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Inside-Out: Chinese academic assessments of large-scale water infrastructure

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Inside-Out: Chinese academic assessments of large-scale water infrastructure

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Abstract

Little is known in the international academic community about Chinese-language research on water management. To remedy this deficit, this paper reviews current mainland Chinese understandings of the role of large-scale water infrastructures as tools of water resources management. We reviewed 461 papers published in mainland Chinese journals by Chinese scholars. This review suggests that the dominant approach to water management reflects the confines of government priorities – large-scale, concrete-heavy, infrastructure-based means of moving water around the country so as to meet demands and stimulate economic growth. Suppression of critical voices means that infrastructure is generally rendered *apolitical*: the critiques are about practical issues, such as technological, managerial or administrative problems. There are exceptions to this characterisation that adopt more critical frames; however, they reflect on water management elsewhere or in the past rather than on contemporary China. While these more critical papers are interesting and important contributions to our understanding of the politics of hydraulic infrastructures, the literature as a whole says little about the politics of infrastructure *in China now*. In effect, much of the literature in Chinese on water management in China simply acts as an arm of a machine – a network of corporations, universities, international institutions and arms of the government, together tasked with identifying and framing what are water management issues, formulating standardised procedures for tackling those issues, and then constructing solutions to them.

国际学术界对水管理方面的中文文献知之甚少。为了弥补这一不足，本文综述了中国大陆有关大型水基础设施作为水资源管理工具的作用的研究。本文回顾了中国学者在中文学术期刊发表的 461 篇论文。这些文章表明，中国占主导地位的水管理方式反映了政府的偏好，即通过大规模、重工程的基础设施建设在全国范围内的输送

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水，以满足需求并刺激经济增长。中文文献中，基础设施通常被视为非政治性的：现有的批评大多针对实践事宜，例如技术、管理或行政方面存在的问题。作为例外，也有一些文章是关于中国之外或中国过去的水管理的。然而，尽管这些“例外的”文章对于解读水基础设施的政治的贡献是有意义且重要的，总体而言，水管理方面的中文文献很少提及有关中国基础设施的政治。事实上，关于中国水管理的中文文献是一台机器的一部分——这台机器是一张由公司、大学、国际组织以及政府部门组成的网络。网络的成员共同作用，从而识别和拟订什么是水管理问题，制订标准化的程序来处理这些问题，并就此构建解决方案。

1 Introduction

When the rivers run dry (Pearce 2006), users are tempted to replenish or replace them through large-scale water infrastructures, such as inter-basin transfers. From the ancient Romans to the present day, cities, irrigation districts and energy projects all around the world used to, currently do or propose to employ inter-basin transfers to sustain their increasing demands for water (Rinaudo and Barraque 2015). Chinese states have been pre-occupied with struggles to drain the North China Plain and then to control flooding on the Yellow River (Pietz 2014) since at least the times of the fabled (and perhaps fictional) Yu the Great [大禹] more than 4 000 years ago. The Dujiangyan [都江堰] irrigation and flood control system in Sichuan was originally constructed nearly 2300 years ago and is still in use today (Zhang *et al.* 2013). Even older (2800 years) and also still in use is the Anfeng reservoir in northern Anhui, built under the supervision of Sunshu Ao [孙叔敖], China's first known hydraulic engineer (Needham 1986: 271). See also Sima Qian's [司马迁] (nd [1988]) essay, *Treatise on Rivers and Canals* [河渠书] and the more recent commentaries on Chinese historical water management (Yao 1987, Zhou 2002).

Billions of people are stressed by water scarcity (Purvis and Dinar 2020), a condition forecast to affect half the world's population by 2030 (Sinha 2020) and to be exacerbated by climate change (Khadem *et al.* 2021). Large, densely populated and economically powerful regions never live within their ecological means (Gupta and van der Zaag 2008). Unsurprisingly, therefore, the world currently has 34 inter-basin water transfers that cost more than \$US 1 billion to construct and that transfer more than 0.23 km³ / year of water over more than 190 km; another 76 are under construction, planned or proposed (Shumilova *et al.* 2018). Even excluding smaller inter-basin transfers, these “artificial rivers” will – if actually constructed – account for about five per cent of global continental discharge to the oceans (Shumilova *et al.* 2018). In China, about eight per cent of all water used is now transferred across basins (Sun *et al.* 2021).

The long-term ecological and hydrological effects of large-scale infrastructures are unclear. Shumilova *et al.* (2018) claim that inter-basin water transfers may fundamentally transform the global water cycle. Some rivers, such as the Owens and Colorado in the USA, are effectively emptied of water; however, others, such as the Yangtze River / Changjiang [长江], seem so far little perturbed by the huge dams constructed in their basins (Chen *et al.*, 2014, 2016). Emanuel *et al.* (2015) illustrate such differentiation of hydrological effects. Other environmental effects of inter-basin water transfers include erosion of deltas and loss of coastline if sediment loads are reduced, saltwater intrusions (Webber *et al.* 2015), destruction of wildlife habitats and subsequent threats to endangered species (summarized by Goodwin 2020) and transport of alien species (Gallardo and Aldridge 2018). Within regions that receive the transported water, groundwater can be replenished, water quality improved, and ecosystems restored (Shumilova *et al.* 2018).

Such spatially uneven environmental impacts are matched by uneven social and economic impacts. While some people enjoy the water or electricity provided by large-scale water infrastructures, those living in source regions suffer eviction from their homes (Rogers and Wilmsen 2020), loss of livelihoods, threats of flooding, destructions of their communities and heightened risks of poverty and food insecurity (Annys *et al.* 2019). The beneficiaries of and losers from a project of water infrastructure are distinct, socially and often locationally (Fraj *et al.* 2019), prompting struggles over different visions of hydro-social territories (Rocha Lopez *et al.* 2019). These struggles over benefits and losses are embedded within changing political economies, in which the political acceptability of state investment in large-scale infrastructure ebbs and flows (Roman 2017).

Such disputes, together with increased understanding of our capacity to save water, of the significance of water re-use and of the relative cost advantages of desalinisation led Rinaudo and Barraque (2015) to postulate that the era of large-scale inter-basin water transfers was coming to an end, at least in the developed world. Yet plans around the world to build new inter-basin water transfer projects (Shumilova *et al.* 2018) suggest that investment in large-scale infrastructures is going to continue. Within China, the official view is that the country must store water to overcome seasonal fluctuations and move water around the country to rebalance regional differences in supply and demand (Xinhua Net 2014). This view has driven a rapid expansion in the number of dams in China and, encouraged by the President (CGTN 2021), the beginnings of a scheme to develop a water network for the whole country. In 2015 and the 13th Five-Year Plan period, 172 key water resources projects were identified (Wang *et al.* 2015); at least 16 of these are inter-basin transfers. According to the Premier, Li Keqiang [李克强], China needs to divert even more water to its arid north and to invest in even more water infrastructure; opening up more canals to deliver water northwards will ‘support economic and social development and optimise China’s national development strategy’ (Reuters 2019). In July 2020, State Council announced that 150 major water resource projects would be promoted, at a cost of RMB 1.29 trillion (Economic Daily 2020).

Given this discrepancy between English-language expressions of pessimism about the future role of large-scale water infrastructures and Chinese practice, how do Chinese authors understand large water infrastructure projects and their place within the broader task of water governance? Although Chinese views about water management affect the waterscapes experienced by nearly 1.5 billion Chinese and by another several billion residents of countries in which Chinese corporations invest, much of the world has little knowledge of the vast endeavour of research on water resources in China. Such a deficit is unacceptable to a field that recognises the importance of context to water management, and that speaks to the roles of culture and politics in managing water. To overcome this problem, in this paper we characterise mainland Chinese interpretations of large-scale water infrastructures as tools of water resources management. (Of course, water infrastructure is not built simply to manage water; like all other construction projects, water infrastructure in China assists in the task of national integration and, comprising about five per cent of all government infrastructure investment, plays an important role in maintaining high rates of growth of gross domestic product. Nevertheless, this paper focusses on Chinese understandings of the role of water infrastructure in managing water.)

Our “outsider” focus is on inside knowledges of large-scale water infrastructures, especially inter-basin water transfers. One author (Jiang) is a hydrologist; the others are all trained in the canons of critical social science. As Australian-trained critical social scientists, we are outsiders, not members of the Chinese academic community. Yet we have sufficient experience of Chinese academic practices, language and water management to understand the insider knowledge that is expressed in the literature we review: five of us were raised in China and another two have a working knowledge of Chinese; all have extensive experience conducting field work in China, notably – but not only – on water management.

First, we explain the method by which we sampled papers. We then describe, in turn, common understandings about the place of inter-basin transfers within the broader task of water management; the range of problems that have been recognised in managing such infrastructures; and the insights that come from more overtly political understandings of water management. The Chinese literature is not written to a non-Chinese audience and almost never positions itself with respect to non-Chinese discourses; our comments are therefore restricted to pointing to its overlap with and divergence from literature with which readers of this journal might be more familiar.

2 Method

A literature search was conducted through the China National Knowledge Infrastructure (CNKI), the largest and most accessed academic online library in China. We sought papers published in Chinese, in mainland Chinese journals. The search was not limited to authors based in mainland Chinese institutions, though we found no first authors from non-mainland institutions. We did not search specifically for “Chinese” authors, but the retrieved authors’ names were all common Chinese names.

Because we focus on Chinese scholarship about water transfers and their administration and control across scales and space, we used search terms that would exclude as far as possible publications that were purely technical or ecological. We searched for papers with the following terms in their title, abstract or keyword list: water, infrastructure, dams, transboundary, south-north water, politics, impact, cost, development, governance, power, inequality, scarcity, conflict, resettlement. The specific search term combinations (listed in the appendix to the paper) were sufficiently broad (for example, “water” AND “politics” OR “water” AND “scarcity”) as to include not only papers about large-scale water infrastructures but also papers about water use efficiency, water reclamation and desalinisation. Thirty-eight separate searches were conducted. Since we wanted to understand the arguments and evidence about these topics rather than to characterise the papers or their authors, we did not randomly sample the papers identified in each search. Instead, in each search, we retrieved the ten most highly cited and the ten most recent papers in the CNKI data base of all core [北大核心] and CSSCI (Chinese Social Sciences Citation Index) journals within the fields of Physical Geography and Topography; Environment Science and Resource Utilization; Hydraulic and Hydropower Engineering; Agriculture; Politics/ Military Affairs/ Law; Education & Social Sciences; Economics & Management. After eliminating duplicates, we retrieved 613 papers.

We then excluded papers that we deemed irrelevant to our research questions. These included: papers located in the pure physical sciences (such as chemical studies of eutrophication); general introductions to research programs; advertisements for design institutes; papers the title of which includes one of the search terms as a place name (for example, place names that include the Chinese word for dam or water (坝 or 水)). Two interview transcripts were deemed irrelevant, as were 12 papers directed at teachers. Articles named “editors’ notes”, “preface” and “to authors” were classified as irrelevant. Two of us independently evaluated papers according to these criteria, leaving 445 papers.

A second search sought papers that advertised critical comments about water management in China. Papers were sourced from searches with title, abstract or keyword containing 水 (water) AND one of 批判, 质疑, 商榷 (respectively: critical, to question, to dispute). These searches yielded another 25 papers, of which 9 were deemed irrelevant.

The abstracts of all 461 papers were then read. Papers that did not promise to comment on large-scale water infrastructures were excluded; so papers about water use efficiency, water reclamation and desalinisation were included if they contrasted those methods with investment in large-scale water infrastructures, but excluded if they eschewed such comparisons. All potentially useful papers, including the 16 from the second sample, were downloaded and read in full (80 papers). Ten of those papers were about water diplomacy or otherwise not relevant to water management inside China. Of the remaining 70

papers, 24 specifically discuss interbasin transfers, 32 are oriented improving the practice of water management and 14 adopt more critical stances towards water management.

3 The need for inter-basin water transfers

"There is more water in the south, but less water in the north. If possible, borrow some water." [“南方水多，北方水少，如有可能，借一点也是可以的” in 作家作品：毛泽东与南水北调。] This remark is attributed to Mao, on a visit to the Yellow River Conservancy Commission in October 1952 (IWHR nd).

Of the 24 papers that discuss interbasin transfers, 13 have such transfers as the main topic. Apart from three papers by Zhao and Wei (2019a, 2019b, 2020) about the Red Flag Project, discussed in section 4, all explicitly or implicitly regarded inter-basin water transfers as obvious ways of resolving spatial discrepancies between water supplies and demands. This ‘obvious necessity’ is perhaps clearest in the case of the South-North Water Transfer Project (SNWTP), the two existing routes of which carry water from the Yangtze River north to Hebei, Shandong, Beijing and Tianjin. As explained by Zhang (2020), ecological protection and economic and social development in the Yellow River Basin and the North China Plain depend on water resources. However, the Yellow River other principal rivers are short of water, which severely constrains economic and population carrying capacity. China’s per capita water resources are only 27% of the world average (Zhang 2016), while the per capita water resources of the North China Plain are only 23% of the China-wide average (Qin et al. 2012), which means that the Plain suffers from severe “resource-based” water scarcity. Groundwater has been used to maintain the region’s development, which led to ecological and environmental problems such as ground subsidence and secondary soil salinization (Shi *et al.* 2014). The common view – also the view of China’s governments – is that China must rely on inter-basin transfers of water to solve this constraint.

A similar argument is applied to other inter-basin transfers. These include local projects, such as attempts to improve the quality of water in Yunnan’s Dianchi Lake by transferring water from the Niulan River (Zhang 2020) and Qingshuihai Reservoir (ADB 2007-2014); Fei *et al.* (2019) propose many more such inter-basin transfers. They also include huge mega-projects, such as the “Red Flag Project”, proposed to divert up to 200 billion m³ of water annually from the Yarlung Zangbo / Brahmaputra, Lancang / Mekong and Nu / Salween Rivers into Xinjiang. As Zhang (2020) explains, this latter project would increase the area devoted to food crops and improve the ecological health of the Yellow River: it is a fundamental component of the sustainable development of the Chinese nation, one of the grand ideas that Yang (2011) proposes. Similar sentiments are expressed in Xie’s (2019) overview of water control in the People’s Republic.

Such inter-basin transfers are to be understood as not only benefitting China now, but as offering benefits in other times and places. Xiao (2018) advocates that Chinese experience in inter-basin transfers be

applied to cross-border diversions, such as the Sino-Kazakhstan Khorgos River Friendship Joint Water Diversion Hub Project (completed in 2013) between China and Kazakhstan. Others equate water management and civilisation, such as Zheng (2019), who praises water diversions as some of the greatest projects of ancient Rome and, indeed, of human history. Such projects are to be understood not simply as about supplying water but as also expressing an ongoing preference for economy over environment – a continuing effort to avoid “the environmental protection trap” (Zhao 2007).

Even so, there is increasing recognition of the need to supplement such inter-basin transfers with greater attention to the management and conservation of existing water resources. At a technical level, this includes optimum allocation modelling, which is a strong feature of the papers we reviewed (see for example, Cao *et al.* 2019, Yang *et al.* 2019), and technologies to raise the efficiency with which water is used in agriculture (Li *et al.* 2012). In terms of water conservation, a standard top-down package of institutional reforms is often proposed: a stringent water resources management system, water pricing and tax reforms, ecological compensation, control over pollution discharges, property rights and trading in water rights or pollution rights (Wang *et al.* 2004, Xie 2019, Zhang 2007), sometimes taking their cues from practices in other countries (Wei and Zhou 2002). Some authors recognise that water shortages are not simply a matter of the quantum of water, but are also created by inefficient use and pollution of available sources (Yang *et al.* 2001, Xue and Zhang 2009). Others take a bottom-up approach, examining the factors that influence the water-using behaviour of individuals or corporations (Han *et al.* 2015, Zhou *et al.* 2019). In part, this emphasis on conservation of water resources reflects the fact that the SNWTP alone will not resolve the supply / demand imbalance on the North China Plain, though it might buy governments some time during which to redress these problems (Li and Zhang 2005, Li *et al.* 2019, Qin *et al.* 2019).

By and large, this strand of the literature offers little that extends official statements about ways of managing water in China. These include a forceful affirmation of the need for interbasin transfers (as exemplified by Li Keqiang’s assertion in Reuters 2019) that are combined with a package of institutional reforms (as exemplified by the work sponsored jointly by the World Bank and the Development Research Center [DRC] of the State Council [World Bank 2019]). The World Bank – DRC report calls for better implementation of water pollution laws, improved river basin governance, greater use of market mechanisms and public-private partnerships, more emphasis on water saving, and accelerated construction of key projects in order to build a modernized water governance system. There is much repetition of and justification for official policy in this strand of the literature.

4 Problems of managing large-scale water infrastructure

Nevertheless, 32 of the 70 papers were devoted to identifying and proposing solutions to important problems in the implementation of projects. These problems include inadequate planning and management

systems; often disastrous resettlement practices; and optimistic calculations of financial returns and water provision – failings that Chinese governments need to anticipate, given the critiques advanced by the global anti-dam movement (Wang 2005). It is also recognised that environmental problems and the forms of organisation of government in China are often incompatible (Shi 2018, Zhang *et al.* 2009), such that environmental management is largely personal rule (or a rule of power) rather than a rule of law (Ren 2015, Wang and Cai 2011).

A specific critique examines the displacement of people induced by large-scale water engineering projects (often known as “reservoir resettlement”, 水库移民) – by 2010, nearly 20 million Chinese people had been resettled, mainly due to the building of dams and reservoirs across the country (Shi *et al.* 2010). Studies centre on practical issues relating to resettlement policies, compensation mechanisms, and livelihood impacts (Liu 2015; Zhao and Yang 2009; Zhu *et al.* 2006). The management of resettlement has been criticised as being guided by a vision that prioritises engineering but ignores resettlement, resulting in unnecessary socio-economic losses and risks (Chen 2010; Shi *et al.* 2010). Shi *et al.* (2010) and Hu (2014) discuss the causes of disputes over resettlement and the manners in which local governments manage them.

By far the most detailed description of what happens to resettlers is Chen’s (2014) book about the resettlements at Danjiangkou for the SNWTP. Chen describes how the Yangtze / Changjiang Water Resources Commission began surveying the areas that were to be inundated in 1991; for the next nearly 20 years, until resettlement actually began, there was no government investment in that area and people were prohibited from constructing or reconstructing houses – in effect, creating a level of disadvantage that cast before-after levels of well-being in a favourable light. Since the actual dates for individuals to be resettled were uncertain and changing, some farmers were left with fields unplanted or crops unharvested. Some people were evicted from their houses and land before their new houses had been completed; shoddy house construction was a major cause for complaint among resettlers. Compensation policies also came under criticism – even if they had to relocate, resettlers were not compensated for land that was not inundated; nor were they compensated for the loss of collective property. Some resettlement sites were too small, too scattered, or too remote; the soil was poor; and road connections to the outside world were limited. In Danjiangkou, small groups of villagers were resettled together, rather than entire villages. As a consequence of these problems, many of the resettled villagers either moved into a town or returned to their original village: in one resettlement site that Chen visited, only 40 per cent of the resettled villagers remained.

Similar management issues plague many infrastructure and water conservancy projects, even in the most developed regions of the country (Zhang *et al.* 2013). The responsibility for project management is fragmented between different ministries and bureaus of the central and local government; for example, a dam and its associated infrastructure may be managed by the water conservancy department, the

hydropower station is managed by the power department, and the ship lock is managed by the transport department, while water volume is managed by the water conservancy department, and water quality by the environmental protection department (Zhang *et al.* 2009). Tiao-kuai dysfunctions compound such bureaucratic separations: for example, the Changjiang Conservancy Commission is an agency of the Ministry of Water Resources and thus has limited ability to coordinate the actions of central government ministries and commissions that have water-related responsibilities or to coordinate the actions of the provinces and municipalities along the river (Xiong 2019; see also Wei and Wang 2019). Departments of the bureaucracy game the systems that are intended to regulate their behaviour, including the system of water prices (Chen and Peng 2019) and rely on formal rather than substantial systems of accounting for environmental effects (Ma 2016, Tang 2016). The eco-compensation system is known to be incomplete (Fang and Yang 2012). Controlling costs is an ongoing problem (Ji and Sun 2018; Yu and Ren 2007). Particularly significant is the fact that there is no unified body to coordinate a strategic diplomatic approach to China's transboundary rivers (Li 2018; Liu *et al.* 2017).

Specific critiques of the River Chief system also point to systemic failures of water governance in China. In an effort to break down the system in which responsibility for water management is fragmented between different departments, the central government began in 2017 to appoint provincial governors or party secretaries as River Chiefs of the rivers that flowed through their province. In turn, governors appointed mayors of municipalities as River Chiefs for 'their' rivers, and so on down to the township level of government. Each River Chief is responsible for the quality of water in their section of the river, having to meet targets set by the chief one level up (Shi 2018 introduces this history). Despite some promising results in pollution control (Office 2017), this system relies on campaign-style enforcement and competes with the established functional departments, each fighting to maintain their core interests, each shirking their overlapping responsibilities (Ren 2015, Zhu 2020). By focussing on rivers, the system ignores the relationship between the river and its broader basin (Cao and Zhou 2019, Liu *et al.* 2016). Thus in practice, the ownership, use rights and management rights of rivers and lakes are unclear, overlapping and unmatched to the River Chief system (Office 2017, Zhu 2020). In a system with severe information asymmetry, principal-agent problems are chronic (Wang and Cai 2011)

Finally, many of the calculations of the financial costs and benefits of projects, and of their potential to deliver water have been criticised. Perhaps the most interesting of these are the critiques of a potential western diversion project that would comprise the third stage of the SNWTP. The official plan, being developed by the Ministry of Water Resources, would divert water from the upper reaches of the Yangtze River / Changjiang [长江] and deliver it to the upper reaches of the Yellow River / Huang He [黄河], which in turn could deliver water to Qinghai, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi and the North Chin Plain. It could divert 17 billion m³ / year of water. The "Red Flag Project" is a far more ambitious proposal to divert up to 200 billion m³ of water annually from Yarlung Zangbo / Brahmaputra, Lancang / Mekong and Nu / Salween Rivers into Xinjiang. The premier, Li Keqiang, has called for

evaluations of this proposal (Gao 2020). In a devastating series of papers, Zhao and Wei dispute this ambitious proposal. First Zhao and Wei (2019a) demonstrate that long canals and long, deep and expensive tunnels would be needed to carry the water northwards. Then (Zhao and Wei 2019b), they point out that standard engineering withdrawal ratios imply that the rivers' annual discharge could provide no more than about 30 billion m³ of water annually. Finally, Zhao and Wei (2020) observe that the source rivers' discharge is highly seasonal, which restricts their capacity to deliver water during the low-flow months of November-April and reduces their water transfer capacity to about 16 billion m³ annually. There is not enough water to irrigate the farmland that is proposed, much less to support a green belt in Xinjiang (Yang *et al.* 2018).

In many respects, the first strand of the literature identifies policies to resolve disparities in water availability across China, whereas this second strand recognises the gaps that exist between policies and their implementation and goes some way to explaining those gaps. Apart from chronic principal-agent problems, bureaucracies are strictly divided functionally, the actions of governments in different localities are poorly coordinated and administrators rely on power rather than law to rule. These are certainly important insights about water governance in China, replicated by outsiders such as Moore (2018), yet this literature does not explain that successive Chinese governments have done little to encourage cooperation between officials in different localities or to enable non-government agents to participate in regional or other formal governance institutions. These institutions are therefore firmly constrained by bureaucratic position, rather than being able to use representational legitimacy to transcend those constraints. Crucially, this literature does not delve into the question of how Chinese water governance came to be this way.

5 How did this situation arise?

This is a question taken up by the 14 papers that adopt or assess more critical approaches to water governance in China. There is an extensive tradition of critical theory in China, though it is largely confined to departments of philosophy or Marxism, and applies to contemporary governance in only a limited way. Critical approaches to water management, that theorise the relationships between people and environments, include Marxist approaches to environmental ethics (Shi and Yang 2013), regional development (Zhou and Yang 2014) and water conservancy (Li 2014). According to Li, the separation between people and nature under capitalism is realised as the irreconcilable contradiction between limited natural resources and overproduction under the logic of capital. Post-human understandings of environments are invited (Wang *et al.* 2020) but post-structuralist political ecology, with its emphasis on the social and cultural construction of nature is identified as a "a confusing post-modern trend of thought" (Li 2019).

While these papers are general rather than historically specific, there do exist a few concrete examples of water management and large water infrastructures that reveal the means through which the

government has accumulated authority in China. For example, Hao and Li (2019) describe the flows of power within a provincial department of water resources. In another example, Zhang and Hang (2019) combine hydrologic data and the evidence in historical documents to analyse how governments took over water management in the western Hexi corridor [河西走廊] between 1932 and 1953. In these mountain spring-fed riverine oases, the provision of water to upstream and downstream localities had been managed at least since Qing times by private civilian water conservancy organisations; even the construction of canal heads and maintenance of canals was largely outside government hands. After 1949, these folk water conservators were incorporated into the local government, enjoying government salaries and forming an incipient water bureau. Yet this was far from a comprehensive system of planned water management, and local water conservancy agencies were still not compulsory. However, in May 1953, Jiuquan Prefecture issued a statement claiming that a severe drought was imminent; under this threat, local governments set up conservation agencies and began systematic planning about how to use water resources when this drought arrived. There is in fact little credible evidence of an actual drought; so the prefecture government was able to claim that its plans had prevented any disaster from occurring. Zhang and Hang conclude that the prefecture government claimed “drought” in much the same way as villages had in the past – as a discursive technique to gain access to more water. The threat of disaster – real or foretold – enabled the government to take over functions previously performed (supposedly inadequately) by local organisations. Hao (2020) likewise documents how the ‘thousand-year history’ of grassroots water conservancy committees, each with their River Chiefs, Dike Chiefs and Bank Chiefs in different regions of China – has now been replaced by the top-down version implemented by the central government. Similar observations have been made about China’s property rights regime (Zhang 2007).

When governments take over local water conservation, this changes the manner in which human-environment relations are understood. One such implication is the transformation of drought from a human disaster to a natural disaster. For example, Zhang and Hang (2019) claim that until 1949, people in the Hexi corridor understood drought as a human disaster, part of a discursive effort to claim water rights, rather than as a disastrous failure of water to flow down from the mountains; yet in 1953, it was precisely the trope of natural disaster that the prefecture government invoked to claim control over water management. This understanding of drought – and, more generally, water shortage – as a natural disaster has permeated Chinese government thinking ever since (Xinhua Net 2014; but see Zhang *et al.* 2013). Likewise, the transformation from grassroots to government water management carries a shift in the nature of expertise that is valued – from local and particular to more abstract and scientific: Zhang (2020) argues strongly in favour of this shift, but Wang and Zhang (2009) observe that the development of science should not exclude local experience. The subtle, locality-specific negotiation of water rights and responsibilities that was the hallmark of the different grassroots River Chief systems across the country has been replaced by a uniform and targeted, authoritarian River Chief system (Huang 2015, Wang and Cai 2011, Hao 2020). The government management of water has also been accompanied by an exclusion of the public from a substantive role in water conservancy (Xiong 2019). Liu and Ren (2008) do point to the

roles of environmental NGOs and urban intellectuals in conflicts over the construction of dams on the Nujiang – though the opportunities to play these roles have since been closed off. Such limited participation encourages what Huang (2014) calls the "Tacitus Trap" – the situation in which no matter what a government says or does, people do not believe the speech or accept the value of the action.

Finally, we draw attention to Zheng's (2019) study of power, identity and national governance in the Roman Empire. Rome's water diversion projects were, according to Zheng, among the greatest projects in ancient Rome and the greatest urban water supply projects in human history. Zheng argues that such large-scale water conservancy projects certainly provided water resources to the citizens and met the needs of the urban population; but they also had a deeper intention – to meet the political needs of the Roman rulers and to proclaim the power of the state, especially in newly-conquered remote areas. Mainly built by the army, large water supply projects demonstrated the administrative legitimacy and administrative obligations of the Roman Empire and revealed the generosity of the Empire and city managers to its subjects: the Empire constructed its ideological power through water. Abundant, clean water also became identified as essential features of Romanised urban life: aqueducts, public baths, flush toilets and fountains transplanted the Roman cultural model to conquered lands, opening a cultural gap between the Roman Empire and other nations. The supply of clean water, concludes Zheng, was – and remains – a source of ideological power.

The central observation of these papers is that the government has taken over functions previously performed by local organisations. Accompanied by a shift towards abstract and scientific as opposed to local and particular forms of expertise, the construction and management of large scale water infrastructures, often in the service of ideological demonstration, have increasingly excluded non-government agents from participation in the task of managing water. It is this exclusion, Moore (2018) claims, that explains why regional or other formal governance institutions, such as river basin commissions, have been unable to garner sufficient legitimacy to overcome inter-departmental and inter-jurisdictional barriers to effective cooperation over the management of water.

6 Conclusion

There is a wide diversity of opinion within the Chinese literature about the merits and the effects of large-scale water infrastructures. The literature is dominated by two (overlapping) groups – those strongly defending the benefits of existing projects and promoting the construction of new ones and those recognising flaws in the delivery and management of existing projects. Given the relative sizes of engineering and management research communities as compared to social science communities in China – and the existence of strong and active research groups within ministries, departments and government bureaux – this is hardly surprising. Nevertheless, there do exist a few accounts of governments supplanting

grass-roots water management organisations, instituting formal, hierarchical systems of governance that – it might be inferred – are at the root of existing gaps between project conception and project delivery.

Critical voices about water infrastructure are more muffled in China than in English-language literature. There is room to be critical about non-political or non-sensitive issues in China, but critical voices about important state projects have long been curbed, as experiences during debates over the Three Gorges Dam testify. Likewise, funding for research about sensitive issues is impossible to secure (So 2019). The Chinese education system places great emphasis on learning and working for the good of the country; the education system's emphasis on science and engineering and the strict division between disciplines mean that, for example, 'water management' – which might encompass economic, political and social concerns as well as hydrology – has transmogrified into a 'water management science' that simply offers no space for hydropolitics (Jiang *et al.*, 2005). Missing, therefore, is a sense of water management as a struggle between competing groups of interests. Some of the most critical voices in academia – those of graduate students and recently-graduated scholars – experience difficulties in finding publishing outlets, unless they can attach a more senior or famous name to their papers.

The literature we have surveyed – in Chinese, published in Chinese journals – is only one component of Chinese scholars' writing about water management in China. Universities provide strong incentives to publish in English, incentives that include both points towards promotion and cash payments (Gonzalez 2012) for academic staff and graduate students (see the example of Tianjin University's Department of Management and Economics *nd*). Thus Chinese scholars' views about the management of water through infrastructure are also published overseas, in English; our knowledge of that literature suggests that, writing in English and for an international audience, Chinese scholars adopt more theoretical perspectives and a more critical tone than when writing in Chinese for a Chinese audience.

This review identifies a dominant approach to water management and large-scale water infrastructures in China. The dominant voices work largely within the confines of government priorities – large-scale, concrete-heavy, infrastructure-based means of moving water around the country so as to meet demands and stimulate economic growth. This is a voice that would be immediately recognisable to readers of Purvis and Dinar (2020), Shumilova *et al.* (2018) or Roman (2017). There is space for more critical commentaries, but these are circumscribed to more practical forms of critique in which infrastructure is generally rendered *apolitical*: the critiques are about practical issues, such as technological, managerial or administrative failures (compare Annys *et al.* 2019). The notable exceptions to this characterisation adopt frames that appear to reflect on water management elsewhere or in the past rather than on contemporary China: as interesting and important as those contributions are, the literature as a whole says little about the politics of infrastructure *in China now*. There is no sense of the geographically and socially distinct beneficiaries and losers from a project of water infrastructure (Fraj *et al.* 2019) struggling over their different visions of hydro-social territories (Rocha Lopez *et al.* 2019) within changing

political environments, in which the political acceptability of state investment in large-scale infrastructure ebbs and flows (Roman 2017). Webber and Han (2017) posited the existence of a China “water machine” – a network of corporations, universities, international institutions and arms of the government, together tasked with identifying and framing what are water management issues, formulating standardised procedures for tackling those issues, and then constructing solutions to them. In many respects, the literature in Chinese on water management in China acts as an arm of that machine.

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Appendix: List of search terms

<i>SEARCH TERM 1</i>			<i>SEARCH TERM 2</i>		<i>SEARCH TERM 3</i>					
1			urban	城市	AND	scarcity	缺 不足			
2			north	北						
3			transboundary	跨界 跨境		politics	政治			
4			politics	跨境						
5			cost	成本	AND					
6	water	水	impact	影响						
7			inequality	不平等 不均衡						
8			development	发展						
9			scarcity	缺 不足						
10			power	权力						
11			governance	治理						
12			interbasin	跨流域						
13			Belt & Road	一带一路						
14			politics	政治				AND	sustainable	可持续
15			cost	成本						
16			impact	影响						
17			inequality	不平等 不均衡						
18	dams	坝	development	发展						
19			scarcity	缺 不足						
20			power	权力						
21			governance	治理						
22			export	出口						
23			international	国际						
24	water infrastructure	水基础设施 水利基础设施	AND	politics	政治					
25	Red Flag River	红旗河								
26	interbasin	跨流域								
27			export	出口	AND					
28			cost	成本						
29			impact	影响						
30	SNWT	南水北调	inequality	不平等 不均衡						
31			development	发展						
32			scarcity	缺 不足						
33			power	权力						
34			governance	治理						
35	water diplomacy	水外交								
36	River Chief System	河长制								

Data availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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