century ago. While Attwood states that "technical improvements may solve some problem while worsening others" (waterlogging and unequal distribution of water and its benefits in this case, for instance), and that after Indian independence irrigation systems "instead of becoming technically and economically more efficient, new canal systems have been extremely wasteful", the historical importance and impact of providing public infrastructure have been enormous. It is in this period that the Indian public works/irrigation bureaucracy was established and expanded.

In the post-war period of the 1950s and 1960s, marked by the need for reconstruction and growing food for a world in shambles, grandiose water resources development schemes were soon found to be in high demand. This was fuelled by the search for national symbols; the context of the Cold War with the Soviet Union and the US vying for symbolic pre-eminence and engaged in proxy-wars in several

countries; and – last but not least – the gradual access to independence of most countries in Asia and Africa. This led to three distinct but interrelated forms of the hydraulic mission that combined to give way to its apogee: first, a re-enactment of the 'Oriental despotism' of ancient times in the Soviet Union and communist China; second an (often) state-led massive capital investment in hydropower dams in western countries (together with irrigation in countries like Spain, Australia, or the western US); and, third, a 'postcolonial despotism' in newly independent 'third-world' countries.

In the Soviet Union, electricity production, and how it would transform society and the economy – a vision long nurtured by Lenin – (Josephson, 2002) received much attention, with Stalin launching his Big Volta Project – epitomised by the Kuibyshev dam – as well as his 1948 "Plan for the Transformation of Nature", a reminder of Gorki's call to "turn mad rivers sane" (Josephson, 2002). In 1953, Khrushchev established his 'virgin-land' policy aimed at intensifying agriculture, which included the expansion of irrigation in Central Asia (from 4.5 million ha in 1965 to 7 million ha in 1991; see Wegerich, 2008). Floated in the 1930s and studied during the 1960s and 1970s, the Siberian River Reversal – a grand project that was to dam northern rivers and make them flow backward, step by step, to the populated agricultural areas of Central Asia – epitomises large-scale projects of that time.

Stalin's Transformation of Nature was echoed by "Mao's War against Nature" (Shapiro, 2001). In the early 1950s China started to plan major flood control and hydropower projects under the advice of Soviet engineers, with – for example- the Sanmenxia dam displacing over 400,000 people and resulting in siltation, salinisation and financial losses. In 1958 and during the "Great Leap Forward" armies of workers were unleashed in major conservancy projects and other iconic projects such as the Red Flag canal.

Figure 1. Inauguration of a canal during the Great Leap Forward



Source: www.iisg.nl/landsberger/rfc.html

In the US, the Bureau of Reclamation and the US Army Corps of Engineers engaged in a sweeping damming of the country's rivers, in a process well described by authors like Worster (1985), Pisani (1992) and Reisner (1993). While irrigation and hydropower generation were the main objectives in the West, Zetland (this issue) recalls how urban sprawl in California was also deeply part of the story. A gigantic project to transfer water from Alaska through the arid West down to Mexico can be taken as the equivalent of the Soviet Siberian river reversal project. Indeed the damming of the Columbia basin and the celebration of America's most iconic dams, such as the Grand Coulee, were the replications of

the Soviet schemes on the Dnepr and the Volga, with its Kuibyshev dam, with the two countries forcefully engaged in a (cold) war of symbols aimed at proving to the world the superiority of their economic/political systems (see Josephson, 2002). For the case of Spain, Lopez-Gunn (this issue) describes how the relentless construction of 800 dams (and irrigated schemes) during Franco's regime was a way of legitimising his power, buying support from rural elites, and producing icons of modernity under the aegis of the *Dirección General de Obras Hidráulicas* (DGOH, established in 1942). Hydropower development soared in countries like Canada (with the establishment of Hydro-Quebec in 1944), in Norway and in Sweden where rivers were "industrialised" (Jakobsson, 2002), or in France, where the Rhone river was equipped with several run-of-the-river dams, "replacing the wild and devastating river with a useful river" and offering the Donzère-Mondragon dam as a national symbol (Pritchard, 2004).

In what was then referred to as the Third World, elites and governments – most notably in newly independent countries – were pressed to deliver 'the fruits of development' to their constituencies and by the necessity to strengthen nation building and the legitimation of their power. These elites enthusiastically embraced the icons of modernity and development epitomised by large-scale irrigation schemes and dams, famously referred to by Nehru as "the temples of modern India". In that they were supported by Western countries – or the Soviet Union, depending on who they sided with in the context of the Cold War – which had both economic and geopolitical interests in fuelling this 'post-colonial hydraulic mission'. Massive investments – most pre-eminently in dams and irrigation systems – in countries with potential rural instability were thought to be the best defence against the spread of Communism. This is where the TVA, marketed in particular by the prophetic tone of Lilienthal's (1944) book *TVA: Democracy on the march*, was to both become an icon of modernity and development and prove a major asset of US overseas development and diplomacy (Ekbladh, 2002): in a matter of years the TVA would become the "grand-daddy of all regional development projects" (Scott, 1998), embodying the social engineering drive that Scott (1998) has termed *high-modernism*, and inspiring a multitude of TVA-like projects in countries as diverse as Sri Lanka, Afghanistan, Columbia, China, South-Africa, and in the Jordan, Danube and Mekong river basins.

Despite the salient role of industrialised countries' companies in both design and construction (not to mention the financing provided by international development banks), the realisation of the hydraulic mission necessitated the creation of national water bureaucracies entrusted with the planning and/or construction of hydropower dams, reservoirs and canal networks for irrigation. The economies of Third World countries were still largely agriculture-based but yields and incomes were stagnant, pressure on land resources and indebtedness increasing, and food security often seen as a national goal. In other words, the urgency and inevitability of the hydraulic mission was obvious, as well illustrated by South Africa where P.K. Le Roux declared (RSA, 1962; cited in Turton et al., 2004) that

In the history of all young civilised countries the time arrives when big and imaginative water development projects must be launched to promote the growth of areas of development, the formation of industries and the generation of electric power, and to create a means of coping with the future population increase, so as to maintain the rate of progress for the country as a whole. That is the principal aim of the Orange River Project.

The four decades following the Second World War would witness massive investments in reservoirs (large dams⁵ increased globally from 5,000 in 1950 to 45,000 in 2000, an average of two new large dams each day; WCD, 2000) while during the same period irrigated areas doubled, from 140 million hectares (ha) to 280 million ha (Molden et al., 2007). The hydraulic mission was in full swing: in South Africa, the Orange River Project was to be "bigger than the TVA itself" (Turton et al., 2004); in Mexico the SRH worked "for the glory of Mexico" (see Wester et al., this issue), while in the US irrigation

⁵ Large dams are defined as dams with a depth of over 15 m and/or a capacity over 3.5 million m³.

development was "pursued with near fanaticism, until the most gigantic dams were being built on the most minuscule foundations of economic rationality and need" (Reisner, 1993).

In other words, all the ingredients of 19th century scientism, hubris and utopias were alive and well. Beyond the objectives of food/energy production or self-sufficiency the hydraulic mission at its height was a celebration of technology and domination over nature, a linear view of history based on Rostowian stages – where mechanisation, intensification, and economies of scale would replace backward if not "barbarous" practices – and the acquisition of icons of prestige reinforcing Cold War ideologies or governments' legitimacy. Yet, beyond ideologies and political objectives, the eminent role of hydraulic bureaucracies was hardly visible on the front scene.

HYDRAULIC BUREAUCRACIES AND POWER, POLITICS AND MONEY

Hydraulic bureaucracies are, first and foremost, the creation of nation states and reflect a number of their concerns and objectives. If, as stressed by Wittfogel, centralised despotic states have emerged from the need of large-scale investments in water control, these needs have also been sometimes concomitantly used by states to strengthen their legitimacy. In the case of Vietnam, as emphasised by Evers and Benedikter (this issue), the post-reunification Vietnamese State revived the wartime rhetoric and propaganda to rally people around massive works of canal digging and dredging and embankments construction. Social cohesion achieved through collective undertakings contributed to state building.

But bureaucracies have their own sets of interests and ideologies. Bureaucratic power is strongly correlated with the size of the budget received from state coffers, the number of staff, and in the case of water the heavy equipment needed for infrastructural interventions. This power is therefore dependent upon fuelling and sustaining the cycle that goes from planning to the construction of infrastructures. In many countries, and Thailand is a good example, water departments keep on their shelves master plans with projects pencilled in to dam every single river that lends itself to dam construction, linked to the attendant development of irrigation areas (or where it is not the case, to flood control or hydropower objectives).

Beyond this institutional incentive, water and bureaucrats are also moved by a professional background where professional gratification is linked with the possibility to be associated with iconic projects where interventions on river systems are seen as the manifestation of the much-needed control of nature by humankind. Many dam projects are presented as obvious, inevitable, urgently needed and enjoying an ideal location allowing water control and hydropower generation, and can become an "engineer's dream" and a "once in a lifetime project", as stated by Lyle Mabbott, the Pa Mong project⁶ manager (Jenkins, 1968). This professional ethos is pervaded by a sense of hierarchy, a faith in planning, and the belief that the considerable technical expertise needed to address water issues insulated engineers from public and laypersons' scrutiny (see Watson et al., and McCulloch, this issue). It has also been associated with the concept of "conservation", whereby scarce and valuable water resources must be put to use at any cost and in their entirety before they "run waste to the sea".

But, history tells us, the interests of nation states and hydraulic bureaucracies in water resources development is also shared by four other categories of powerful actors, namely politicians, construction companies, landed elites and development banks (see Molle, 2008 for further analysis of this web of interests). Water bureaucrats, state-level and local politicians, water business companies, and development banks are often tightly associated in 'synergetic relationships' whereby the ways the flows of water are created or modified by water infrastructure are intertwined with flows of power and influence, often manifested in the form of political or financial benefits, whether private or collective.

Collusion between business, politics and bureaucrats in the water sector is a commonality shared by virtually all countries (Repetto, 1986) and has been well documented in countries such as Japan

⁶ The Pa Mong dam was planned to be built on the Mekong river in the 1960s and 1970s and would have been the biggest dam in the world at that time.

(Feldhoff, 2002) and the US (Reisner, 1993; McCool, 1994). These groups are associated in 'iron triangles' (Woodall, 1993), systems of vested interests that encourage bribery, bid-rigging, exchange of favours, or simply overestimation of benefits and neglect of costs in order to secure a steady flow of projects. Lopez-Gunn (this issue) refers to the Spanish "steel and concrete brotherhood" and public evidence in the 1990s of revolving doors and closed, nepotistic relationships between the DGOH and the big construction companies, intersecting the interests of politicians in the electoral value of water projects. In Thailand "irrigation projects are large and visible rewards that politicians can offer in exchange for support. Members of Parliament are active in lobbying RID [Royal Irrigation Department] for projects, at the request of their constituencies. MPs and representatives in provincial assemblies may be contractors themselves or have links to them and stand to gain from building projects" (Bruns, 1991). Evers and Benedikter (this issue) describe the seamless relationship between decision-makers in water bureaucracies and the construction companies. According to Briscoe (1999) "Rent-seeking behaviour is deeply embedded in the social and political fabric of all major irrigating countries and thus changes only slowly and usually because of major exogenous threats".

In the US, the so-called 'iron-triangle' linking state politicians, federal agencies and private companies has long been famous for blurring the frontier between private and public benefits (Gottlieb, 1988; Worster, 1985; Zetland, this issue). Projects were, in particular, fuelled by 'logrolling', or the trading of votes between legislators pushing for their own project (the "Thou shall not attack a project from another district" principle; see Gottlieb, 1988).

In the South interest groups often form 'iron rectangles' (Molle et al., 2009) with the additional interests of development banks. For development banks, large projects hold the promise of concrete and large-scale changes, maximising aid flow while minimising project management costs (Howe and Dixon, 1993), but staff members of Banks also have vested interests (promotion and end-of-the-year bonuses) in maximising loans and disbursing money. This has given way to what has been termed "the lending culture", which is particularly perverse in a context where there is hardly any financial sanction for the banks, or individual officers, in case of a failed project.

Other apexes of these interest networks often include farmers and landed elites where irrigation is concerned. Lopez-Gunn (this issue) recalls the influence of farming elites in Spain in the development of water resources and the maintaining of the share of irrigation in allocation. Smythe, Powell and others had foreseen the advent of smallholder irrigation in the US as an activity that would guarantee independence, collaboration, equality, and democracy. Yet, as Worster (1982) argued, irrigation eventually did "little to promote democracy, that instead it was capable of creating a Leviathan in the desert". According to Worster the pursuit of profits by large-scale farmers stumbled over the evidence that the large-scale hydraulic infrastructures needed to store and mobilise distant water, which led to a call for state, and later federal, intervention, prompting the emergence of powerful hydraulic bureaucracies and the establishment of a durable *modus vivendi* of mutual dependence and shared benefits.⁷

Many examples of these synergic relationships could be given but they are well encapsulated by the example of India where members of state parliaments, MLAs (Members of the Legislative Assembly), have a strong interest in perpetuating the 'supply orientation' of water bureaucracies, that is, the

⁷ To better appreciate this historical turn it is interesting to quote at length the prophecies of William E. Smythe in his book *The Conquest of Arid America*. Smythe envisioned the establishment of a society based on the labour of industrious and independent small farmers intensively cultivating their land:

The future of California will be very different from its past. It has been the land of large things – of large estates, of large enterprises, of large fortunes. Under another form of government it would have developed a feudal system, with a landed aristocracy resting on a basis of servile labor. These were its plain tendencies years ago, when somebody coined the epigram, 'California is the rich man's paradise and the poor man's hell'. But later developments have shown that whatever of paradise the Golden State can offer to the rich, it will share, upon terms of marvellous equality, with the middle classes of American life. Over and above all other countries, it is destined to be the land of the common people... Upon the ruins of the old system a better civilization will arise. It will be the glory of the common people, to whose labor and genius it will owe its existence. Its outreaching and beneficent influence will be felt throughout the world.

latter's focus on physical construction of new infrastructure or rehabilitation of existing water control systems. (Re)building of infrastructure allows an MLA to 'show his/her metal' to constituents, as well as extract financial resources to fund political campaigning, that is, generate funds to secure re-election.⁸

Being elected from a specific constituency MLAs are centrally involved in the implementation of government policies and programmes in their constituencies. Their role can be understood as that of 'resource brokers'. "[A] successful MLA is a 'fixer' (...), someone who can get a man a job, divert development monies into the constituency, help secure a contract, find a place in a school or a hospital" (Potter, 1986). "[I]n exchange for electoral support [groups] gained access to resources" (Manor, 1989). The phenomenon has been labelled as 'competitive populism' (Frankel, 1990). One of the best things an MLA can do is get an irrigation canal constructed, extended or repaired to improve water supply to farmers in his/her constituency (Ramamurthy, 1995). For example, the Hemavathy irrigation project in the Cauvery basin was originally designed as an intensively irrigated rice scheme, but under political pressure the design was extended to include many additional (sub) districts and constituencies, while keeping available water constant. The envisaged cropping pattern changed from rice to 'irrigated dry crops' with the extension of canal length and commanded area, water being theoretically spread thinly to a larger number of irrigators. In the Tungabhadra Left Bank Canal in the Krishna basin a case was found where the length of a secondary canal was doubled as the implementation of an electoral promise, without a change in water availability for the canal.

The populist logic of such extension and spreading of irrigation canal systems is that of "equal benefits for all", which, however, is not realised in practice. The main political support base for MLAs in most rural constituencies is the rich peasants. Rich peasants act as 'resource brokers' in local situations themselves, and thereby wield considerable local political influence. Rich peasants tend to appropriate more than their share of the theoretically thinly spread irrigation water. This is unlikely to be opposed very strongly by MLAs, as this might endanger their re-election, which strongly depends on their rapport with local leaders controlling 'vote banks'. The resulting unequal distribution of irrigation water is usually represented in geographical terms as the difference between 'head-enders' and 'tail-enders' and the blame put on the irrigation bureaucracy's poor management. With their populist discourse MLAs depoliticise the issue of unequal water distribution. The role of class and other social relations of power as cause and consequence of unequal distribution are obscured by homogenising farmers into a single category and defining a common enemy in a poorly functioning irrigation department.

The leverage of the MLA over government bureaucrats is based on his/her power over the compulsory transfers of these bureaucrats every 3 years. In the informal 'market for public office' bureaucrats have to pay for good postings, or for avoiding being transferred to unfavourable ones. The money for this is generated largely through construction contracts, which are the basis of the system of administrative and political corruption in the water sector. The funds thus generated finance the electoral process (see Wade, 1982, 1984, 1985 for detailed analysis). The hydraulic mission orientation is thus not just supported by water resources professionals' dispositions and private and institutional interests, but equally, if not more importantly so, by elected politicians as the construction activities associated with that 'mission' play a structural role in the reproduction of the political system.

CHALLENGES TO HYDRAULIC BUREAUCRACIES

The rise to power and the pre-eminence of hydrocracies during the hydraulic mission era have met with increasing challenges during the past 40 years. Internationally, the environmental destruction wrought by the hydraulic mission led to increasing protests, starting in the 1960s and 1970s, with the rise of the environmental movement and opposition to new dams (Allan, 2002). This was strongly the case not only in the western USA (Berkman and Viscusi, 1973; Gottlieb, 1988; Feldman, 1991; Reisner, 1993) and in the Netherlands (Disco, 2002; Wiering and Arts, 2006), but also in many other countries where the

⁸ This discussion is based on Mollinga, 2003.

power of hydrocracies started to be challenged. This has led to increasing calls for an "ecological turn" in water management (Disco, 2002; Allan, 2006), with more emphasis being placed on "putting water back into the environment" (Allan, 2002). Besides the environmental challenge, hydrocracies have faced challenges from other bureaucracies within the state, the drop in funding for water infrastructure, growing protests from civil society, and decentralisation processes.

The first challenge has been internal, with *rivalries between hydrocracies and other state bureaucracies*. The rent-seeking opportunities and the power of the discourse justifying large-scale public water investments make it hardly surprising that dominant bureaucracies have frequently faced competition from other departments or ministries. In Thailand for example, the supremacy of the Royal Irrigation Department came to be challenged in the 1970s by the rise of the Department for Energy Development and Promotion (DEDP). DEDP was first established as an instrument to foster projects that could make use of the (temporary) surplus hydropower made available by new large dams. While DEDP started with the planning and implementation of collective pumping stations designed to irrigate a few hundred hectares each (these stations ended up dotting Thailand's waterways by the thousands), it soon found itself planning mega-projects such as the Khong-Chi-Mun diversion project, which envisioned bringing the water of the Mekong to irrigate several million hectares in Northeast Thailand (Molle and Floch, 2008). A similar competition was observed recently between the ministry of agriculture and the ministry of natural resources and environment, both struggling to impose their version of a multi-billion-dollar project dubbed the "Thai water grid".

The most classic example is provided by the intense rivalry in the US between the Bureau of Reclamation and the US Army Corps of Engineers, who strongly competed with each other to build dams in the western US (Reisner, 1993). Another example is the competition between the Irrigation Departments in Pakistan and the Water and Power Development Authority (WAPDA), created in 1958 at the federal level to allocate and manage water at the national level and to construct large water works (van Halsema, 2002).

The most common type of competition has been between the water bureaucracy and the agricultural bureaucracy, like the long-standing struggles between the ministry of housing and local government and the ministry of land and natural resources in the UK (McCulloch, this issue). In Mexico, the struggle between the hydrocracy and the ministry of agriculture took on epic proportions, with the hydrocracy using the argument that the state should develop and manage water through a central water authority to safeguard and regain its autonomy (Wester et al., this issue). The competition between water and agricultural ministries sometimes results in a division of roles, with the ministry of water responsible for large-scale infrastructure and the ministry of agriculture in charge of smaller infrastructure. The Netherlands is a clear example of this, with Rijkswaterstaat taking on the large water works, and the ministry of agriculture in charge of land consolidation programmes. In other countries, usually where agriculture is a major activity, as in Vietnam (with the ministry of agriculture and rural development), both responsibilities may be conflated under one single powerful administration.

Lastly, a special case of rivalries between hydrocracies is between agencies specifically set up for hydropower development and more generalist hydrocracies, such as the Federal Electricity Commission in Mexico and the National Water Commission and its predecessors. This includes river basin development agencies not directly falling under the control of a national hydrocracy, such as the Tennessee Valley Authority (TVA) and the Organization for the Development of the Senegal River Valley (OMVS).

A serious threat to the power of water bureaucracies has been the *financial squeeze* that has beset many countries since the 1980s. With state budgets under pressure, expenditures curtailed under structural adjustment programmes or otherwise, the large inflow of money that fuelled the unchecked cycle of water resources development came to be threatened. Most often, under the pressure of development banks, many water administrations have been downsized or reformed. The paradigmatic example is that of the National Irrigation Administration (NIA) in the Philippines, which became a "financially autonomous agency" in the early 1980s, meaning it no longer received government

subsidies for irrigation management, operation and maintenance (O&M), but had to rely on irrigation service fees collected from water users to finance its budget (Oorthuizen, 2003). After a period of rapid growth in the 1970s, with a 20-fold increase in the budget between 1971 and 1979, and its number of staff rising from 3000 in 1965 to a peak of 43,000 in 1977, NIA experienced a dramatic decline in its budget in the early 1980s and was made responsible for repaying foreign loans for irrigation investments from its own budget (Oorthuizen, 2003). In Morocco, the *Offices de Mise en Valeur* have seen the number of staff curtailed and a number of services have been privatised or outsourced.

Financial dearth, together with a neoliberal critique of state management, has also been a key factor behind the adoption of participatory irrigation management programmes worldwide. While the rationale of such programmes appealed to the necessity of putting decision-making closer to the users and their problems it also included an attempt to shift part of the O&M costs of water infrastructures to the users themselves. This move was also associated with growing frustration among donors and bankers concerning the escalating costs of the construction and frequent rehabilitation of irrigation schemes. In some countries, however, the pressure to reform water bureaucracies was partly ducked and these hydrocracies – like the Royal Irrigation Department in Thailand, the DSI in Turkey, or Indian hydrocracies – retained most of their status. In other cases, budget reductions merely translated into delayed and deferred maintenance and further degradation of infrastructures.

A third challenge to hydraulic bureaucracies has come from *environmental movements*. The emergence of environmental values worldwide in the 1970s resulted in the passing of many environmental acts/laws and the establishment of ministries dealing with the environment and (often) natural resources. One of the striking examples of how water bureaucracies have had to adapt to shifting societal values is provided by Espeland's (1998) account⁹ of the effects of the 1970 National Environmental Policy Act (NEPA) on the Bureau of Reclamation and the Orme dam it wanted to build as part of the Central Arizona Project. The need for environmental impact statements (EIS) and the new type of staff (sociologists and biologists) that joined the Bureau as a result of NEPA, combined with public opposition, finally led to the decision not to build the Orme dam. However, the deeper effects of the Orme dam controversy was that it changed the Bureau, with EIS and public involvement in decision making now institutionalised (Espeland, 1998). A similar process occurred in the Netherlands, where debates in the 1970s on the Oosterschelde storm surge barrier, spearheaded by environmentalists and a small group of activists from Yerseke (de Schipper, 2008), led to drastic design modifications and deeper changes in the Dutch hydrocracy (Bijker, 2002; Disco, 2002; Wiering and Arts, 2006). Yet, on balance and looking at the world level, environmental concerns have been only moderately – and often, marginally – incorporated in the worldview and practice of hydrocracies.

More generally, water bureaucrats have been challenged by *civil society*. One paradigmatic illustration is that of the many social movements against dams in the 1990s which contributed to a slump in the construction of large dams and the cancelling of a number of projects. This culminated in the setting up of the World Commission on Dams in 1998, which tried to establish standards to ensure fair and balanced decision-making.

Popular mobilisation has also been instrumental in derailing the Spanish National Hydrologic Plan, as explained by Lopez-Gunn (this issue); one of the most contentious points of the Plan was the transfer of water from the Ebro to the south east of Spain while other interbasin transfers have also run into public opposition and been shelved.

Centralised water bureaucracies are also threatened by *decentralisation of power to the regional or local levels*. This process implies that decision-making is increasingly shifted to the level of the persons concerned by the projects, their benefits and also their externalities. In the case of the Mekong delta in Vietnam (see Evers and Benedikter, this issue), this has led to the growth of hydraulic bureaucracies at the provincial level but the influence of the central government remains high (with also a high

⁹ Espeland's account, together with Gottlieb's (1988) book on water in California, is one of the very few long-term analyses available on the inner working and transformations of water bureaucracies written by insiders.

representation of people from northern Vietnam in local hydraulic companies) both through state-owned or military-owned construction companies (which implement the biggest projects) and its crucial control over, or influence in, the bidding processes of infrastructural projects.

In Spain, the power, long concentrated in the *Dirección General de Obras Hidráulicas* (DGOH), was partly fragmented in the process of regionalisation which saw Spain's regions acquiring increasing political and financial autonomy. Lopez-Gunn (this issue) shows how the hydraulic mission has been replicated at the provincial level after the weakening of the concept of national solidarity on which the central government previously based its hydraulic plans of 'general interest'. Construction interests have moved to the provincial level – where water resources development is again used to strengthen and legitimise regional powers – and are thriving on capital-intensive projects that now include desalination and treatment plants. This fuels a revival of neo-corporatism and the suspicion that rent-seeking has also been decentralised.

The tension between the central and provincial governments is particularly acute in federal countries such as the United States, Canada, Mexico, Brazil, Australia, India or Nigeria, where relationships between federal and state prerogatives about water have always been a key aspect of water management. In most of these settings regional states tend to pursue their own hydraulic mission, with a focus on their interests rather than on wider river basin management or environmental health: this is clearly visible in India, where states tend to 'rush for water' irrespective of what happens in other riparian states or of past agreements; and also in more regulated contexts such as the Murray-Darling basin in Australia where the federal government eventually had to step in to regulate state water use (see Crase et al., this issue), or in the Colorado basin (Kenney, 2009).

A last threat is that of the emergence of *supra-national layers of governance*. This is well illustrated by the elaboration and current application of the EU Water Framework Directive (WFD), which aims at achieving a "good ecological status" for EU water bodies by 2015. The Directive comes with a number of economic concepts – the user-pay, polluter-pay, and full cost-recovery principles – as well as mandatory participatory orientations that theoretically override national strategies (or lack thereof). Whether the organisation of water management at the basin level, the polluter-pay principle and full cost-recovery are going to be fully applied is doubtful (they seem to frequently gloss over socio-economic and political realities) but they do prompt adjustments in water bureaucracies. Watson et al. (this issue) argue, however, that in England participation has been minimal and the WFD 'absorbed' by the Agency but the interbasin transfers of Spain's National Hydrologic Plan were partly derailed because of their non-adherence to its economic or environmental principles (see Lopez-Gunn, this issue).

REPRODUCTION STRATEGIES IN A CHANGING WORLD

Faced with this host of challenges water bureaucracies, like all bureaucracies, have adopted several strategies to secure their interests or reinvent themselves in a changing world. The resistance of hydrocracies to change and their resourcefulness in maintaining their command-and-control and construction orientation – under the guise of apparently drastic institutional reforms – has been highlighted by Mollinga and Bolding (2004), based on in-depth studies of irrigation reforms in seven countries. Gottlieb (1988) and McCool (1994) make a convincing argument that this is also the case in the western USA, while Mollinga (2008) paints a similar picture for India. This raises the question whether there is something special about hydrocracies that makes them resilient to change, as suggested by Lach et al. (2005) for the US.

One of the strategies hydrocracies have followed has been to *shift costs to users*. In some cases, as in the Philippines case mentioned earlier, external pressure added to a political will to reduce costs have meant that water bureaucracies have had to accept a sharp reduction of their budget. In other cases, they have (in general reluctantly) accepted to adopt cost-recovery policies, with hikes in water charges (or establishment of such charges in countries where there were none). In many instances, as in

Sri Lanka, Thailand or Pakistan these policies created attrition and popular opposition and were soon aborted.

In Turkey, the transfer of the financial burden of O&M to farmers was the main objective of the irrigation management turnover programme (Ünver and Gupta, 2003). In Mexico, the "Big Bang" approach to irrigation reforms was pioneered in the early 1990s, with a very rapid transfer of irrigation management and the associated costs to water user associations (Rap et al., 2004). However, the transfer programme also strengthened the hydrocracy's control over the irrigation districts, and it was part of a broader policy package that made it possible for the hydrocracy to regain bureaucratic and financial autonomy (Rap et al., 2004).

A second strategy has been to *capitalise on the rhetoric on privatisation* and its alleged benefits, most of the time propelled by development banks. It is increasingly apparent that the pressure exerted by the neoliberal discourse about "rolling back the state" has been aptly capitalised upon by private economic interests which have succeeded in promoting the transformation of public services (often monopolies) into for-profit private businesses (also often implicit monopolies) (see Galbraith, 2008).¹⁰ In some countries, like Morocco or Vietnam (see Evers and Benedikter, this issue), officials in charge of maintenance in irrigation districts were able to buy the public machinery of their agency to set up a private company which would be hired to deliver the same service. In Iran, management of some irrigation schemes has been taken over by semi-private companies mostly staffed by the very same persons previously in charge of operations. Rap (2004) provides striking instances of how irrigation management transfer in Mexico provided benefits to previous employees of the hydrocracy and for the presidents of the new water user associations. In Thailand, East Water – a private company set up to serve the tourist and industrial hub on the South East of Bangkok – buys water from the Royal Irrigation Department at very low cost and sells its back to users with a handy profit: the company's board membership includes several figures of the Thai water establishment.

In many countries, project planning and design capacity have been shifted to private companies or consultants belonging to academia. In South Africa, for example, the government has outsourced most of its technical capacity and expertise to the point that it is virtually unable to take decisions without resorting to costly consultancies. These apparent losses of prerogatives by hydraulic bureaucracies have been compensated by the fact that many of these consultants are former civil servants who capitalised on the new policy by opening their own businesses; they now carry out studies similar to those they were formerly doing in the administration but with much higher payoffs. It is doubtful that this change is beneficial to the government and the country but its desirability is predicated upon the (dubious and purported) claim for efficiency trumpeted by market fundamentalists. In other cases, there is a seamless interaction between water bureaucrats and consulting firms which frequently share the benefits associated with the funds released for particular studies.

A *counter-strategy* to pressures towards decentralisation and subsidiarity has consisted in taking advantage of the observed difficulty in harmonising competing claims from provinces or subbasins and coordinating their needs and actions to recentralise decision-making. For example, the relative ineffectiveness of the efforts of Australian states in reducing water over-allocation led to a re-concentration of decision-making power at the central level (Turrall et al., 2009; Crase et al., this issue). McCulloch (this issue) describes how in the UK and Wales water control was gradually concentrated in the Water Resources Board during the 1964-1973 period but also how the board was gradually undermined by its lack of remit over quality and environment issues and by privatisation trends. Challenged by the ministries for the environment, which claim a regulation role over natural resources, water bureaucracies in the ministries of agriculture – as can be seen in Southeast Asia, for example – frequently lobby for the establishment of a water ministry with extended power over water resources planning and management. Likewise, despite the growing power of Spain's regional governments in

¹⁰ This can be seen in the health or education sectors and probably most clearly in the telecommunications sector with virtual monopolies in mobile phone operators that can be observed in countries as diverse as Mexico, Thailand or France.

water issues, the failure to harmonise competing claims might well lead to a re-centralization of power as foreshadowed by the merging of the environment and agricultural ministries in 2008, seen by some as the return to power of the old 'hydraulic' guard after a number of years when the New Water Culture movement was very influential with the earlier ministry of environment (see Lopez-Gunn, this issue).

A fourth strategy has consisted of hydrocracies *diverting, neutralising and reconfiguring institutional reform efforts* they have been confronted with. Such reform programmes have been implemented as part of development loan packages as provided by international agencies, with the substantive elements of such reforms often strongly shaped by multilateral funding agencies, with more or less support of sections of national governments depending on the case. In the irrigation sector there is a long history of such reforms (Mollinga and Bolding, 2004).

The reform of the NIA in the Philippines is an early (1980s) and famous case in irrigation studies. A close look at that reform history shows that the introduction of 'financial autonomy' of the irrigation agency, which would assumedly enhance its management orientation and performance and would make it more accountable to water users, has not exactly accomplished that. Through clever management of its (mostly foreign-funded) project budgets and other mechanisms, the organisation has managed to maintain its construction orientation, while irrigator influence in governance and management has remained as limited as it was (Oorthuizen, 2004; Panella, 2004). The case of irrigation reform in the 1980s and 1990s in Indonesia under the Suharto regime is equally interesting. The World Bank and Asian Development Bank pushed reform packages to decentralise management to water user associations, to achieve greater accountability of the irrigation administration to farmers, and to shift the orientation of the hydrocracy from construction to management, that were effectively 're-routed' by the Indonesian irrigation bureaucracy (Suhardiman, 2008). The agency successfully insisted on doing physical rehabilitation of systems before turnover of management, and by defining basically all irrigation systems as 'government schemes' in need of physical improvement, even when many systems were farmer- managed (Bruns, 2004).

A similar story can be told about the Andhra Pradesh, India irrigation reform effort that started in 1996. This is a story of an attempt at radical reform through legislating a reorientation of the irrigation agency towards a 'service-oriented' bureaucracy, and legally prescribed elected bodies of irrigators at different levels of the system (water user association or WUA, distributary committee, and project committee) as the structure of farmer management and governance. The first two, lower, levels of committees were created through elections for WUAs in 1997; the project committees in the state were only constituted in 2009. The first wave of reform, which lasted into the early 2000s was, to a large extent, captured at field level by a class of richer peasants- *cum*-local contractors-*cum*-party cadre, undermining the representation and accountability component (Mollinga et al., 2004). The irrigation department managed to regain much of its lost ground through amendments to the Act that is the basis of the reform (Nikku, 2006).¹¹ The political momentum of the reform declined as reform programmes multiplied across sectors, as well as through a series of drought years in the early 2000s that meant a strong reduction of irrigated areas, as well as being instrumental in the electoral defeat in 2004 of the chief minister of the state that started the reform. Donor interest in the reform waned in the process.

Stopping here and concluding that everything is as it was before, would, however, be a mistake. The Andhra Pradesh reform process, no matter how imperfect it was as against its stated objectives, has created a constituency of farmer-irrigators pursuing change, and a group of senior bureaucrats has continued to make attempts to further the reform, or bring it back on track. This is undoubtedly a slower process and one less prone to media attention than the 'big bang' approach of 1996-97 with all its national and international political fanfare, but it may be the *longue durée* of irrigation reform. The establishment of the project committees in 2009, which are potentially powerful farmer-governing

¹¹ Cf. Suhardiman (2008) on the Indonesian public works bureaucracy successfully reshaping the Water Law to neutralise reform that would have reduced the power of the agency.

bodies, as well as the creation of multidisciplinary teams in the irrigation agency for project management, suggest that the reform process is continuing. Research attention has often been focussed, at least in the irrigation sector, on the more spectacular episodes of reform processes, and on those programmes formulated and/or implemented in the context of international development funding, probably not in the least because research funding also tends to be associated with such programmes. This may, we suggest, have created a bias in the way reform is looked at, with little attention to and understanding produced of 'internal' reform dynamics as compared to those driven by global reform paradigms and international development funding.

CONCLUSIONS

We conclude by suggesting some pertinent areas for further research on water bureaucracies.

First, the role of water resources development in nation building in our view merits further research, particularly from a comparative perspective. In this context, research could look at the ways irrigation, flood control and hydropower have played different roles in state formation, and at the impact of globalisation on the national character of water resources development.

Second, the internal dynamics of hydrocracies remains heavily under-researched, despite a slowly growing number of studies on the topic. The reasons for the lack of organisational ethnographies of hydrocracies, studies of water resources engineers as a profession, sociologies of water agencies, and social studies of government water science, for instance, are not totally clear. The difficulty to be both an insider and an observer at the same time, the technical orientation of these bureaucracies and the level of technical expertise required from (social science) researchers to enter the field might be some of the reasons; but hydrology, hydraulics and civil engineering are not quantum mechanics. A more likely explanation seems to us that 'critical' perspectives in water studies have tended to 'take the water users' side', and concentrate on the study of localised water management practices and resistance to the projects of state bureaucracies (cf. Baviskar, 2007).

Third, the 'hydraulic mission' notion, though very evocative, needs further unpacking. The strength of the construction, supply enhancement, harnessing water for full control etc. disposition of hydrocracies is very clear, but the reasons for this strength and persistence are only partly understood. Instead of evolutionary schemes of paradigm succession, a framework that looks at the reasons for dominance among competing paradigms seems to be closer to contemporary reality (Swatuk, 2008).

Fourth, it is reasonable to suggest that the transformations in the dispositions of water bureaucracies in recent decades have been mainly triggered or forced by environmental critique. Arguably, this will also be the case in the decades to come. Understanding causes and process of 'ecological turns' in water bureaucracies therefore seems important, and more generally, which political alliances in broader society facilitate bureaucratic transformation in the water sector.

Fifth, research on corruption in the water sector, another under-researched area in water studies, strongly suggests that in the context of developing countries international assistance (notably, development bank funding for infrastructural projects) has been very instrumental in the reproduction of water bureaucracies' technical orientations, notwithstanding stated objectives of reform in the recent period. This raises the question of the international development funding/water bureaucracies' alliance, for instance, as presently profiling in the context of debates on the Millennium Development Goals and climate change. Another alliance that merits more attention is that between hydrocracies and private construction businesses and consultants.

Sixth, an even less-common area of focus is that of the gendered character of hydrocracies, whether it is the gender composition of its staff, the masculinity of its organisational culture, or the gender dimensions of the technologies built and managed (cf. Zwarteveen, 2008).

Seventh, though there was a time when senior water professionals wrote 'memoirs of their working lives', the voice of water professionals is much less heard in this manner in current public debate. Biographies of water bureaucrats reflectively reporting on their careers and the projects they have

been involved in would be a significant contribution to the understanding of the evolution and dynamics of water bureaucracies.

All this and more – there is work to be done on water bureaucracies. We continue to welcome articles on the life and times of hydrocracies in the pages of *Water Alternatives*.

REFERENCES

- Adams, R. McC. 1974. Historic patterns of Mesopotamian irrigation agriculture. In Downing, T.E. and Gibson, M.G. (Eds), *Irrigation's impact on society*, pp. 1-7. Tucson: The University of Arizona Press.
- Allan, J.A. 2002. *The Middle East water question: Hydropolitics and the global economy*. London and New York: I.B. Tauris.
- Allan, J.A. 2006. IWRM: The new sanctioned discourse? In Mollinga, P.P.; Dixit, A. and Athukorala, K. (Eds), *Integrated water resources management: Global theory, emerging practice and local needs*, pp. 38-63. New Delhi: SAGE Publications.
- Atchi Reddy, M. 1990. Travails of an irrigation canal company in South India, 1857-1882. *Economic and Political Weekly* 25(12): 619-628.
- Attwood, D.W. 2007. Small is deadly, big is wasteful. The impact of large-scale industrial systems in western India. In Baviskar, A. (Ed), *Waterscapes. The cultural politics of a natural resource*, pp. 11-39. Ranikhet Uttaranchal: Permanent Black.
- Barker, R. and Molle, F. 2004. *Evolution of irrigation in South and Southeast Asia*. Comprehensive assessment of water management in agriculture, Research Report No. 5. Colombo: International Water Management Institute (IWMI).
- Baviskar, A. (Ed). 2007. *Waterscapes. The cultural politics of a natural resource*. Ranikhet Uttaranchal: Permanent Black.
- Berkman, R.L. and Viscusi, W.K. 1973. *Damming the West: Ralph Nader's study group report on the Bureau of Reclamation*. New York: Grossman Publishers.
- Bijker, W.E. 2002. The Oosterschelde storm surge barrier: A test case for Dutch water technology, management, and politics. *Technology and Culture* 43(3): 569-584.
- Bray, F. 1986. *The rice economies: Technology and development in Asian Societies*. Oxford: Blackwell Publishers.
- Briscoe, J. 1999. The financing of hydropower, irrigation and water supply infrastructure in developing countries. *Water Resources Development* 15(4): 459-491.
- Brummelhuis, H. ten. 2007. *King of the waters: Homan van der Heide and the origin of modern irrigation in Siam*. Chiang Mai, Thailand: Silkworm Books.
- Bruns, B. 1991. The stream the tiger leaped: A study of intervention and innovation in small scale irrigation development in Northeast Thailand. PhD thesis. Cornell University, Cornell, USA.
- Bruns, B. 2004. From voice to empowerment: Rerouting irrigation reform in Indonesia. In Mollinga, P.P. and Bolding, A. (Eds), *The politics of irrigation reform. Contested policy formulation and implementation in Asia, Africa and Latin America*, pp. 145-165. Aldershot: Ashgate.
- Costa, J. 1911. Política hidráulica misión social de los riegos en España. Reprint [1982]. Madrid: Edición de la Gaya Ciencia.
- Crase, L.R.; O'Keefe, S.M. and Dollery, B.E. 2009. The fluctuating political appeal of water engineering in Australia. *Water Alternatives* 2(3): 440-447.
- de Bernon, O. 1997. Note sur l'hydraulique théocratique angkorienne. *Bulletin de l'Ecole Française d'Extrême Orient* LXXXIV: 340-348.
- de Caldas, R.S. 1939. Aspectos do problema das secas. In *Memorial das secas [collection of papers]*, pp. 123-150. Mossoro, Brazil: Colleição Mossoroense.
- Disco, C. 2002. Remaking "nature": The ecological turn in Dutch water management. *Science, Technology & Human Values* 27(2): 206-235.
- Eisenstadt, S.N. 1958. The study of oriental despotism as systems of total power. *Journal of Asian Studies* 17(3): 435-446.
- Ekbladh, D. 2002. "Mr. TVA". Grass-root development, David Lilienthal, and the rise and fall of the Tennessee Valley Authority as a symbol for U.S. overseas development, 1933-1973. *Diplomatic History* 26(3): 335-374.
- Endfield, G.H. and Nash, D.J. 2002. Missionaries and morals: Climatic discourse in nineteenth-century central southern Africa. *Annals of the Association of American Geographers* 92(4): 727-742.

- Ertsen, M. 2006. Colonial irrigation: Myths of emptiness. *Landscape Research* 31(2): 146-167.
- Espeland, W.N. 1998. *The struggle for water: Politics, rationality, and identity in the American Southwest*. Chicago: University of Chicago Press.
- Evers, H.-D. and Benedikter S. 2009. Hydraulic bureaucracy in a modern hydraulic society – Strategic group formation in the Mekong delta, Vietnam. *Water Alternatives* 2(3): 416-439.
- Feldhoff, T. 2002. Japan's construction lobby activities – Systemic stability and sustainable regional development, *ASIEN* 84: 34-42.
- Feldman, D.L. 1991. *Water resources management: In search of an environmental ethic*. Baltimore and London: The Johns Hopkins University Press.
- Frankel, F.R. 1990. Conclusion. Decline of a social order. In Frankel, F.R. and Rao, M.S.A. (Eds), *Dominance and state power in modern India. Decline of a social order*. Volume II, pp. 482-517. Delhi: Oxford University Press.
- Galbraith, J.K. 2008. *The predator state: How conservatives abandoned the free market and why liberals should too*. New York: Free Press.
- Gottlieb, R. 1988. *A life of its own: The politics and power of water*. San Diego: HBJ Publishers.
- Groslier, B.P. 1979. La cité hydraulique angkoriennne: Exploitation ou surexploitation du sol? *BEFEO (Paris) T LXVI*: 161-202.
- Guerra, P. and Guerra, T. 1980. *Seccas contra as seccas*. Mossoro, Brazil: Colleção Mossoroense.
- Haghe, J.-P. 1998. Les eaux courantes et l'Etat en France (1789-1919): Du contrôle institutionnel à la fétichisation marchande. PhD thesis. l'Ecole des Hautes Etudes en Sciences Sociales, Paris.
- Haghe, J.-P. and Barraqué, B. 2001. Un ingénieur des Ponts et Chaussées hydraulicien: Nadault de Buffon. Paper presented at the International Symposium OH2: Origins and History of Hydrology, Dijon, May, 9-11, 2001.
- Halsema, G. van. 2002. Trial and re-trial: The evolution of irrigation modernisation in NWFP, Pakistan. PhD thesis. Wageningen University, Wageningen, the Netherlands.
- Hamilton-McKenzie, J. 2009. California dreaming: Selling the irrigationist dream. *The Journal of Historical and European Studies* 2: 27-38.
- Hope, E. 1900. *General Sir Arthur Cotton: His life and work*. London: Hodder & Stoughton.
- Howe, J.A. and Dixon, J.A. 1993. Inefficiencies in water project design and operation in the Third World: An economic perspective, *Water Resources Research* 29(7): 1889-1894.
- Jakobsson, E. 2002. Industrialization of rivers: A water system approach to hydropower development. *Knowledge, Technology and Policy* 14(4): 41-56.
- Jenkins, D. 1968. The Lower Mekong Scheme. *Asian Survey* 8(6): 456-464.
- Josephson, P.R. 1995. "Projects of the Century" in Soviet history: Large-scale technologies from Lenin to Gorbachev. *Technology and Culture* 36(3): 519-559.
- Josephson, P.R. 2002. *Industrialized nature: Brute force technology and the transformation of the natural world*. Washington, DC: Island Press.
- Kennedy, D.J. 2009. The Colorado river: What prospect for 'a river no more'? In Molle, F. and Wester, P. (Eds), *River basin trajectories: Societies, environments and development*, pp. 123-146. Wallingford, UK: CAB International.
- Lach, D.; Rayner, S. and Ingram, H. 2005. Taming the waters: Strategies to domesticate the wicked problems of water resource management. *International Journal of Water* 3(1): 1-17.
- Lansing, J.S. 1991. *Priests and programmers: Technologies of power in the engineered landscape of Bali*. Princeton, NJ, USA: Princeton University Publishers.
- Leach, E.R. 1961. *Pul Eliya, a village in Ceylon: A study of land tenure and kinship*. Cambridge: Cambridge University Press.
- Lilienthal, D.E. 1944. *TVA: Democracy on the march*. Harper and Brothers, New York.
- Lipchin, C. 2003. *Water, agriculture and Zionism: Exploring the interface between policy and ideology*. Paper presented at the 3rd conference of the International Water History Association, December 2003, Alexandria, Egypt.
- Lopez-Gunn, E. 2009. "Agua para todos": The new regionalist hydraulic paradigm in Spain. *Water Alternatives* 2(3): 370-394.
- Lovin, H.T. 2002. Dreamers, schemers, and doers of Idaho irrigation. *Agricultural History* 76(2): 232- 243.
- Manor, J. 1989. Karnataka: Caste, class, dominance and politics in a cohesive society. In Frankel, F.R. and Rao, M.S.A. (Eds), *Dominance and state power in modern India. Decline of a social order*. Volume 1, pp. 322-361. Delhi: Oxford University Press.
- McCool, D. 1994. *Command of the waters: Iron triangles, federal water development and Indian water*. Tuscon: The University of Arizona Press.

- McCulloch, C. 2009. The Water Resources Board: England and Wales' venture into national water resource planning 1964-73. *Water Alternatives* 2(3): 461-475.
- Molden, D.J.; Frenken, K.; Barker, R.; de Fraiture, C.; Mati, B.; Svendsen, M.; Sadoff, C. and Finlayson, M. 2007. Trends in water and agricultural development. In Molden, D. (Ed), *Water for food – Water for life, Comprehensive Assessment of Water Management in Agriculture*, pp. 57-88. London: Earthscan.
- Molle, F. 2008. Why enough is never enough: The societal determinants of river basin closure. *International Journal of Water Resource Development* 24(2): 247-256.
- Molle, F. 2009. River basin planning and management: The social life of a concept. *Geoforum* 40(3): 484-494.
- Molle, F.; Wester, P. and Hirsch, P. 2007. River basin development and management. In Molden, D. (Ed), *Water for food – Water for life. Comprehensive Assessment of Water Management in Agriculture*, pp. 585-624. London: Earthscan.
- Molle, F. and Floch, P. 2008. Megaprojects and social and environmental changes: The case of the Thai "water grid". *Ambio* 37(3): 199-204.
- Molle, F.; Lebel, L.; Foran, T. 2009. Contested Mekong waterscapes: Where to next? In Molle, F.; Foran, T.; Käkönen, M. (Eds), *Contested waterscapes in the Mekong region: Hydropower, livelihoods and governance*, pp. 383-413. London: Earthscan.
- Mollinga, P.P. 2003. *On the waterfront. Water distribution, technology and agrarian change in a South Indian canal irrigation system*. Wageningen University Water Resources Series. Hyderabad: Orient Longman.
- Mollinga, P.P. 2008. The water resources policy process in India: Centralisation, polarisation and new demands on governance. In Ballabh, V. (Ed), *Governance of water: Institutional alternatives and political economy*, pp. 339-370. New Delhi: Sage.
- Mollinga, P.P. and Bolding, A. 2004. The politics of irrigation reform: Research for strategic action. In Mollinga, P.P. and Bolding, A. (Eds), *The politics of irrigation reform: Contested policy formulation and implementation in Asia, Africa and Latin America*, pp. 291-318. Aldershot, UK: Ashgate.
- Mollinga, P.P. and Bolding, A. (Eds). 2004. *The politics of irrigation reform. Contested policy formulation and implementation in Asia, Africa and Latin America*. Aldershot: Ashgate.
- Mollinga, P.P.; R. Doraiswamy and K. Engbersen. 2004. Capture and transformation: Participatory irrigation management in Andhra Pradesh, India. In Mollinga, P.P. and Bolding, A. (Eds), *The politics of irrigation reform. Contested policy formulation and implementation in Asia, Africa and Latin America*, pp. 240-262. Aldershot: Ashgate.
- Nikku, B.R. 2006. The politics of policy. Participatory irrigation management in Andhra Pradesh. PhD thesis. Wageningen University, the Netherlands.
- Oorthuizen, J. 2003. *Water, works and wages: The everyday politics of irrigation management reform in the Philippines*. New Delhi: Orient Longman.
- Oorthuizen, J. 2004. The politics of irrigation policy implementation: Networks of votes, bribes and Coca-Cola in the Philippines. In Mollinga, P.P. and Bolding, A. (Eds), *The politics of irrigation reform. Contested policy formulation and implementation in Asia, Africa and Latin America*, pp. 263-290. Aldershot: Ashgate.
- Panella, T. 2004. Irrigation development and management reform in the Philippines: Stakeholder interests and implementation. In Mollinga, P.P. and Bolding, A. (Eds), *The politics of irrigation reform. Contested policy formulation and implementation in Asia, Africa and Latin America*, pp. 95-144. Aldershot: Ashgate.
- Pisani, D.J. 1992. *To reclaim a divided West: Water, law and public policy, 1848-1902*. Albuquerque: University of New Mexico Press.
- Potter, D.C. 1986. *India's political administrators 1919-1983*. Oxford: Clarendon Press.
- Pritchard, S.B. 2004. Reconstructing the Rhône: The cultural politics of nature and nation in contemporary France, 1945-1997. *French Historical Studies* 27(4): 765-799.
- Ramamurthy, P. 1995. The political economy of canal irrigation in South India. PhD thesis. The Graduate School of Syracuse University, Syracuse, USA.
- Rap, E. 2004. The success of a policy model. Irrigation management transfer in Mexico. PhD thesis. Wageningen University, Wageningen, the Netherlands.
- Rap, E.; Wester, P. and Pérez-Prado, L.N. 2004. The politics of creating commitment: Irrigation reforms and the reconstitution of the hydraulic bureaucracy in Mexico. In Mollinga, P.P. and Bolding, A. (Eds), *The politics of irrigation reform: Contested policy formulation and implementation in Asia, Africa and Latin America*, pp. 57-94. Aldershot, UK: Ashgate.
- Ravesteijn, W. and Kop, J. (Eds). 2008. *For profit and prosperity: The contribution made by Dutch engineers to public works in Indonesia, 1800-2000*. Zaltbommel: Aprilis. Leiden: KITLV Press.

- Reisner, M. 1993. *Cadillac desert: The American West and its disappearing water*. (Revised and updated). New York: Penguin Books.
- Repetto, R. 1986. *Skimming the water: Rent-seeking and the performance of public irrigation systems*. World Resources Institute Research Report No. 4. Washington, DC: World Resources Institute.
- RSA (Republic of South Africa). 1962. Report on the proposed Orange River Development Project. Doc. No. W.P. X'62. Pretoria, South-Africa: Department of Water Affairs.
- Schipper, P. de. 2008. *De slag om de Oosterschelde: Een reconstructie van de strijd om de open Oosterschelde*. Amsterdam/Antwerpen: Uitgeverij Atlas.
- Schreyger, E. 1984. *L'Office du Niger au Mali 1932 à 1982. La problématique d'une grande entreprise agricole dans la zone du Sahel*. Weisbaden, Germany: Steiner.
- Scott, J.C. 1998. *Seeing like a state: How certain schemes to improve the human condition have failed*. New Haven and London: Yale University Press.
- Shapiro, J. 2001. *Mao's war against nature: Politics and environment in revolutionary China*. Cambridge and New York: Cambridge University Press.
- Smythe, E.A. 1905. *The conquest of arid America*. 2nd edition, Reprint. Seattle, Washington: University of Washington Press.
- Stargardt, J. 1986. Hydraulic works and Southeast Asia polities. In Marr, D.G. and Milner, A.C. (Eds), *Southeast Asia in the 9th and 14th centuries*, pp. 23-49. Canberra: Australian National University.
- Stargardt, J. 1992. Le cosmos, les ancêtres et le riz; l'eau dans l'espace urbain des Pyus en Birmanie. In Condominas, G. (Eds), *Disciplines croisées, hommage à Bernard-Philippe Groslier*, pp. 311-33. Paris: Ecole des Hautes Etudes en Sciences Sociales.
- Stevens, J.E. 1988. *Hoover dam: An American adventure*. Norman: University of Oklahoma Press.
- Steward, J.H. 1978. Initiation of a research trend: Wittfogel's irrigation hypothesis. In Ulmen, G.L. (Ed), *Society and history: Essays in honor of Karl August Wittfogel*, pp. 3-14. The Hague: Mouton Publishers.
- Stott, P. 1992. Angkor: Shifting the hydraulic paradigm. In Rigg, J. (Ed) *The gift of water: Water management, cosmology and the state in Southeast Asia*, pp. 47-58. London: School of Oriental and African Studies.
- Suhardiman, D. 2008. Bureaucratic designs. The paradox of irrigation management transfer in Indonesia. PhD thesis. Wageningen University, Wageningen, the Netherlands.
- Swatuk, L.A. 2008. A political economy of water in Southern Africa. *Water Alternatives* 1(1): 24-47.
- Swyngedouw, E. 1999. Modernity and hybridity: Nature, *regeneracionismo*, and the production of the Spanish waterscape, 1890-1930. *Annals of the Association of American Geographers* 89(3): 443-465.
- Swyngedouw, E. 2007. Technonatural revolutions: The scalar politics of Franco's hydro-social dream for Spain, 1939-1975. *Transactions of the Institute of British Geographers* 32(1): 9-28.
- Turrall, H.; Connell, D. and McKay, J. 2009. Much ado about the Murray river – The drama of restraining water use. In Molle, F. and Wester, P. (Eds), *River basins trajectories: Societies, environments and development*, pp. 263-291. Wallingford, UK: CABI.
- Turton, A.R.; Meissner, R.; Mampane, P.M. and Seremo, O. 2004. A hydropolitical history of South Africa's international river basins. Report to the Water Research Commission. Pretoria: African Water Issues Research Unit (AWIRU), University of Pretoria.
- Ünver, O. and Gupta, R.K. 2003. Water pricing: Issues and options in Turkey. *International Journal of Water Resources Development* 19(2): 311-330.
- Vésin, D. 1992. Histoire du Fleuve Rouge. Gestion et aménagement d'un système hydraulique au Tonkin des années 1890 jusqu'à la seconde guerre mondiale. PhD thesis. Université de Paris 7, Paris, France.
- Wade, R. 1982. The system of administrative and political corruption: Canal irrigation in South India. *Journal of Development Studies* 18(3): 287-328.
- Wade, R. 1984. Irrigation reform in the conditions of populist anarchy: An Indian case. *Journal of Development Economics* 14(3): 285-303.
- Wade, R. 1985. The market for public office: Why the Indian state is not better at development. *World Development* 13(4): 467-497.
- Ward, J. 2000. The evolution of water management in Australia. In Tisdell, J.; Ward, J. and Grudzinski, T. (Eds), *The development of water reform in Australia*, pp. 15-24. CRC for Catchment Hydrology, Milestone Report. Canberra, Australia: The CRC for Catchment Hydrology.
- Watson, N.; Deeming, H. and Treffny, R. 2009. Beyond bureaucracy? Assessing institutional change in the governance of water in England. *Water Alternatives* 2(3): 448-460.
- Wegerich, K. 2008. Hydro-hegemony in the Amu Darya basin. *Water Policy* 10(S2): 71-88.

- Wehr, K. 2004. *America's fight over water: The environmental and political effects of large-scale water systems*. New York and London: Routledge.
- Wester, P. 2008. Shedding the waters: Institutional change and water control in the Lerma-Chapala basin, Mexico. PhD thesis. Wageningen University, Wageningen, the Netherlands.
- Wester, P. 2009. Capturing the waters: The hydraulic mission in the Lerma-Chapala Basin, Mexico (1876-1976). *Water History* 1(1): 9-29.
- Wester, P.; Rap, E. and Vargas-Velázquez. 2009. The hydraulic mission and the Mexican hydrocracy: Regulating and reforming the flows of water and power. *Water Alternatives* 2(3): 395-415.
- Whitcombe, E. 1972. *Agrarian conditions in northern India. Vol. I. The United Provinces under British rule, 1860-1900*. Berkeley: University of California Press.
- Wiering, M.A. and Arts, B.J.M. 2006. Discursive shifts in Dutch river management: 'Deep' institutional change or adaptation strategy? *Hydrobiologia* 565(1): 327-338.
- Wijeyewardene, G. 1971. *Hydraulic society in contemporary Thailand?* Canberra: Australian National University.
- Willcocks, W. 1935. *Sixty years in the East*. Edinburgh and London: William Blackwood & Sons.
- Wittfogel, K.A. 1957. *Oriental despotism: A comparative study of total power*. New Haven: Yale University Press.
- Woodall, B. 1993. The logic of collusive action: The political roots of Japan's Dango System. *Comparative Politics* 25(3): 297-312.
- WCD (World Commission on Dams). 2000. *Dams and development: A new framework for decision-making*. London: Earthscan.
- Worster, D. 1982. Hydraulic society in California: An ecological interpretation. *Agricultural History* 56(3): 503-515
- Worster, D. 1985. *Rivers of empire: Water, aridity, and the growth of the American West*. Oxford: Oxford University Press.
- Zetland, D. 2009. The end of abundance: How water bureaucrats created and destroyed the southern California oasis. *Water Alternatives* 2(3): 350-369.
- Zwarteveen, M. 2008. Men, masculinities, and water powers in irrigation. *Water Alternatives* 1(1): 111-130.