

Nine dragons stirring up the river: conceptualizing the one resource two systems phenomenon in transboundary environmental management

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Abstract

This paper proposes and applies a new analytical framework for collaborative public sector governance. Based on Ostrom's IAD, the framework casts government agencies as actors and transboundary dynamics as institutional parameters. This theoretical proposition applies the logic of collective action to the management of environmental resources within a multi-layered and fragmented governance environment, thereby aiming to understand how governance structure enables resilience. More specifically, the study revisits the IAD through the up-scaled lens of transboundary collaboration, integrating Jensen and Lange's governance framework to situate the analysis in a complex institutional setting that includes national and regional interaction. The framework uses the meta-language and analytical approach of a revised model of institutional rational choice, problematizing the sustainability challenge as a governance failure. The applied case – water governance in Hong Kong – explores from a theoretical perspective how de-fragmentation reforms can enable strategies for a more resilient water procurement regime. The paper begins by outlining a theoretical gap in the literature, namely the value in applying a model of collective action to the agency level. It continues with the Hong Kong case, and concludes with broader applications of the framework to environmental governance reform and a call for additional research. This paper makes three contributions. First, it explores the critical but under-theorized link between the structure of public sector governance systems and collaborative capacity for resilience. Second, it applies the rational choice concept of self-interested individuals to actor-agencies, particularly with respect to the fulfilment of individual organizational objectives within a complex institutional milieu. Finally, the paper explores the potential of the IAD to explain broader governance dynamics, thereby applying collective action at a level often labeled formal but nonetheless sharing some attributes with informal situations, including resource type, multiplicity and diversity of actors, and negotiated outcomes.

Keywords: Institutional analysis, environmental governance, China

1. Introduction

The *new institutional economics* literature helps explain how governance challenges are addressed through collective action, creating a third space distinct from the public and private sectors. The related concept of *institutional rational choice* refers to the self-interested behavior of actors within formal and informal constraints governing the institutional environment. The literature boasts a variety of empirical studies, including congressional behavior and the role of institutions in collective action (Hall and Taylor 1996), the ability of trust, reputation, and reciprocity to facilitate co-management of common pool resources (Ostrom 1998), cooperative equilibrium and coordination within social institutions (Calvert 1995), and the role of institutions in minimizing transaction costs among contracting parties (Williamson 1981). A related strand of public choice literature addresses governance failures that arise from perverse incentives and lead to inefficiencies (see: Self and Peacock 1993; Buchanan and Tollison 1984; Schwartz 1994). Empiricized issues include rent seeking, principal-agent dynamics, the influence of interest groups in democratic systems, and the influence of politics in bureaucratic choice. The literature's concepts of shared resources and coordination are relevant to this paper, especially as they pertain to patterns of interaction developed through recurrent institutional cooperation.

The literature typically casts individuals as the unit of analysis and discrete institutional environments as the sphere of interaction. This study proposes a hybrid analytical framework derived from Ostrom's Institutional Analysis and Development (IAD) framework and Jensen and Lange's transboundary water governance framework. In so doing, it parts from the literature in two critical ways: the treatment of organizations as individual actors, and the treatment of transboundary dynamics as institutional parameters. This allows broader-scale governance challenges such as transboundary environmental management to be systematically

conceptualized using a common language and theoretical basis. The focus on organizations diverts the discussion from political matters and towards the administrative capacity of agencies to collaborate in multi-layered, fragmented institutional environments. When viewed in more pragmatic terms, the efficacious management of environmental resources across borders is increasingly defined by operational agreements and collaborations among public agencies, underscoring the necessity of contemplating administrative capacity when analyzing structural resilience. It is at this level that this study makes its contribution.

2. Theoretical model

2.1 Literature review

This paper continues by exploring the proposed model's two theoretical contributions: actor-agencies and complex institutional parameters. First, the implicit theoretical proposition – that public sector governance can be understood through an institutional rational choice model – extends the unit of analysis, typically the individual person, to the agency as an individual actor. Few studies explicitly examine the behavior of organizations as resembling that of individual actors. Araral's (2009) study of the strategic interaction between aid donors and recipients examines public agencies and donor organizations as actors. In his model, the goal of the bureaucracy is survival, while the goal of the donor agency is to expand its own loan portfolio. Araral frames the behavior of these actors as products of incentive problems and moral hazard.

In modeling institutional rational choice, this theoretical proposal seeks to explain how *actor-agencies* pursue organizational objectives within the institutional structure of transboundary challenges (e.g. environmental management, terrorism, and financial crises).

Individual actors are agencies whose characteristics within the model resemble those of individual persons in other models: interests, positions within a power structure, access to information, and analytical capacity. It is within the first of these, interests, where the proposed framework makes its most ambitious theoretical proposal. The other three factors are regarded as control variables. For example, management of information (access and analysis) is assumed to be consistent across agencies, with none having a singular advantage. This is increasingly plausible given the advent of information technology and its impact on analytical capacity. The literature has generated a variety of theories and empirical studies about the role of information management (see: Snellen and van de Donk 1998; Andersen, Belardo, and Dawes 1994; Workman, Jones, and Jochim 2009; Rocheleau 2000). Although variability in this factor may partly explain differences in strategic behavior, the issue is beyond the scope of this paper. Position within the power structure is assumed to be fairly straightforward, broadly reflecting the administrative hierarchy typically outlined in public documents. Further, this model does account for outlier cases in which unusually effective leadership or close relationships account for strategic decisions that are not rational based on normal assumptions.

This analysis of actor agencies therefore focuses on interests, specifically in three dimensions: origins, strategic execution, and impact. These three are selected because they correspond with standard theories about the policy process, namely the flow of initiatives from conception to implementation (see: Lasswell 1951; Jann and Wegrich 2007; Howlett, Ramesh, and Perl 1995). They also relate directly to the three dimensions of the IAD, namely situational factors, action arena, and outcomes. First, the origin of interests extends from the already-stated assumption regarding power structure. Agencies must support the larger strategic directives of their parent agencies and ministries, in observance of their relative position within a hierarchy.

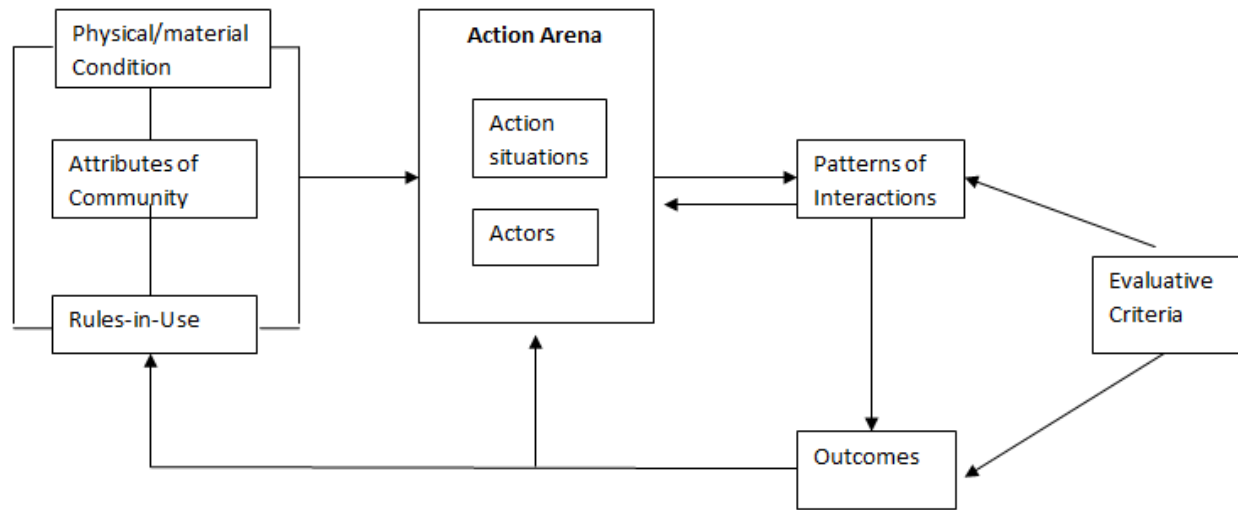
Second, with regard to strategic execution, coordination can be increasingly challenging in a system where governance of a particular sector is divided into functional areas and spread across multiple ministries. An agency may have varying levels of flexibility in interpreting strategic directives, depending on which tier of the hierarchy it occupies. According to the literature about policy implementation and street level bureaucrats (Lipsky 2010; Sabatier 1986; Meyers et al. 2003), there may be a distance decay function in the effectiveness of coordination as a policy moves from its managerial origins to the “ground level.” Depending on the agencies in which particular water governance functions reside, there may be differing levels of adherence to given policy initiatives, leading to coordinative inefficiencies. Third, the described level of individual agency discretion becomes more relevant as differing interpretations of the same authoritative mandate lead to different strategic endpoints. This relates to the impact dimension. Even clear strategies, when interpreted by individual agencies, can produce differing and potentially conflicting approaches to execution, and thereby suboptimal or inefficient outcomes. As such, the institutional rational choice model holds that individual agencies act not only within the authoritative confines of strategic directives but also within their own individually-determined interests for operational efficiency and strategic efficacy. As such, it may not be the quality of the specific strategy that explains outcomes, but the management structure of the agencies executing it.

2.2 Institutional analysis

With the dimensions of analysis regarding actor agencies now outlined, this discussion turn to an exploration of the second theoretical contribution of the proposed framework, transboundary

dynamics as institutional parameters within the rational choice model. In this model, the sphere of interaction is an institutional structure defined principally by law, geography, relationships, and strategic options. The conditions governing such environments can be captured using the IAD framework (Figure 1).

Figure 1: Institutional Analysis and Development Framework (adapted from E. Ostrom 2007)



Ostrom defines the physical and material characteristics of a good through a 2x2 matrix overlaying the cost of excludability with the degree of rivalry (one user’s consumption denies another user consumption by equivalent proportion) (Polski and Ostrom 1999). Attributes of the community include generally accepted norms of behavior, shared understanding about issues, preferential homogeneity, and the role of trust and reputation. Rules-in-use relate to boundaries, positions, scope, authority, and information. Given these situational conditions, actors meet inside the action arena to generate solutions to governance challenges. In this analytical context, the characteristics of actors (resources, preferences, etc.) and those of the situation (participants, outcome possibilities, costs and benefits, etc.) are systematically operationalized. The assumption is that the institutional environment is uniform in its conditions and characteristics,

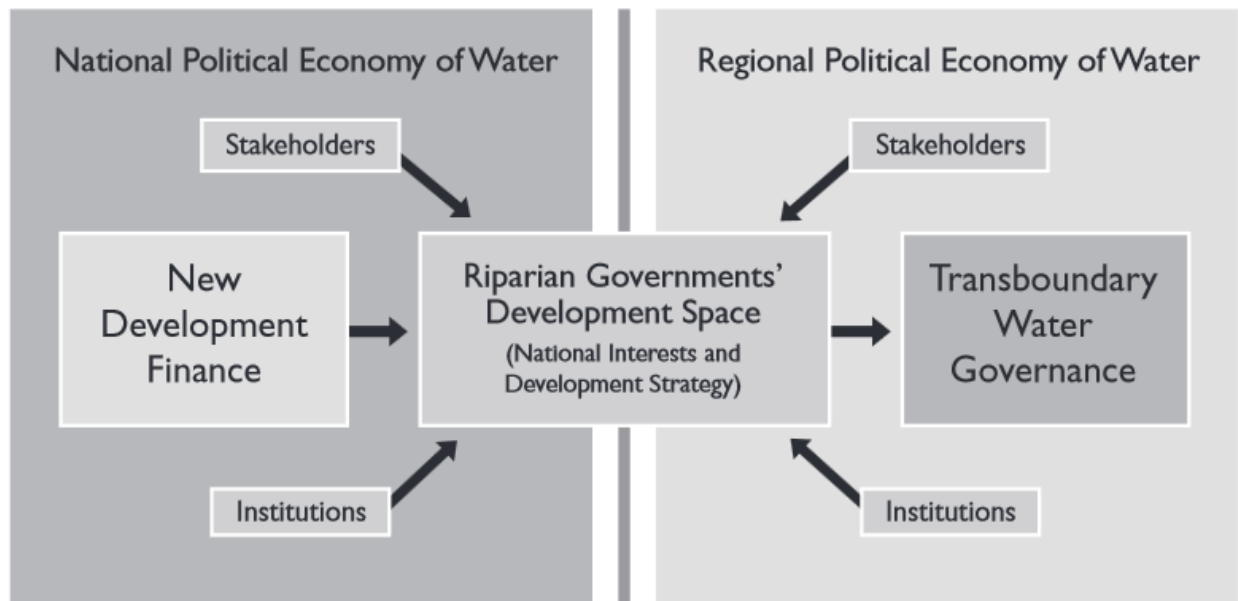
thereby directing the analytical focus to patterns of interactions and outcomes. Nevertheless, governance challenges are often confronted in highly complex and heterogeneous environments, such as those involving transboundary collaborations and agreements. Can the IAD alone accommodate this wickedly complex array of factors?

2.3 Transboundary governance

Jensen and Lange (2013) propose a framework that provides several analytical dimensions that, in combination with the IAD, have the potential to capture such complex institutional dynamics. The authors' framework identifies several stakeholder types in the political economy of water, including private investors, donors, civil society organizations (NGOs), and intergovernmental organizations such as regional cooperatives. The authors also cite "riparian governments" such as water and environmental agencies and agencies overseeing activities with environmental impact such as mining, energy, and agriculture. The authors give special attention to elites within these organizations. This framework enables the analysis of political and institutional dimensions in multi-layered governance environments.

Figure 2 illustrates how the framework conceptualizes the influence of various stakeholders within the national and regional spheres on broader development strategies. This framework therefore introduces the critically important *meta-scalar* dimension of governance environments.

Figure 2: Framework for transboundary water governance (Jensen and Lange 2013)

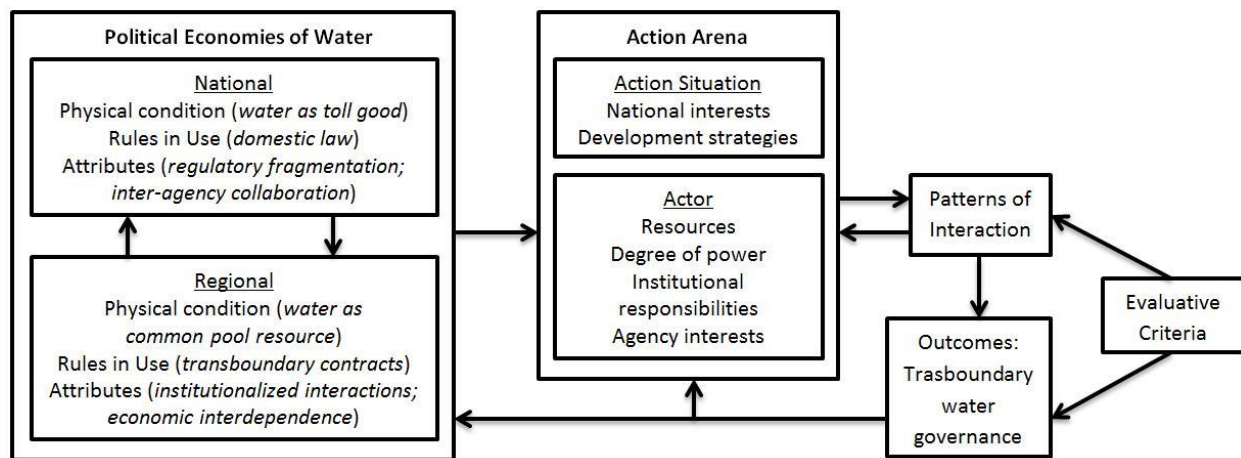


The nature of transboundary challenges underscores the importance of contemplating a larger area of impact than that defined by political boundaries or agency responsibilities. In combining the IAD framework with the Jensen and Lange framework, the cross-agency action arena features not only multiple actors with differing interests and scope of legal authority, but also a layered system in which some are able to exert influence only within a limited jurisdictional space. Within the IAD framework, patterns of interactions influence outcomes, the latter represented as “transboundary water governance” in the Jensen and Lange framework.

2.4 Combined framework

Underlying this paper’s theoretical proposition is the hybrid framework in Figure 4. By accounting for two institutional environments – national and regional – this framework adds the degree of complexity necessary to capture the dynamics of a multi-level and fragmented transboundary governance challenges.

Figure 3: Hybrid framework for transboundary water governance



The physical condition of the good, rules-in-use, and attributes of interaction – herein re-labeled *political economies* to emphasize institutional dimensions – are derived from the IAD but split into respective national and regional scales (a contribution of the Jensen and Lange framework). The result is a finer-grained analysis of each. Rules pertaining to issues such as environmental management are often unique to the national context, but in the regional context only as stringent as stipulated by transboundary agreements. With regard to elements not covered by such agreements, there may be a “lowest common denominator,” whereby the resource is managed only as well as the least stringent regulatory body deems appropriate. This is a problem common to water management; for example, watersheds are rarely coincident with political and jurisdictional boundaries. The Jensen and Lange framework is also captured in the IAD’s “action situation,” structuring the scope of analysis into interests and strategies, and thereby enabling the

disaggregation of analytical units by organizational purpose. In addition to systematizing a higher degree of institutional complexity, this hybrid framework also provides an analytical tool for comparing domestic governance structures across international actors.

Before proceeding with the case illustration, it is necessary to situate the theoretical model and its framework within the larger context of two additional literatures: governance dynamics across borders, and environmental sustainability. First, broader issues of governance in the Hong Kong-Guangdong region have received ample scholarly attention, particularly after the 1997 “handover” and in the wake of rapid industrialization around the Pearl River Delta. A 2014 report by Liu and Williams is the only comprehensive comparison of the water governance histories of Singapore and Hong Kong. The authors find that Hong Kong and Singapore have adopted contrasting strategies in confronting water scarcity since the 1960s. This highly detailed report compares policy development, current frameworks, and technical issues, and also outlines differences in governance structures. The report represents a practitioner perspective, providing an opportunity to extend the issue into the theoretical sphere. Hills (2001) examines the relationship between Hong Kong and China through the perspective of regional environmental management, arguing that Hong Kong has been slow to develop coordinated policies but that objectives shared with the mainland may ultimately enable closer cooperation on “ecological modernization.” In regards to transboundary initiatives and the influence of scale, Lee (2013) compares the *regime approach* of political-based localization to the *political ecology perspective* of resource-based localization, adding “critical” border studies to analyses of water management.

Ho and So (1997) examine borderland dynamics and integration in Hong Kong and Singapore. The authors argue that historical context explains differences in the degree of integration between the two cities. The Hong Kong-Guangzhou region is more “culturally

contiguous” with regard to language, customs, and the bonds between the two at the family and community level. Ho and So find that, on the other hand, ethnic, linguistic, and religious tensions have historically characterized borderland integration between Singapore and Malaysia. Another distinguishing factor is the flow of investment capital, which is bi-directional between Hong Kong and Guangdong, but not reciprocal in the Singapore-Malaysia case (with investment dominated by the former). Furthermore, the regional economic balance is different between the two cases. Johor provided labor and water to Singapore during the new city-state’s rapid industrial growth in the latter half of the 20th century (Ho and So 1997). As such, Singapore was a principal customer for Johor’s water, with little competition from other rapidly industrializing regions for limited supply. In Hong Kong’s case, the Chinese side of the borderland has experienced concurrent industrialization, and will arguably continue its rapid development while Hong Kong maintains its shift to lower water-intensive economic growth (e.g. services). As such, in regards to the number of powerful actors, competition for water is higher in the Hong Kong-Guangdong region than it is in Singapore. This adds complexity to the transboundary dynamic in regard to a more balanced power structure. For example, Guangdong’s cities are helping to sustain China’s decades-long economic growth, and water is a critical resource to maintain industrial activity. At the same time, Hong Kong is seen as a critical partner for China, both economically and politically, and this symbiotic relationship underlies the water governance environment. Finally, the concept of a political “boundary” between Hong Kong and China is a sensitive topic, and this is duly noted herein. This report emphasizes systemic and administrative differences between the two, rather than political ones.¹ This approach aims to ensure the continued relevance of the study regardless of the outcome of political debates concerning Hong

¹ For example, the quality of the water extracted in China fails to meet Hong Kong’s standards, and must undergo a second purification process before distribution. This can be seen as a systemic difference in the regional sense.

Kong's autonomy. Further to the issue of a dualist system, a literature has recently emerged about "fragmented authoritarianism," specifically the growth of pluralism in China. Issues include the emerging power of local governments (Zhong 2003), "top-down" environmental management (Chunmei and Zhaolan 2010), hydropower policy (Mertha 2009), and regulation of wind energy markets (Lema and Ruby 2007). Many such studies focus on environmental challenges, providing a friendly literature setting for research about the governance aspects of water management.

Second, this paper weaves environmental sustainability into the larger discussion about governance structure and transboundary collaboration. Specifically, it argues that a fragmented governance system at the national scale potentially results in operational and economic inefficiencies, including moral hazard, that compromise the efficacy of regional initiatives. With regard to environmental management, the literature about governance system architecture and its ability to enable collaboration has room for development. For example, many studies about water supply management, particularly with regard to sustainability, focus on the functional aspects of conservation through technology and demand management. Topics include water quality systems (Huang and Xia 2001), benchmarking of domestic water usage (Mui et al. 2007), and state intervention to encourage corporate environmental initiatives (Martinsons et al. 1997). Studies with broader scope often invoke the concept of resilience, a term commonly used in the context of environmental sustainability. This terminological application includes studies about the relationship between ecosystem stability and economic development (Perrings 1994), the function of social-ecological systems (Folke et al. 2002), and complementarity between the goals of environmental conservation and economic development (Barbier 1987). Non-environmental resilience studies have more robustly considered systemic dimensions. Examples include

economic recovery in the face of destabilizing events, such as natural disasters (Rose 2004) and shocks to labour demand from industrial restructuring (Blanchard and Katz 1992; McGahey and Vey 2008). Pendall et al. (2010) examine resilience through “space-time” boundaries, emphasizing the importance of scale and the temporal nature of shock events. Examining two common frameworks for resilience – *equilibrium analysis* and *complex adaptive systems analysis* – the authors conclude that the concept is “fuzzy” but useful for connecting “disparate conceptual paradigms.” A line of resilience research has also emerged around economic growth trajectories. For example, Chinitz (1961) examines how path dependencies reflect an element of economic determinism and underscore the difficulty of transforming industrial structure. Safford’s (2009) comparison of American rust belt cities argues that the historical development of local social and network structures explains differences in economic resilience. Structural characteristics have also been cited in comparisons of the degree to which cities transition to post-industrial economies (van Winden 2008). Within this broad realm of resilience studies, this paper focuses on the structural dimension of environmental resilience.

It is evident from this broad review of literature, and the interwoven theoretical proposal, that there is scope for the introduction of more complex analytical frameworks for environmental management, particularly in borderland regions. The proposed framework is now applied to the case of water governance in Hong Kong. The goal is to illustrate how such a framework can be populated with empirical specifics. In recognizing the differences between frameworks, models, and theories (Schlager 1999), this case does not propose specific hypotheses about relationships among variables. It aims only to apply a system for conceptualizing relevant dimensions of analysis.

3. Case: Hong Kong

3.1 Background

This section begins with a background about Hong Kong's water supply regime, continues with a problem statement, and concludes by examining how the proposed theoretical model contributes a better understanding of Hong Kong's governance challenges. This background briefly describes the Hong Kong's water procurement regime, in order to establish a foundation for the later discussion of institutional and governance dynamics. Hong Kong sources 70-80% of its water from China's Dong River, through multiple contracts with neighboring Guangdong province (China Water Risk 2014).² Multiple agreements and supplements have progressively increased the volume of water supplied by China to Hong Kong, from 23 million m³ per annum in 1960 to 1,100 million m³ as stipulated in a fifth agreement signed in 1989 (Chau 1993). Per the contract terms, this supply is guaranteed regardless of drought conditions (China Water Risk 2014). Throughout the past several decades, Hong Kong has experimented with various water sourcing initiatives that could serve as an alternative to Dong River supply, but none has been consistently adopted over the long term. This lag in progress for developing a diversified supply regime has made Hong Kong increasingly reliant on existing procurement contracts with mainland China.

As early as the 1970s, researchers warned of Hong Kong's imminent water scarcity crisis (Aston 1977). Nevertheless, the city's extended reliance on Dong River supply can be seen as evidence of a strategy of economic expediency. Compelled by rising energy costs, Hong Kong abandoned desalination efforts in 1981 (Edwards 2013). Desalination is an energy-intensive

² China has around 40 transboundary water agreements, but these do not necessarily meet the standards recommended by the United Nations Watercourses Convention (Chen, Rieu-Clarke, and Wouters 2013).

process and high energy costs have been cited as a significant disbenefit by opponents of desalination programs (Semiati 2008; Dolnicar and Schäfer 2009). Furthermore, the presence of cheaper water supply from China also made desalination a comparatively costly option. As such, desalination has been used haltingly in Hong Kong and sits at the margin of the water source profile, moving in and out of favor with fluctuations in alternative source cost and availability. For example, the Lok On Pai desalination plant, already plagued by problems including inexperienced management and engineering faults, was closed after only several years of operation due in part to the completion of a reservoir and unusually high rainfall in 1977 and 1978 (Mody 1997). Despite decades of entrenched reliance on the Dong River, Hong Kong is currently exploring a plan to expand desalination capacity, with one proposed facility projected to produce 49% of the amount of rainwater harvested in 2011 (HKLC 2012). However, a 2008 paper from the Water Supplies Department insisted that a desalination plant was not needed for 20 years, arguing that supply from the Dong River was adequate (Eng 2008). This assumption of supply security is symptomatic of the moral hazard phenomenon explored later in this paper.

Hong Kong has a history of water rationing “events,” with the most recent occurring in 1982. Over the turbulent decades of intermittent supply, and in the time since, importation of water has become regarded as the most expedient and economic solution to the city’s water crises (Liu 2014). This belief marked a turning point in Hong Kong’s water governance strategy, as the city de-emphasized alternative supply sources and focused on a single source (Liu 2014). Nevertheless, Hong Kong has not failed to produce innovative solutions, particularly during times of supply bottlenecks. The city has long operated a seawater toilet flushing program, with 80% of residents participating in the scheme. However, 82 million m³ of fresh water continue to be used annually for flushing (Cheng 2012). Hong Kong has recently embarked on a plan to

increase the coverage of saltwater flushing systems to include satellite new towns, and is also exploring the possibility of extending these systems to more remote areas (Chau 1993). The city has also experimented with sea-bound freshwater reservoirs. Hong Kong's Total Water Management initiative calls for long-term supply enhancement strategies, including protection of water resources, more aggressive reclamation efforts, and desalination.

Hong Kong's water sustainability is reliant on demand patterns both within Hong Kong and in neighboring Guangdong province. Water demand within Hong Kong has risen in conjunction with its growth as a major urban center. However, restructuring from manufacturing to service industries has reduced industrial water demand, offsetting some of the increase in demand from the city's growing population and the evolving water usage patterns of increasingly wealthy households (Mui et al. 2007). Further, Hong Kong's population is expected to increase by 700,000 residents between 2010 and 2020, resulting in higher demand and water shortage risk (HKLC 2012). By 2030, Hong Kong's water demand is projected to be 40% higher than 2012 levels (Chan 2013). The city's water sustainability is also contingent on regional demand. More than 40 million people in Hong Kong and Guangdong rely on Dong River water (Chan 2013). The long-term supply capacity of the Dong River is increasingly uncertain due to growing household and industrial water demand in China's upstream catchments (Chan 2013; Liu and Williams 2014). For example, Guangdong province has embarked on a plan to increase power generation capacity by 45% between 2010 and 2015, in order to accommodate 15.9 million new inhabitants; this places significant strain on the water demand profile (LeClue 2012). Further, several of China's most economically vibrant cities, including Huizhou, Dongguan, and Shenzhen, rely on the Dong River for water supply, and these cities are projected to face significant water shortages by 2020 (Liu 2012). Despite expectations that the Guangdong region

will evolve into a more innovation and knowledge-driven economy with a focus on higher value goods (Asia Business Council 2011), the demand for water is still likely to increase based on a growing population and the continued presence of water-intensive industries.

For this case, Singapore serves as a backdrop to set Hong Kong's water governance challenges in starker relief. Comparisons between the two cities are common for nearly every benchmark measure of growth, including economic development, property markets, education, health, and a variety of other issues. This comparison often makes sense because both share certain characteristics including the absence of a hinterland, relative (Hong Kong) or complete (Singapore) governance autonomy, a recent history of neoliberal economic growth initiatives, and the proximity of each to a large and powerful neighbor. Singapore has developed a resilient, self-sustaining water procurement model that eliminates the need to renew long-term supply contracts with neighboring Malaysia (Tortajada, Joshi, and Biswas 2013). Upon its independence from Malaysia in 1965, Singapore entered into two water supply agreements with neighboring Johor State, Malaysia; these initially accounted for 80% of Singapore's water supply (Liu 2014). The expiration of second agreement in 2061 is likely to herald Singapore's complete self-sufficiency in regard to water supply. Arguably, Singapore's reluctance to rely on Malaysia for such a critical resource has stimulated an environment of innovation and resource conservation, resulting in the development of alternative supplies such as "NEWater" (which constitutes 30% of supply) and desalination (10%) (Liu 2014). Other initiatives, according to Singapore's long term water strategy outlined in the Water Masterplan, include a water catchment zone (90% of the country) triple the size of Hong Kong's (30%), and aggressive demand management programs that include water-saving fixtures for a public housing system that serves more than 80% of the population. Singapore has also aggressively developed a reservoir system, now

totalling 16, and has recently completed a landmark project to convert the Singapore River into a freshwater reservoir. Water was critical to Singapore's early survival as a newly independent state, and the early political leadership gave supply considerable priority in the planning and policy arenas. By casting water as a critical dimension of national security, the government established political support for a broad suite of supply programs. As a result, Singapore has positioned itself not only as a model of efficiency and self-sustainability, but also as a knowledge center for water technology innovations. For example, the Economic Development Board has allotted SG\$470m since 2006 for research and development in the water industry (Goh 2012).

3.2 Water governance challenges

This case continues by describing three critical problems within Hong Kong's governance environment: fragmentation, inefficiency, and moral hazard. First, Hong Kong has a highly fragmented water governance system in which multiple agencies hold various management responsibilities (Liu and Williams 2014; Holland 2014). Specifically, eleven bureaus and offices (under three different secretaries) have a role in water policy formulation or execution (Hong Kong SAR Government 2013). Officially, two departments, the Water Supplies Department and the Drainage Services Department, manage water in Hong Kong and each has specified governance responsibilities (Cheng 2012). The Water Supplies Department focuses primarily on delivery to end-users, including matching demand and supply, developing water infrastructure, and managing water quality (HKWSD 2013). The department also reviews procurement contracts. The Drainage Services Department manages stormwater and wastewater services, including flood prevention and sewage. The Environmental Protection Department sets policy in

a variety of areas, including water pollution control and sewage management (HKEPD 2013). The department has also collaborated with the city of Shenzhen and the province of Guangdong in developing environmental management models for the Pearl River Estuary and pollution mitigation plans for Deep Bay. However, it has no operational responsibility beyond conceiving policy plans (Liu 2013). Sitting with the Environmental Protection Department under the authority of the Permanent Secretary for the Environment (HKEB 2013), the Sustainable Development Branch provides support to other departments and bureaus in the form of technical assistance and sustainability assessments (HKSDB 2009). The branch's sustainability indicators related to natural resources include freshwater supply and demand fulfilment, and indicators related to environmental quality include marine and river water pollutant management (HKSDB 2014). Other agencies with policy or operational interest in water management include the Development Bureau, Buildings Department, Planning Department, Food and Health Bureau, Food and Environmental Hygiene Department, Agriculture, Fisheries and Conservation Department, and the Electrical and Mechanical Services Department (Liu and Williams 2014). By contrast, Singapore's Public Utilities Board (PUB) and National Environment Agency, both under the Ministry of the Environment and Water Resources, manage all government departments having interest in water supply. This integrated approach addresses all aspects of the "water loop," including treatment, distribution, reclamation, supply, rainwater collection, and stormwater management (PUB 2013). In its focus on the "four taps" (catchment, imports, reclamation, and desalination), the PUB has integrated the supply management system.

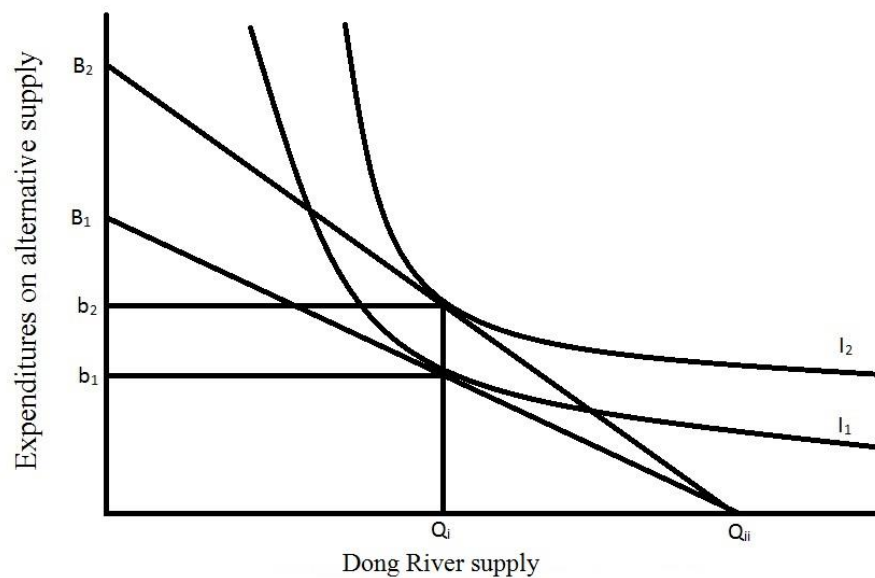
A second problem arising from Hong Kong's water management system is economic inefficiency. Hong Kong's water tariffs are one third those of Singapore, and there are no plans for a rate increase (LeClue 2012). Freshwater supply is deeply subsidized and consumer prices

have been frozen since 1995. The seawater flushing system is free to users (O'Neil 2014), compromising efforts to recover costs associated with the extraction and delivery of seawater (Liu 2013). Despite the constancy of artificially low water tariffs, the cost of supplying water increased nearly 70% between 1995 and 2012, while cost recovery decreased from 102% to 60% (F. Lee 2013). The gap is filled by government subsidies, whose costs are ultimately borne by taxpayers. Although most taxpayers are consumers of water and thereby benefit from the subsidy, the pricing mechanism does not align usage with payment. This creates a perverse incentive to over-consume at the individual level (e.g. among households and businesses). Furthermore, 14% of domestic users pay nothing for water, based on the free allotment of initial units (12 cubic meters) (F. Lee 2013). Ng and Tang (1999) describe Hong Kong's political economy of governance as a product of pro-growth, market-led forces, with the planning regime "biased" towards growth but facing pressure from an increasingly democratized society. In the case of artificially low water tariffs, these forces would seem to complement one another; the expedient reliance on a cheap water source (despite its unsustainability) and a subsidized pricing regime that would appear to be politically favorable. However, this subsidy masks some of the inherent pricing inefficiencies in the water system. Additionally, it fails to account for the broader environmental costs associated with increasing levels of water extraction from the Dong River. The implications of environmental degradation are not isolated solely to the Chinese side, as the Dong River empties into the Pearl River, whose mouth and estuary are adjacent to Hong Kong and have a direct impact on areas such as Lantau Island and Tuen Mun. The fragmentation of water management creates additional inefficiencies by unnecessarily increasing administrative costs due to managerial and operational redundancies (Liu 2013). The Hong Kong government has addressed inefficiencies in various ways. First, it has made modest gains in reducing leakage

and non-revenue water, from 25% of total supply in 2000 to 19% in 2011 (B. Ng 2012). It has also pledged to address water demand through a Total Water Management program that addresses the period until 2030. This program includes enhanced education about conservation, promotion of saving technologies, leakage control, and the expansion of seawater toilet flushing programs.

The final problem is related to Hong Kong’s overly optimistic reliance on Dong River supply, leading to a chronic underinvestment in alternative sources. This exposes Hong Kong to fluctuations in price and supply from the source of 80% of its water, and threatens the city’s resilience to forces often outside of its control. This pattern of behavior could arguably be described as a moral hazard, leaving the city’s water governance system inadequately situated to absorb supply shocks that may result from the inevitable destabilization of the Dong River water supply. Figure 4 illustrates the potential impacts of a more aggressive funding regime for alternative water supply sources.

Figure 4: Investment in alternative supply



B_1 represents the current budget for water procurement, for both Dong River contracts and alternative sources. B_2 represents a hypothetical budget line for an increased procurement budget (funded potentially through higher tariffs or efficiency gains). Q_i represents the fixed amount of water supply from the Dong River as stipulated in transboundary procurement contracts. This amount does not vary based on changes in the overall budget for water procurement (including Dong River and alternative sources). Q_{ii} represents a hypothetical fixed point for the quantity of water supplied to consumers if no expenditures were appropriated to supply from alternative sources. I_1 and I_2 represent the respective indifference curves between expenditures for Dong River supply and alternative sources. Gains through a change from B_1 to B_2 would be applied largely to expenditures on alternative supply (b_1 to b_2), assuming continuation of the prevailing Dong River contract terms on volume and price. As such, an additional levy may be justified for further investment in research, development, operation, and maintenance of alternative sources such as desalination and used water purification. Over an extended period, additional capacity in alternative sources may fill the supply gap emerging from increased demand and rivalry for Dong River water, thereby reducing Hong Kong's reliance on China for water. This would have implications not only for the city's supply sustainability and resilience in the event of a Dong River supply shock, but for political dynamics as well. Indeed, Hong Kong's reliance on Dong River supply has raised concerns that China may use the dependence to extract political concessions (Chau 1993).

Although Hong Kong and Singapore are both major urban centers relying on larger neighboring countries for a critical resource, there is a stark difference in the sustainability of their models that, for Hong Kong, may become more apparent over time. These divergent development paths can be explained in part by governance behavior within the institutional

environments where water contracts have been negotiated. Each system has emerged from a unique set of historic circumstances, with governance structures and water management strategies reflecting the situational mandates of independence and self-sufficiency. However, a more contentious transboundary relationship between Singapore and Malaysia may partially explain why Singapore has outpaced Hong Kong in water resource management, regarding efficient governance structures and by extension supply innovation.

3.3 Application of framework

In service to the examination of governance structure as an explanation for Hong Kong's current water insecurity, this paper grafts the proposed institutional rational choice model onto the city's water governance ecology, using the hybrid framework. With regard to goods characteristics, water in the national context is characterized by rivalry among users ("subtractability") and uncostly exclusion. It is most commonly interpreted as a toll good from the perspective of individual end-users, including households and businesses. The case of water as a toll good raises the issue of market failures, including monopoly supply (V. Ostrom and Ostrom 1999). In the regional context, however, water is a common pool resource characterized by similar user rivalry (at a higher scale of actors), but differs from the previous classification in that there is a high cost of exclusion. This reflects the typical conceptualization of water resources used in the many studies of irrigation and natural resource management by Ostrom, Araral, and other scholars of the Bloomington School of new institutional economics. It is this second classification of water (common pool resource) that concerns the hybrid framework.

This study applies a re-scaled definition of “user” to accommodate the buy-sell dynamics between Hong Kong and mainland China. This necessarily elevates the scope of analysis but the model maintains its relevance. China has the ability to exclude Hong Kong from Dong River water consumption (by virtue of its up-stream position), thereby exploiting a monopolistic buy-sell dynamic that resembles the one between end-users and utilities. This analysis examines the relationship not between households and utilities, but between Hong Kong and China. In this case, China is the sole external supplier of water to Hong Kong, a matter all the more critical given that Hong Kong currently lacks scalable supply redundancies and feasible substitute programs. Nevertheless, even the analytical up-scaling described above fails to fully capture the breadth of the institutional context governing the region’s water resource management. This broader unit of analysis relates to Ostrom’s action arena, in which individual actors engage one another in exchange, problem solving, and other collective efforts. Six cities currently share usage of Dong River water, with the five in China already consuming nearly their entire allotment (Liu 2012). Other actors include corporations with rare earth mining interests in Guangdong province, and formal and informal agriculturalists, all of whose activities present threats to the supply of quality water (Liu 2012). However, this analytical framework only considers government bodies as actors in the resource management process.

With regard to *rules in use*, the framework distinguishes two scales of the political economy, national (domestic law) and regional (transboundary contracts). This division relates to attributes as well, with the national scale including regulatory fragmentation and interagency collaboration, and the regional scale including institutionalized interactions (collaborations) and economic interdependence. The *attributes* dimension of the hybrid framework also accounts for informal norms and institutions, such as the high degree of economic interdependence between

Hong Kong and the mainland, and the degree of implicit strategic interaction among Hong Kong's water-related agencies. The dynamics of these relationships differ between the two scales, necessitating their separate treatment in the framework.

Within the context of their respective transboundary agreements, the water authorities of Hong Kong and Singapore have acted rationally; Singapore for self-preservation and Hong Kong for economic expediency. The *action arena* accounts for assumptions about interests and strategies. With regard to its constituent *action situation* element, the hybrid framework begins to fulfil its purpose. Agency interests and strategies vary not only by role and influence, but by their presence in either a strictly national context or a more broadly regional one. Agencies from both systems (Hong Kong and China) are involved in the management of water resources, with some collaborating directly on related environmental initiatives. Nevertheless, these actors may also harbor conflicting interests and occupy varying levels of their respective governance hierarchies. Indeed, agencies governing water in Hong Kong reside at various levels within the hierarchy (see the organizational chart in Hong Kong SAR Government 2013). These dimensions are captured in the *actor characteristics* box (resources, degree of power, etc.).

Adding complexity to this study is the relationship between Hong Kong and China in the post-handover system. Hong Kong relies on China for water, while China relies on Hong Kong to be an anchor for regional economic growth. This symbiotic relationship has ossified with reunification and the attendant political and economic integration (Hills and Roberts 2001). Nevertheless, this co-dependent dynamic may distort transboundary water markets, perpetuating Hong Kong's suboptimal and potentially unsustainable procurement regime. In the Hong Kong case, the riparian environment exists almost exclusively on the Chinese side, but the impacts of environmental management flow – literally and figuratively – into Hong Kong's territory via the

mouth of the Pearl River. The regional political economy of water in the Hong Kong case is represented institutionally within this model by the various environmental governance collaborations between Hong Kong and Guangdong Province. Along with these regional stakeholders, institutions and stakeholders at the national level – including the multiple agencies governing water management in Hong Kong – collectively exert influence on riparian development “space.”

Combining these two frameworks is a critical step to understanding the unique governance environment in Hong Kong, as the intricacy of the IAD framework in identifying not only actors and interactions but interests and environmental characteristics suits the fragmented and multi-scalar governance environment captured by the Jensen and Lange framework. In a 2014 white paper (SCIO 2014), the Chinese government underscored its view of the Sino-Hong Kong relationship as one defined by “one country, two systems.” A framework accounting for transboundary water governance, therefore, should be versatile enough to accommodate two systems within a single analytical sphere. In this case, the transboundary governance environment cannot be analyzed as a single unit with uniform characteristics. This theoretical proposal is an attempt to accomplish this.

4. Conclusion

Many operational solutions have been proposed to address Hong Kong’s water sustainability concerns. However, these are only patchwork solutions in the larger context of supply insecurity. This paper argues that resilience-based structural reform is the only way to trigger the step-change in water governance necessary to ensure Hong Kong’s long-term sustainability. Despite

the fact that Hong Kong's extended supply contracts with China appear to have successfully addressed the city's persistent and seemingly imminent water supply crisis, structural reform in water governance is necessary to address emerging challenges to resilience inherent in an increasingly unsustainable procurement regime. This study's research question has asked whether and how the de-fragmentation of Hong Kong's water governance system can facilitate the development and execution of more resilient water supply management strategies, thereby addressing the argument that sustainable growth is enabled by resilience in the structure of environmental governance institutions. The proposed analytical framework makes progress in identifying how Hong Kong's water governance de-fragmentation can improve the resilience and sustainability of supply. It illustrates the complexity of interaction among regional stakeholders, thereby making a stronger case for a simplified strategic voice. It also conceptualizes the fragmentation challenge by underscoring how coordination among agencies at the strategic and operational levels influences outcomes through patterns of repeated interaction. If this approach indeed improves strategic outcomes in regards to domestic operations and transboundary contract negotiations, then the case for a more streamlined bureaucracy (like the one in Singapore) emerges.

This proposal proceeds from the argument that a more unified structure enables better strategic coordination, gives stronger effect to water policy, and ultimately serves as a foundation for improved regional agreements. Therefore, this study makes the important but largely overlooked link between the structure of domestic governance systems and international agreements for managing environmental resources. In a broader sense, this study has also endeavored to link governance structure with resilience. Assuming Hong Kong's incumbent water governance structure poses three potential challenges – fragmentation, inefficiency, and

moral hazard – the extended logic would hold that the city’s resilience capacity to absorb supply shocks is currently compromised. Fragmentation delays and complicates strategy development and policy implementation. Inefficiency limits the resources available for such policies. Moral hazard directs governance efforts towards suboptimal sourcing solutions. Taken in combination, these arguably constitute a weakly resilient governance regime. This framework is a step forward in further understanding these limitations.

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