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Spatial fit and water politics:
Managing asymmetries in the Dongjiang River basin

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ABSTRACT

The aim of this paper is to explore how classic upstream-downstream conflicts of water resources management can be interpreted more broadly in terms of spatial misfits and disparities between the river basin, territorial jurisdictions, degrees of political influence and socio-economic conditions. It applies the analytical concept of spatial fit in order to explore issues of governance in managing water in the Dongjiang River basin, selected by virtue of the huge political and economic asymmetries existing between the upstream Jiangxi Province and the downstream Pearl River delta region. Using the concept of spatial fit, the paper explores the complex environmental, socio-economic and political geographies which frame the interdependencies of water use and management within the river basin. It analyses attempts by stakeholders at different levels and locations in the basin to advance their own water-related interests and the initiatives some are developing to share benefits and costs more equitably across the basin.

Keywords: River basin management; spatial fit; Dongjiang River

1. Introduction

As any water professional will agree, the task of managing water resources is inherently spatial. Given the physical attributes of H_2O, its universal prevalence (in the atmosphere, in organisms, in watercourses, in aquifers) and its indispensability for all living beings, water inevitably has multiple geographies. Managing this vital natural resource involves organising the use, distribution, retention and treatment of water between areas of abstraction and use, between upstream and downstream communities and between the river and its catchment – to name just three of the most problematic spatial dimensions. The geography of water is not only multi-faceted, therefore, but also asymmetrical. This results in severe spatial externalities, whereby the costs and benefits (economic and otherwise) of managing water are spread unevenly and often inequitably. It is little wonder, then, that attempts to improve water management have regularly been accompanied by a search for the optimal spatial unit of water management.

Problems of spatial fit are familiar to political scientists, economists and geographers interested in determining optimal units of governance for various policy fields, in particular relating to the provision of public goods (Young and Underdal 1997, Young 2005, Moss 2012). For water professionals, the river basin represents the spatial unit most suited to overcoming characteristic problems of spatial fit. By managing water resources for a whole river basin they hope to address the interdependencies between upstream and downstream

effects, water quality and water quantity, and water and land use. Since the 1980s river basin management (RBM) has advanced from a scientific concept with isolated applications to a global policy paradigm shaping water management across the world (Conca 2006, Molle 2008, Butterworth *et al.* 2010). The unitary river basin agency or authority has become, for many water professionals, the ideal organizational form for resolving problems of spatial fit between the physical geography of water resources and the political territories of jurisdictions. In practice, however, RBM often proves difficult to institutionalize. Experience from across the globe suggests that RBM may resolve some, but not all, problems of spatial fit relating to water and may even generate new problems beyond the water sector (Moss 2003, Mostert *et al.* 2007, Huitema *et al.* 2009). Similarly, the model unitary river basin authority is today increasingly subjected to criticism for lacking accountability to democratic procedures, compatibility with existing institutional structures and adaptability to address cross-sectoral issues (Schlager and Blomquist 2008, Borowski *et al.* 2008, Huitema *et al.* 2009).

It is against this backdrop of academic debate and practical experience relating to problems of spatial fit and RBM that the following paper investigates the case of the Dongjiang River (a tributary of the Pearl River) in China. The Dongjiang River Basin is characterized by huge spatial asymmetries between the impoverished und under-developed upstream communities of Jiangxi Province and the wealth and influence of the downstream Pearl River delta cities. The aim of this paper is to explore how classic upstream-downstream conflicts of water management and their attempted resolution can be interpreted in terms of spatial misfits and disparities between the river basin, territorial jurisdictions, levels of political influence and socio-economic conditions. Using the concept of spatial fit, the paper explores the complex environmental, socio-economic and political geographies which frame the interdependencies of water use and management within the river basin. It analyses attempts by stakeholders at different locations in the basin to advance their own water-related interests and the initiatives some are developing to share benefits and costs more equitably across the basin. As well as using the concept of spatial fit to shed fresh light on the geography of water in post-reform China, the paper makes observations from the Dongjiang River case on how to incorporate the multiple geographies of water and power asymmetries into a more nuanced, but wider-ranging understanding of spatial fit.

First the paper sets out the case for using the concept of spatial fit to explore water governance and RBM, based on a critical review of the literature (section 2). The following section presents the Water Allocation Plan for the Dongjiang River basin of 2008 as an attempt to address severe spatial asymmetries and misfits of water resources management (section 3). This empirical case is subsequently interpreted with respect to issues of spatial fit (section 4). A short conclusion summarizes the principal findings and highlights their implications for future research on spatial fit (section 5).

2. Problems of spatial fit and river basin governance

The problem of fit was identified by the Science Plan on Institutional Dimensions of Global Environmental Change (IDGEC) in 1999 as one of three clusters of factors which strongly shape the performance of institutions that govern human/environment relations (Young 2005). The basic idea is, in the words of Oran Young, that “the effectiveness of social institutions is a function of the match between the characteristics of the institutions themselves and the characteristics of the biogeophysical systems with which they interact” (Young 2005, p. 57). One obvious dimension concerns spatial fit; that is, the degree to which a resource regime matches the spatial scales of the resource or ecosystem it is designed to

manage (Ekstrom and Young 2009). Examples are fishery conservation regimes which cover the migratory pathways of fish and the need for global institutions to deal with climate gas emissions.

The older literature on misfits in human/environment relations – whether spatial or otherwise – tended to view this relationship in a somewhat deterministic way. Lee (1993) was typical in claiming that the use of resources was likely to be unsustainable when human responsibility does not match the spatial, temporal or functional scale of the natural phenomena. Similarly, Folke *et al.* (1998) asserted that spatial mismatches occur where the boundaries of management do not coincide with the boundaries of the ecological entity. Recent research, whilst advocating the importance of spatial fit, has taken a more reflective, nuanced stance, pointing out – for instance – that establishing the bounds of spatial fit is not as straightforward as it might appear (Moss 2012). Not every natural resource can be readily ascribed a territorial remit. Moreover, if the complex ecosystems on which it is dependent are also taken into account – as they should be – then the spatial boundaries can become very blurred. In short, there is no simple procedure for determining appropriate system boundaries (Young 2005, p. 58).

Problems of spatial fit are frequently cited as critical factors behind the unsustainable management of water resources (e.g. Young 2002, Dietz *et al.* 2003, Folke *et al.* 2007). Policies or strategies which address only a part of the water system, such as a stretch of a river or a point source of pollution, run the serious risk of ignoring, or even creating, negative external effects. Orienting water resources management around the river basin, with its clearly delineated boundary for surface water, appears to promise the resolution of such spatial misfits. Consequently, the ecosystem logic underpinning river basin management is today accepted by most hydrologists, water biologists and ecologists, as well as water engineers.

Experiences of institutionalizing river basin management, however, warn against overenthusiastic expectations. Since the late 1980s the literature has, on the basis of extensive empirical evidence, challenged the notion of creating perfect spatial fit which underlies a purist interpretation of river basin management. Firstly, even in hydrological terms, river basin management does not solve all boundary problems. The river basin follows surface water, not groundwater, boundaries. These physical boundaries themselves are overridden where water supply networks or artificial waterways connect two or more river basins. Secondly, river basin management, although improving spatial fit within the water sector, often creates new spatial misfits elsewhere (Moss 2003, Horlemann and Dombrowsky 2012). A river basin authority, covering a different territory to political jurisdictions, will generally lack the legitimacy and authority of democratically elected bodies of local, regional or central government. It will also experience difficulties in collaborating with policy fields not organized around river basins which are nevertheless critical for water policy, such as urban development, agriculture, forestry, transportation and energy (Moss 2003, Mostert *et al.* 2007, Pahl-Wostl *et al.* 2007). Thirdly, structuring water management along an eco-system boundary has often encouraged water managers to focus on biophysical, rather than socio-economic, problems of water management. The quest for perfect biophysical fit can result in important social and economic factors, such as population trends, regional economic development or traditional modes of water use, being overlooked (Huitema *et al.* 2009).

The perfect spatial fit, in other words, does not exist. The replacement of existing institutional units by organizations oriented around biophysical systems will inevitably create new boundary problems and fresh mismatches. However, it would be erroneous to assume, on the basis of this criticism, that addressing spatial misfits is not central to water resources

management. What is needed are more nuanced and broader understandings of the phenomenon of spatial fit as well as less deterministic approaches to resolving spatial fit problems. We conclude this section by outlining two novel perspectives on spatial fit and RBM which are particularly pertinent to the subsequent case study of the Dongjiang River basin.

Firstly, instead of striving to design the ideal river basin management institution capable of maximizing spatial fit we need to consider the territorial unit of the river basin in a broader context of overlapping social, economic, political and physical spaces (Lipschutz 1999). In line with this thinking, research today tends to advocate informal collaboration between multiple agencies within a river basin in preference to the creation of a formalized, unitary river basin organization as favoured in the past (Schlager and Blomquist 2008, Borowski *et al.* 2008, Butterworth *et al.* 2010). This requires paying less attention to the structure of an authority responsible for managing a river basin and far more to the interactions between the multiple organizations affecting water use within a basin.

Secondly, there is an urgent need to consider the power asymmetries inherent to spatial misfits – a seriously under-researched aspect of river basin management. From the perspective of an emergent literature highlighting the inherently political and contested nature of water resources management (Allan 2003, Zeitoun and Allan 2008, Molle *et al.* 2008), analysis of spatial fit needs to consider the (often overlapping and dynamic) power asymmetries between stakeholders. The asymmetrical relationship between upstream and downstream communities in managing water resources is just one such example. Others spatial dimensions can relate to the politics of scale, position and place (Lebel *et al.* 2005) or the relationship between everyday politics, state water policy, inter-state hydropolitics and the global politics of water (Mollinga 2008). Efforts to improve spatial fit, consequently, involve reordering power constellations around water and its use, resulting in some actors emerging strengthened and others losing influence.

Before these two new perspectives – on the multiple geographies and the power asymmetries of water resources management institutions – are used to interpret the Dongjiang River basin case we need to acquaint ourselves first with recent attempts there to manage problems of spatial fit through institutional reform and new planning initiatives.

3. The Dongjiang case: managing spatial misfits

In August 2008 the Guangdong Provincial Government issued a “Plan to Allocate Dongjiang River Basin’s Water Resources” (Guangdong Provincial Government 2008). The Plan is considered by both researchers and water managers as a significant initiative because it includes both water quantity and water quality control objectives. It has been hailed as the country’s first such prototype because past attempts to regulate water use by the country’s Water Resources Departments focused primarily on one parameter—quantity—and lacked effective inter-agency cooperation with the Ministry of Environmental Protection in addressing water pollution (Chen and Yue 2008). Of particular relevance for this paper, the plan has been branded a promising scheme to merge a river basin-based management model with a jurisdiction-based management approach. The underlying belief is that by creating an overarching water resources plan and an organization – the new Dongjiang River Basin Authority – with a spatial remit which strives to accommodate both the Dongjiang River basin and the territory of Guangdong Province, more effective solutions to water management problems should be possible.

With its headwater region located in southern Jiangxi, the Dongjiang River flows through the eastern half of Guangdong before it discharges into the Pearl River estuary (see Figure 1). It is a primary source of drinking water for about 35 million people who live in Heyuan, Huizhou, Dongguan, Guangzhou, Shenzhen and Hong Kong (DRB Authority 2007). The economies in the upper catchment (Xunwu, Heyuan) are dominated by the agricultural sector (see Table 1). Cities located in the middle and lower catchments (Huizhou, Dongguan, and Shenzhen) have been characterized by a high degree of concentration of industrial production since the 1990s. Both Dongguan and Shenzhen, however, have gradually shifted their structure to favour the tertiary sector in the past five years. The economies of Guangzhou and Hong Kong, located at the western and southern tips of the river basin respectively, are both dominated by the tertiary sector. The populations dependent on the Dongjiang's water thus include those surviving on subsistence-level income in three poor rural counties (Xunwu, Anyuan and Dingnan) located in southern Jiangxi, as well as those residing in the wealthy cities of Shenzhen, Guangzhou and Hong Kong. In 2010, Xunwu reported a per capita GDP of US$1,634, a fraction of Shenzhen's and Hong Kong's respective figures of US$14,018 and US$30,800 (Table 1).

3.1 Increasing conflicts over water quantity and quality

The hydrologists' concerns over the Dongjiang river basin's long-term sustainability are driven and supported by an accumulation of empirical observations made throughout the entire river basin. Firstly, in the downstream segment, the rapidly growing industrial and population centres extract an increasingly large amount of water from the river system and this has, since the 1990s, led to a brewing water shortage problem. The overall water abstraction ratio for the Dongjiang was recorded at 35.4% for many years and Guangdong's water research community was alarmed when the ratio shot up to 38.5% in 2004 (He et al. 2009). In the 1980s it was reported that cities located inside and next to the river basin extracted about 4 billion m^3 of water from the Dongjiang each year. This figure jumped to 8.95 billion m^3 in 2005 (*Southern Metropolis Daily*, 17 April 2008).

Secondly, the looming water shortage problem was compounded by a worsening water pollution problem, which has been widely observed and recorded in the Dongjiang river basin's upstream, midstream and downstream sections. In the headwater region, which encompasses the territories of the counties of Xunwu, Anyuan and Dingnan inside Jiangxi Province and accounts for 13.3% of the Dongjiang's overall drainage area (see Figure 1), waterways leading into the Dongjiang have been found to be heavily polluted. Measurements taken by Jiangxi Province's Hydrological Bureau of eight water quality parameters—including BOD_5, NH_3-N, TP and TN—at three water quality monitoring stations during the 2000-2009 period showed that the overall water quality in the headwater region had deteriorated (Zeng 2010). The major causes of deterioration included the wanton discharge of wastewater from substandard rare earth mines, the runoff of fertilizer and pesticide excessively applied to navel orange orchards and the release of untreated sewage from growing urban settlements.

While the overall water quality in the Dongjiang's midstream section has been regarded as much better than those monitored in the headwater region, rapid population growth in Heyuan and Huizhou, as well as the increased rate of application of fertilizer and pesticide to boost productivity in their agricultural sector, has contributed to a mild deterioration of the river's water quality in its mid-segment. Specifically, measurements taken at two water quality monitoring stations—located in Longchuan and Heyuan (marked

"A" and "B" respectively in Figure 2)—showed that the values of two key parameters, BOD_5 and NH_3-N, had gradually crept up between 2001 and 2007 (Jiang et al. 2009).

Figure 1. Dongjiang river basin as defined by hydrologists

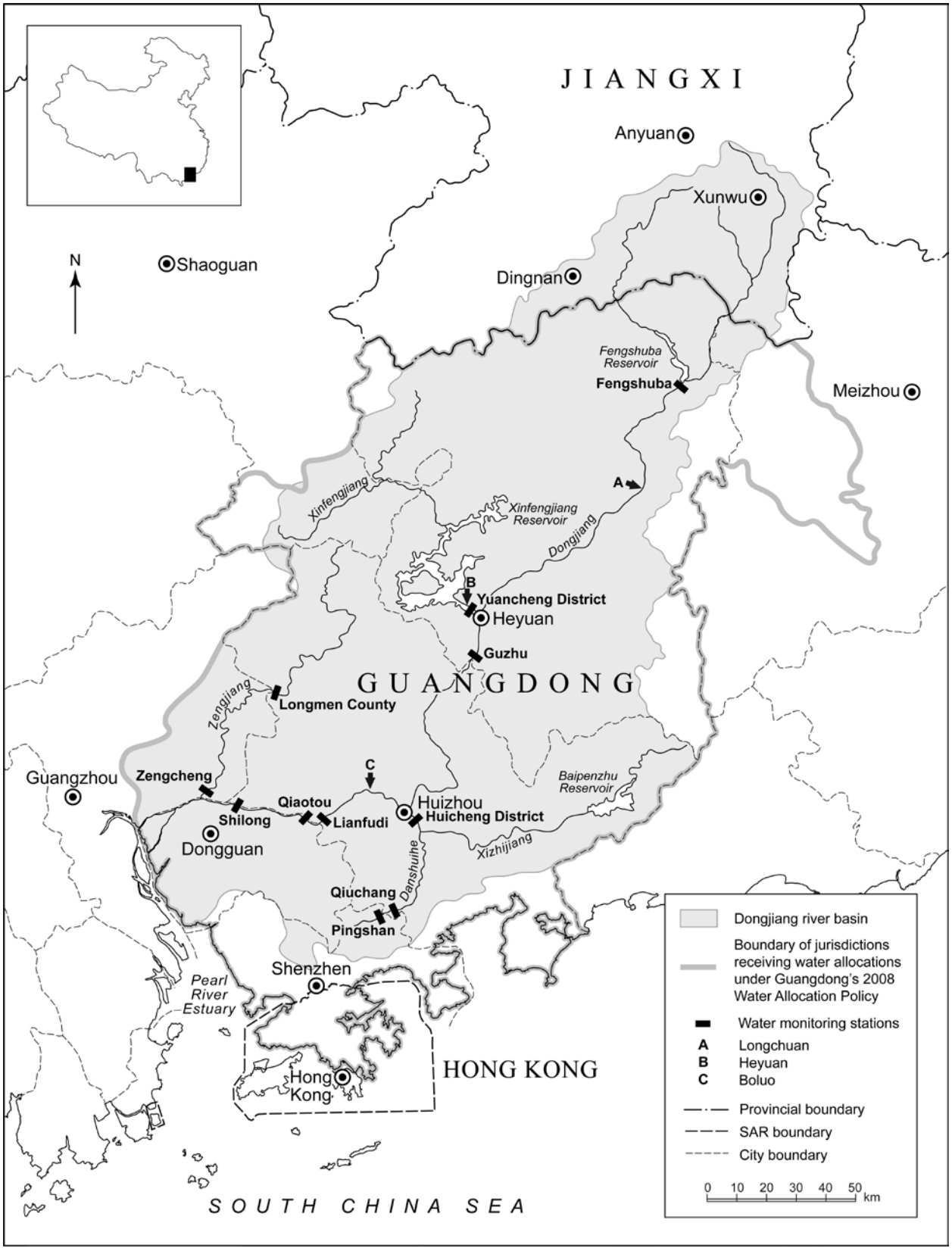

Table 1. Basic socio-economic characteristics of jurisdictions located inside and adjacent to the Dongjiang River basin

	Land area (km^2)	*Population*			*Per capita GDP (US$)*			*Composition of GDP (%)*					
	2010	2000	2005	2010	2000[d]	2005[e]	2010[f]	2000			2005		
Upstream								Agr	Ind	Tert	Agr	Ind	Tert
Xunwu, Jiangxi[a]	2,311	287,000	289,000	317,000	313	646	1,634	45.6	15.1	39.4	43.4	18.5	38.2
Meizhou, Guangdong[b]	15,876	3,805,200	4,118,400	4,244,600	571	950	2,191	31.9	35.9	32.2	23.1	41.5	35.4
Heyuan, Guangdong[b]	15,642	2,267,800	2,782,400	2,958,200	462	927	2,972	37.2	26.5	36.3	20.7	39.4	39.9
Shaoguan, Guangdong[b]	18,385	2,736,500	2,922,600	2,830,200	849	1,438	3,663	24.1	43.6	32.3	17.5	42.5	40.0
Midstream													
Huizhou, Guangdong[b]	11,356	3,218,000	3,706,900	4,601,100	1,676	2,715	5,705	14.8	58.0	27.2	9.3	57.1	33.6
Downstream													
Dongguan, Guangdong[b]	2,472	6,448,400	6,560,700	8,224,800	1,653	4,125	7,835	6.3	54.6	39.1	0.9	56.7	42.4
Guangzhou, Guangdong[b]	7,287	9,948,000	9,496,800	12,709,600	3,096	6,668	12,833	4.0	43.4	52.6	2.5	39.7	57.8
Shenzhen, Guangdong[b]	1,953	7,012,400	8,277,500	10,372,000	3,963	7,534	14,018	1.0	52.5	46.5	0.2	53.2	46.6
Hong Kong[c]	1,104	6,866,000	6,935,900	7,067,800	24,000	25,600	31,800	0.1	14.3	85.6	0.1	9.2	90.7

	2010		
	Agr	Ind	Tert
Xunwu, Jiangxi[a]	37.9	27.9	34.2
Meizhou, Guangdong[b]	3.9	58.8	37.3
Heyuan, Guangdong[b]	1.3	54.6	44.1
Shaoguan, Guangdong[b]	5.4	43.1	51.5
Midstream			
Huizhou, Guangdong[b]	2.3	62.9	34.8
Downstream			
Dongguan, Guangdong[b]	0.4	50.9	48.7
Guangzhou, Guangdong[b]	1.3	35.4	63.3
Shenzhen, Guangdong[b]	0.1	47.2	52.7
Hong Kong[c]	0.1	11.4	88.5

Sources:

[a] For Xunwu county, the figures for 2000 were taken from Jiangxi Provincial Bureau of Statistics, 2001, *Jiangxi Statistical Yearbook 2001*, Beijing: China Statistical Press. Figures for 2005 were taken from Jiangxi Provincial Bureau of Statistics, 2006, *Jiangxi Statistical Yearbook 2006*, Beijing: China Statistical Press. Figures for 2010 were taken from Jiangxi Provincial Bureau of Statistics, 2011, *Jiangxi Statistical Yearbook 2011*, Beijing: China Statistical Press.

[b] For cities located inside Guangdong Province, the population and per capita GDP figures were taken from Guangdong Provincial Bureau of Statistics, 2011, *Guangdong Statistical Yearbook 2011*, Beijing: China Statistical Press. The composition of GDP figures for 2000 were taken from Guangdong Provincial Bureau of Statistics, 2001, *Guangdong Statistical Yearbook 2001*, Beijing: China Statistical Press; the 2005 figures were taken from Guangdong Provincial Bureau of

Statistics, 2006, *Guangdong Statistical Yearbook 2006*, Beijing: China Statistical Press; and the 2010 figures were taken from Guangdong Provincial Bureau of Statistics, 2011, *Guangdong Statistical Yearbook 2011*, Beijing: China Statistical Press.

[c] For Hong Kong, the figures for 2000 were taken from *Hong Kong Year Book 2000*, Hong Kong SAR Government, 2001 and *Hong Kong Year Book 2001*, Hong Kong SAR Government, 2002. Figures for 2005 were taken from *Hong Kong Year Book 2005*, Hong Kong SAR Government, 2006 and *Hong Kong Year Book 2006*, Hong Kong SAR Government, 2007. Figures for 2010 were taken from *Hong Kong Year Book 2010*, Hong Kong SAR Government, 2011 and *Hong Kong Year Book 2011*, Hong Kong SAR Government, 2012.

[d] Per capita GDP figures for 2000, except for Hong Kong, were converted from RMB into US dollars using the official exchange rate on December 29, 2000 (RMB8.28 = 1US$).

[e] Per capita GDP figures for 2005, except for Hong Kong, were converted from RMB into US dollars using the official exchange rate on December 31, 2005 (RMB8.07 = 1US$).

[f] Per capita GDP figures for 2010, except for Hong Kong, were converted from RMB into US dollars using the official exchange rate on December 31, 2010 (RMB6.59 = 1US$).

Figure 2. Jurisdictions covered by Guangdong's 2008 Water Allocation Plan

The water quality in the Dongjiang river basin is worst in the downstream cities of Dongguan, Shenzhen and Guangzhou. The widespread decline in the Delta's water quality has given rise to inter-city conflict over the questions of who should shoulder the responsibilities for cleaning polluted water and how, and where, a city should be permitted to gain access to Dongjiang water. For instance, a persistent cross-boundary water pollution problem afflicting the Dongjiang's downstream river network has become a source of conflict between Huizhou and Shenzhen in recent years. Danshuihe, which is a Class-2 tributary of the Dongjiang, originates in Shenzhen and drains into Xizhijiang—a Class-1 tributary of the Dongjiang—inside Huizhou (Figure 2). Since the late 1990s, uncontrolled discharge of untreated industrial and urban wastewater originating from settlements inside Shenzhen has polluted Danshuihe and directly contributed to turning the river's water in Huizhou's section into the lowest classification of Grade V+, meaning that the water is not suitable for use for any purpose (He et al. 2009).

3.2 Objectives and control mechanisms

The formulation of the Water Allocation Plan for the Dongjiang was premised on two major considerations. First, the Hong Kong Special Administrative Region was accorded top priority in the allocation exercise, which simply re-affirmed the fact that the provision of Dongjiang water to the former British colony has always assumed national-level political importance. Secondly, in regard to the deployment and utilization of water resources from the basin's three major reservoirs, a new order of priority—flood prevention, municipal water supply, then power generation—was introduced. Power generation, the *raison d'etre* for constructing the reservoirs in the first place, was relegated to a lower priority status. The re-arranged order of priority gave recognition to the fact that cities located in the basin's downstream region have assumed greater economic importance than in the past and that they are also increasingly dependent on the Dongjiang as the primary source of their municipal water supply systems.

Based on a study of extensive hydrological data pertaining to the river basin, Guangdong's policymakers decided to cap, at 10.66 billion m^3 per year, the total amount of Dongjiang water that could be safely—ecologically speaking—withdrawn (Chen and Yue 2008). This amount, equivalent to about 33% of the river's average annual discharge, was argued as a safe margin by hydrologists and ecologists who devised the Plan (*Southern Metropolis Daily*, 17 April 2008). It is based on the calculation that this should ensure a regular flow of water in the river so that cities dependent on it for water supply will be able to withstand the worst impacts of a prolonged four-year drought period, considered a very rare occurrence. Table 2 lists the apportioned figures for eight individual cities. The overall boundary of jurisdictions receiving Dongjiang's water under the Plan is shown in Figure 1.

Under the terms of this Plan, city-level officials with water protection duties are expected to introduce measures to ensure that the water discharged from their jurisdictions would meet two minimal standards stipulated in the Plan—a minimum discharge volume and a water quality objective. To this end, eleven water quality monitoring stations were designated by the provincial authorities, covering the entire river basin within Guangdong Province (Figure 1). The water quality monitoring results recorded at these stations serve to provide the best evidence, as well as leverage, for a downstream jurisdiction to demand compliance, on the part of its immediate upstream neighbour, with the Plan's minimal standards. According to the Plan's operational design, the basin's overall water quality objectives are thus to be achieved through the power of the watchful eyes of a cascade of monitors concerned for the welfare of downstream communities.

Table 2. The ratio of total allocation to total water consumption

Jurisdiction	*Total allocation*[a] *(100 million m^3/ year)*	*Total water consumption*[b] *(100 million m^3/ year)*	*Ratio of total allocation to total water consumption (%)*
Upstream			
Meizhou*	0.26	22.31	n.a.[#]
Heyuan	17.63	18.04	97.7
Shaoguan**	1.22	22.10	n.a.[#]
Midstream			
Huizhou	25.33	21.99	115.2
Downstream			
Dongguan	20.95	21.48	97.5
Guangzhou***	13.62	78.32	n.a.[#]
Shenzhen	16.63	17.70	94.0
Hong Kong	11.00	9.56[c]	115.1
Total	*106.64*	*211.50*	*n.a.*[##]

Notes:
n.a. Not available
* The water allocated to Meizhou is supplied to only one of its eight administrative divisions—Xingning.
** The water allocated to Shaoguan is supplied to only one of its ten administrative divisions—Xinfeng.
*** The water allocated to Guangzhou is supplied to two of its twelve administrative divisions—Zengcheng and Guangzhou's eastern section.
# The ratio could not be determined for Meizhou, Shaoguan and Guangzhou because the total water consumption figure for each of their concerned administrative sub-divisions is not available.
The overall ratio could not be meaningfully determined because of data unavailability for Meizhou, Shaoguan and Guangzhou.

Sources:
[a] The total allocation figures were taken from Guangdong Provincial Government, 2008, "Guangdong Province's Water Resources Allocation Plan for the Dongjiang River Basin" (in Chinese).
[b] The total water consumption figures, except for Hong Kong's, were taken from *Guangdong Water Resources Bulletin 2008* (in Chinese), Guangdong: Water Resources Department of Guangdong Province.
[c] The total water consumption figure for Hong Kong was taken from *Hong Kong Year Book 2008*, Hong Kong SAR Government, 2009.

3.3 Early outcomes

The Plan has now been implemented for over five years, but no formal evaluative reports have yet been released or published by the authorities. Nevertheless, informal praise has been lauded on the project. Guangdong's Water Resources Department announced in 2011 that the Dongjiang River Basin Authority, since its creation, had successfully implemented water re-deployment plans to counter the drought effects of the dry seasons in the previous three years. In addition to such claims to success, some early, and more profound, outcomes of the Plan can be discerned in the form of reactions by some of the jurisdictions affected by it.

Firstly, the Plan has proved effective in deliberately under-allotting water resources (except for Huizhou and Hong Kong), designed as a contribution to Guangdong Province's overall strategic scheme to achieve province-wide targets for energy saving and emission reduction (Chen and Yue 2008). Framed by this strategic perspective, the Plan's drafters believed that the imposition of a permanent limit on the amount of water allowed for each city would provide enormous incentives for city officials and enterprises to devise action programmes to reduce the use of water and recycle wastewater. City officials in Dongguan, for instance, upon learning that their annual allotted amount was 2.095 billion m^3, which was about 7.5% lower than their actual annual consumption, immediately proposed a series of measures to deal with an expected shortfall in water supply (Duan 2008).

Secondly, upon the implementation of the Plan, the upstream city of Heyuan immediately revived its long-cherished dream of piping and selling Xinfengjiang Reservoir's water directly to the downstream cities of Dongguan, Shenzhen and Guangzhou (Xie and Huang 2008). This proposal has been repeatedly rejected by Guangdong's provincial authorities because it was considered by hydrologists and ecologists as extremely damaging to the river's ecology since the scheme would divert up to two billion m^3 of the reservoir's water away from the river's sub-Heyuan section. In an effort to overcome the province's concern, the proponents of this commercial scheme in 2007 re-formulated the project as one that focused on building only a potable water supply system. In 2008 and 2009, Heyuan reportedly signed memoranda of understanding with Dongguan, Shenzhen and Guangzhou to serve as the latter's sole supplier of potable water (Chen and Gan 2008). However, the final approval for the project has yet to be granted by Guangdong's provincial authorities (Liu 2012).

Thirdly, in 2010, an engineering proposal, named "West water re-deployed to the East", was presented by some hydrologists as a solution to the looming water shortage problem faced by Shenzhen and Dongguan under the restricted provisions of the 2008 Water Allocation Plan (Liang 2011). Specifically, the proponents of this scheme argued that up to 2.07 billion m^3 of water could be diverted from the relatively water-abundant Xijiang (West River), a tributary of the Pearl River system located on the western bank of the delta region, and channelled through a 95 km aqueduct to supply the thirsty cities located on the delta's eastern bank. They pointed out that, altogether, the urban economies of Shenzhen, Dongguan and Guangzhou—which account for 60% of Guangdong's total GDP—constituted the province's growth engine. The future development potential of these cities is, however, constrained by Guangdong's "cap and allocate" water plan. Guangdong's water planners have apparently also lent their support to this option because it allows these cities to source their water from two rivers rather than one, thereby significantly lowering the urban centres' water supply-related risks.

4. Interpreting the case: between multiple geographies and power asymmetries

On the basis of the above analysis of the problems, objectives and initial impacts surrounding recent institutional reform of water resources management in the Dongjiang River basin we now explore issues of spatial fit there in more depth. In what ways does the creation of the Dongjiang River Basin Authority and Water Allocation Plan represent a novel attempt to overcome problems of spatial fit between the hydrological unit of the river basin and territorial jurisdictions? What additional socio-economic, political or physical geographies have influenced their institutional design and are likely to affect their performance? How have power asymmetries within and beyond the river basin helped shape the institutional arrangements and who are likely to be the principal winners and losers of the reform?

To take the first of these three questions, the DRBA and the Water Allocation Plan represent, on face value, a highly interesting middle-way between purist river-basin and jurisdictional approaches to the spatial organization of water. The spatial domain of the DRBA, being a provincial body, is restricted to Guangdong Province, but within the province follows the boundary of the Dongjiang River basin (see Figure 1). The Plan covers, in addition, areas both beyond the province – notably Hong Kong SAR – as well as beyond the river basin in eastern and southern Guangdong. This is partly because the Plan targets water allocation issues requiring cross-basin collaboration, but also – interestingly – because of competing definitions of the Dongjiang River basin boundary in the delta region. The way in which the DRBA is configured to accommodate both river basin and political boundaries is greatly facilitated by the fact that 86.7% of the Dongjiang catchment lie inside Guangdong Province. In situations where the territory of a river basin is distributed more widely amongst various jurisdictions, as in the case of the other two principal tributaries of the Pearl River – the Xijiang (West River) and Beijiang (North River) – this model would be far less viable. The Dongjiang River Basin Authority (DRBA) works more effectively, in terms of accomplishing its stated mandate, than the Xijiang (West River) River Basin Authority (XRBA) because the former deals with municipal boundaries that are confined to one single province—Guangdong Province. The mayors of municipalities lying inside Guangdong Province answer directly to the Province's leaders. The DRBA, being an arm of Guangdong's Department of Water Resources, therefore wields much power, on behalf of the provincial government, over city-level and county-level officials in regard to water use issues. By contrast, river basin authorities overseeing inter-provincial boundaries are more constrained in what they can do to acquire compliance and cooperation from two or more provincial authorities because the latter hold a higher bureaucratic rank than the former and they can refuse to cooperate with the river basin authorities without any consequences

In terms of the recent literature on river basin governance, the DRBA is a good example of how the authorities have created an institutional arrangement to fit not simply the river basin's topographic boundaries but "its principal problems and its principal communities of interest" (Schlager and Blomquist 2008, p. 149). In a way, the creation of the DRBA is very much driven by the "politics of position" and the "politics of place" (Lebel *et al.* 2005), where stakeholders located in specific locations within a given area (the river's downstream section inside Guangdong Province) and sharing similar identity, status and resources (Guangdong Province's constituent cities) decided to create a new layer of institution to address their shared concerns. In this case, the DRBA is thus organized around the "communities of interest" that comprise only those cities that are located inside Guangdong Province and are dependent on Dongjiang's water.

As this analysis implies, the spatial dimensions surrounding the creation and operation of the DRBA reach well beyond the quest to maximize fit between river-basin and

jurisdictional territories. The case of the DRBA is illustrative of a number of other important geographies at play. One of these is scalar. With the DRBA the Guangdong provincial government has created a new mid-level management layer located between the central office of the Department of Water Resources at the top of the province's water management hierarchy and the Water Research Bureaus of the cities at the bottom. From this perspective, the creation of the DRBA does not represent a radical reordering of water management in the province, but rather a sub-provincial institution-building programme designed to strengthen the management capacity of the Department of Water Resources. The provincial government benefits from the creation of the DRBA firstly by being better able to achieve the economic development targets set by the central government and, secondly, by possessing an overarching organizational entity capable of dealing with occasional, intense inter-city conflicts over water quality problems. In addition, the DRBA can make up for the perceived ineffectiveness of the river basin body responsible for the entire Pearl River, the Pearl River Water Resources Commission (PRWRC). The PRWRC is one of seven sub-national organizations created by the national Ministry of Water Resources to manage inter-jurisdictional conflicts over water. In practice, the PRWRC, like the other river commissions, has long been faulted for being too weak, politically, legally and financially (da Silveira and Richards 2013). Its effectiveness in the Dongjiang river basin is further compromized by the low priority it accords to the basin's water management problems and by the fact that its two sub-units (water districts) responsible for the basin do not match the basin's boundary (Figure 2). From Guangdong's perspective the PRWRC has failed to pursue the province's grievances against its upstream neighbours over transboundary water pollution problems. In terms of the "politics of scale" (Lebel *et al.* 2005), the creation of the DRBA is therefore an expression of the Guangdong provincial government's reluctance to relinquish power to the central government, its frustration at the ineffectiveness of the PRWRC and its unwillingness to delegate authority to the municipal water bureaus.

A further "geography" at play is socio-economic. In a number of ways, the Water Allocation Plan reflects emerging socio-spatial trends in the region. The new priority accorded to flood protection and municipal water supply over hydroelectric power can be read as a response to the growing economic importance of the downstream cities and industrial production centres. The Plan's primary objective—to assure a high degree of reliable supply of water to cities throughout DRBA's jurisdiction—is accomplished not by taking water away from hydropower generation and giving it to the cities, but by consolidating the power of regulating the water discharge rates of the three main reservoirs in the hands of one single agency—the DRBA. By controlling the timing and the rate of discharge of water from the three main reservoirs placed under its jurisdiction the DRBA can now determine and control the level of water in the river in a way that assures downstream cities of a reliable supply of sufficient fresh water, even in the most unlikely event of a four-year long drought period. This is also reflected in the Plan's provisions to improve protection of downstream settlements from water pollution via the strategic location of monitoring stations on the borders between upstream and downstream jurisdictions. The same motive lies behind the measures to secure water supplies for the urban conurbations downstream, whether via the top priority water allocation for Hong Kong SAR or the West River water transfer scheme for Dongguan and Shenzhen. The city of Heyuan, located in the mid-segment of the river basin, is seeking to reap financial benefit from its advantageous geographical position by selling drinking water to the wealthy (and thirsty) cities downstream via a direct water pipe circumventing the intervening area. All these developments are expressions of a "politics of position", in which the parties involved strive to maximize benefits and minimize vulnerabilities dependent on their geographical location in the river basin.

This brings us to the third question relating to power asymmetries. In many ways, the DRBA and the Water Allocation Plan are the product of power asymmetries in the region. What is officially couched in terms of a rational logic to promote river basin management can equally be viewed as an attempt by the Guangdong provincial authorities to strengthen their own influence vis-à-vis the central government, other provinces and its own local authorities. Exploiting the relative weakness of the PRWRC, the provincial government has set up its own river basin authority and plan. The DRBA is politically empowered by the provincial government to exercise regulatory control over local authorities' water use – by means of strict allocation quotas – in the interest of promoting Guangdong's overall policy agenda. Being limited to Guangdong Province, the DRBA has effectively excluded, and politically marginalized, both the upstream Jiangxi Province and downstream Hong Kong SAR from the process of formulating the Water Allocation Plan. At the same time, the DRBA's influence, in terms of its command over water allocations, extends beyond the river's natural boundary and reaches parts of Shenzhen and all of Hong Kong SAR. Overall, the likely beneficiaries include the provincial water authorities with their additional resources to implement the Plan, water users in downstream cities with their guaranteed (if limited) water allocations, as well as the privileged Hong Kong SAR, and mid-stream communities with options for water trading with downstream cities. Most likely to lose out are Jiangxi Province, for being effectively marginalized from the whole exercise, and power generation companies losing control over the use and deployment of water from their major reservoirs. In other words, it is likely that the operation of the DRBA and the implementation of the Plan may help preserve, if not accentuate, the asymmetrical power relationships within and beyond the river basin. This supposition is backed by the observation that the poorest administrative unit (Xunwu county) and the richest jurisdiction (Hong Kong SAR) have been, and are still being, excluded from the plan-making and decision-making processes relating to water allocation in the basin.

At this early stage of implementation there remain many open issues, however, which could alter this picture, possibly reducing some of the described asymmetries. For instance, it is unclear whether water fees paid by the wealthy downstream cities act as a form of compensation to poorer upstream communities and whether such payments could be used to reward them for water conservation services, thus improving water quality and incomes upstream at the same time. It is also uncertain how the system of compliance to the Plan's stipulations will work in practice. Downstream users can now report instances of non-compliance to the DRBA. With the hard data that is being collected at the monitoring stations the DRBA can pursue established protocols in requiring upstream transgressors to take remedial action. Additionally, the DRBA can take the most contentious cases all the way up to the provincial authorities for resolution. How far the authorities will be willing to apply these sanction mechanisms in practice remains to be seen.

5. Conclusions

We conclude this paper by summarizing the principal findings and reflecting on their implications for future research on problems of spatial fit in water resources management. The case of the Dongjiang River basin resonates in many ways with findings from recent research on how best to address problems of spatial fit between hydrological and jurisdictional units of governance. The DRBA and the Water Allocation Plan are oriented around the river basin, but not exclusively. The DRBA operates only within the boundaries of Guangdong Province and the Plan extends to additional areas outside the province dependent on water from the Dongjiang. This construction, though spatially imperfect to purists of river

basin management, would appear to hold considerable potential to overcome past water quality and quantity problems. It has enabled the introduction of water quality monitoring at strategic points between key jurisdictions. It has set water allocation quotas for all communities dependent on the basin for their water supply, encouraging water conservation programmes. It has also created a mid-level organization – the DRBA – in a position to regulate intra-basin conflicts over water allocation and use in the absence of adequate intervention by the sub-national water commission PRWRC. From this perspective the institutional arrangements for the Dongjiang River basin reflect the complex realities and particular context of water resources management in the region and are therefore, according to the recent literature on river basin governance, likely to be more effective as a result.

The two other perspectives applied in this paper – on multiple geographies and power asymmetries – suggest that other readings are possible which shed a less favourable light on the new arrangements. The introduction of socio-economic and political dimensions to the equation has revealed the importance of huge spatial disparities between wealthy and influential downstream cities and under-developed and weak upstream communities behind the design of the Plan, disparities which are unlikely to be redressed – and may even be exacerbated – by its implementation. The principal objective of the Plan is to provide the downstream industrial and residential centres with guaranteed supplies of water in adequate quality. Compensation arrangements for the upstream communities remain, by contrast, unclear. The DRBA and Plan strengthen the hand of the provincial government vis-à-vis not only its constituent local authorities but also the central government, in the shape of the sub-national PRWRC.

Both new perspectives – as applied to the Dongjiang River basin – raise important issues for future research. Firstly, they fundamentally challenge the assumption, common in the literature on river basin management, that the downstream community is ‘naturally’ in the weaker position, owing to its dependence on upstream water use and pollution. This applies only if the resource water is the sole point of reference. By broadening the perspective to include social, economic and political relationships between upstream and downstream communities, the position of each becomes far less clear-cut. The seemingly ‘given’ asymmetry in favour of the upstream user can be counteracted by, say, the superior economic wealth or political influence of a city at the mouth of a river. Secondly, the quest for improved spatial fit for water resources management is shown to be a very political project. However well it is framed as a rational step towards integrated, basin-based management, power contestations and alliances will inevitably be highly instrumental. An important task for future research on spatial fit – as on water resources management in general – is to address the (spatial) politics of water not as something peripheral, or even distasteful, but as something very real and therefore very significant for understanding and shaping the future of water governance.

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