The governance of large dams

A new research area

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Our current familiarity with large infrastructures, the place they hold in the landscape and the roles they play in modern living combine to make us lose sight of their long-term, system-wide effects. In this paper, the action of the large infrastructures of dams in structuring both the biophysical and the societal environment in which they reside is elucidated. Thereafter, the particular nature of the governance of large water infrastructure is clarified by juxtaposing the governance of large dams between governance in general and infrastructure management in particular. Finally, the paper concludes by identifying the necessity for research on the governance of large dams.

1 Introduction

Infrastructures form an integral part of modern day societies and continue to play a role in shaping the landscape, harnessing environmental resources and influencing the interactions of people with the biophysical environment and each other. We have long been familiar with the network infrastructures of the roads and railways, as well as the water supply and sanitation systems, and are becoming accustomed to the increased connectivity associated with the social network infrastructures. The reflexive manner in which social actions are constrained, enabled and shaped by infrastructures, which are themselves shaped by society, forms the focus of scientific interest for structuration theorists (Giddens, 1986), complexity scientists (Vespignani, 2009) and the motivation for the exploratory analysis undertaken in this paper. Indeed, it is through the lens of water governance practice that the authors wish to explore how people, as they interact with an infrastructure and its associated technology in their ongoing practices, enact

structures which shape their emergent and situated use of that infrastructure and technology (see Orlikowski, 1992).

In undertaking such an exploration, we first briefly examine the meaning of water governance, then move on to describe the practice of infrastructure management. Next, we choose to focus on a large water infrastructure – dams – and to indicate how the governance of large dams differs from infrastructure management and governance per se on the basis of seven key characteristics. Finally, we identify the need for research on the governance of large dams and argue for a transdisciplinary approach to this new research area.

2 Water governance

There are many interpretations of the term governance. A common element in the various usages is the distinction from government as exemplified by Rhodes (1996) "governance signifies a change in the meaning of government, referring to a new process of governing". Recently, Lautze et al. (2011) stressed three common features in governance definitions: governance is consistently viewed as a process, taking place through institutions (including mechanisms, systems and traditions), and involving multiple actors. Furthermore, they emphasized that governance is not about the outcomes of the process. Rather, the desirable outcomes will be different for different actors, and that "it is impossible to know that such outcomes are in fact 'good' without a participative and transparent process to define a good outcome" (Lautze et al., 2011). In our view:

- Governance is different from government per se (Stoker, 1998). Particularly, it includes non-government actors as well.
- Governance stresses the need to find new processes and mechanisms to deal with the multi-actor character (or the network character) of societies (Klijn, 2008).
- Governance is about the processes by which societies govern. These processes should lead to outcomes, but the outcomes are

not central; rather they are themselves to be decided upon among multiple actors in a governance process.
- Governance processes are typically shaped through a mix of three archetypical institutions of markets, hierarchies and networks.

The last point requires further explanation. Where markets operate, they operate in certain regulated spaces within society (Hermans et al., 2006). Regulation can come from hierarchies or networks, where the latter would include 'self-regulation' in line with a view of 'self-organising networks' (cf. Rhodes, 1996). The same applies to networks; they operate in certain spaces of society, but always within a larger context of, or featuring, certain hierarchical features. Hence the importance of command-and-control mechanisms in managing networks, and balancing between hierarchies and networks (De Bruijn and Herder 2009; Vespignani, 2009).
In particular, water governance refers to the manner in which power and authority are exercised and distributed in society, how decisions are made and to what extent citizens can participate in decision-making processes concerning water (WWDR, 2003). In essence, water governance deals with how a society governs the access to and control over water resources and their benefits.

3 Infrastructure management

The design and construction of large infrastructures has long been the domain of the engineer. Technical knowledge and its application in protecting society from natural disasters, e.g. floods, or in insulating society against natural variability by securing the supply of resources, e.g. irrigation systems, have laid the foundations for development. The management of the infrastructures has traditionally also been the domain of engineers and this has led to many highly specialized and advanced technologies for infrastructure operation. Examples include automatic operating systems for dams, national traffic monitoring and operational control systems, power grid load management, amongst many others. The infrastructure operation systems represent the pinnacle of a phased and structured approach to problem solving (De Bruijn and Herder,

2009) in line with the technological purpose of the infrastructure design. Such systems often cannot accommodate altered perceptions on the value of the infrastructure, its impact in society, changes in the manner of its use, nor adapt flexibly to altered circumstances such as an emergency situation. Similarly, such systems are seldom designed to accommodate requirements at the whole systems level; instead they are designed to work efficiently and well within the constraints of existing policy and decision-making structures. Indeed, such systems may even constrain actors in the scale at which they may attempt to adapt to altered circumstances and requirements (Vreugdenhil et al., 2010).

Just as with administrative governance, infrastructure management occurs throughout modern society and forms the daily task of many of its technically trained members. In the case of large water infrastructure, infrastructure management activities can focus on issues such as the management of an irrigation network, the treatment and delivery of safe drinking water, the construction and maintenance of dikes, and the construction and subsequent operation of large dams.

4 Governance of large dams

The governance of large-scale water infrastructure constitutes a special case of governance. Whereas general governance theories and frameworks stress the human and social character, focusing on governance as processes between actors, we choose to stress the particular nature of the governance of a large water infrastructure – dams- by juxtaposing it between governance in general and infrastructure management in particular.

The seven key characteristics of: (i) the environmental resource; (ii) the unit to be governed; (iii) institutions; (iv) scale; (v) knowledge; (vi) the actors; and (vii) the distribution of costs and benefits, which are used as the basis of the analysis, are described hereafter and a summary of the analysis is presented in table 1.

4.1 The environmental resource

Infrastructure represents human interventions in the biophysical environment to manage the risks associated with natural variability, and alter the access to and use of ecosystem goods and services. Currently, many countries deal with the effects on the environment of the construction of physical infrastructure through the policy instruments of environmental impact studies, mitigation and environmental management systems. However, the ongoing relationship between physical infrastructure and its environment throughout the lifetime of the infrastructure often goes unacknowledged. The cumulative or long-term effects of large infrastructures can only manifest over time and are not always understood at the outset. For instance, the effect of road and rail networks on the fragmentation of the habitat of many terrestrial species and the environmental impact of reduced freshwater flows on the aquatic environment of downstream rivers and estuaries were not foreseen by infrastructural engineers. Evidently, while the benefits of infrastructures are clear to those involved in their design and construction, the environmental and long-term societal costs (e.g. displaced communities, health risks) are not always clear (Brown et al., 2009). The need to acknowledge the deep connection between infrastructures and the environment within which they exist and to take the resource limits and requirements for the maintenance of ecosystem goods and services into account was emphasised by the World Commission on Dams in 2000 (WCD, 2000) and reiterated in the recent ten year review (Moore et al., 2010).

4.2 The unit to be governed

Unlike normal governance processes, governance of infrastructure is focused on physical infrastructure. The governance of large-scale infrastructures needs to acknowledge and centralise the connection between the social and physical (i.e. infrastructural) phenomena. In the field of technology development and innovation studies, the awareness of this connection has given rise to the development of a 'Large Technical Systems' approach for studying the development

of technical infrastructures (Coutard, 1999; Ravensteijn et al., 2002; De Bruijne, 2006). Similarly, this connection is a critical element in the study of the governance of large water infrastructure and the characteristics and limits of infrastructure, thus determining the scope of governance. Large-scale infrastructure has a number of characteristics, namely, the infrastructure controls an environmental resource, it has high upfront costs, there are sunk costs which make projects irreversible, and there is a high degree of path dependency. In addition, infrastructure projects are often high prestige projects resulting in infrastructures that can become symbolic and form part of social identity e.g. the Dutch dikes.

4.3 The institutions

Governance is about institutions. How do actors in society shape institutions and what institutions are suitable modes of governance in given circumstances? Thus, if governance is about the process, then the institutions, and institutional diversity, are one of the outcomes of the processes; which then in turn condition subsequent governance processes. This is the view that is visible, for instance, in the work by Ostrom on institutions (Ostrom, 2005). Likewise, large infrastructures can be considered both the outcome of, and exogenous context variables for, governance processes. Through these governance processes, large infrastructures are shaped by institutions and in turn shape institutions (see Giddens, 1986; Orlikowski, 1992). Initial norms, rules and procedures lead to critical decisions regarding the construction of large infrastructure. Once the infrastructure is created, it tends to re-shape the norms, actors, rules and procedures. Indeed, the practice of managing the infrastructure may not even cohere with the spirit of its design, i.e. the paradigm underlying its design and implementation (Franzeskaki et al., 2010).

4.4 The scale

Three scale dimensions can be distinguished with regard to large infrastructure. First, most large infrastructures are designed to last a long time and in practice have longer lifetimes than envisaged in the design phase (Wieland, 2010). Second, large infrastructures extend over large spatial scales or have an influence that extends over large spatial scales. For instance, dams enable harvesting of a resource that has a fluvial scale and environmental effects extending downstream. Third, administration of an infrastructure may take place either at the scale of the infrastructure e.g. local dam operator, or completely elsewhere such as in the capital city.

Both the temporal and the spatial scales do not match well with government or governance scales. Governments are in power for short periods of time and the different levels of governance may not match the scales of the infrastructure.

4.5 The knowledge

Large technical infrastructures raise a number of knowledge related issues. The technological dimension involved easily leads to the emphasis of technological knowledge over other forms of knowledge, with engineers rather than social scientists holding a central role. The only exceptions are economists, because of the huge investments needed (Coutard, 1999).

The special role played by technical knowledge, however, easily leads to the assumption that there is such a thing as 'right' knowledge, and that 'sound science' can (help) settle disputes over infrastructures. However, despite the cleverness of engineers, hydrologists, ecologists and other scientists, a high degree of uncertainty in still associated with their knowledge, which is also generic rather than situation-based. This is reflected, for instance, in the calls for 'adaptive management' and transdisciplinary studies (Dronkers and De Vries, 1999). Therefore, although a recurring conception is that 'hard' science can settle disputes over infrastructures, often it

cannot. As is known from the literature on 'intractable controversies', 'wicked problems' and policy change and learning, knowledge cannot always settle these controversies. Knowledge can be contested, with different 'coalitions' favouring different types of knowledge. In fact, a significant part of the literature on such disputes concerns disputes related to water and water infrastructures (see Sabatier and Weible, 2007). In works on governance, the 'subjectivity' of knowledge and the importance of perceptions and mental models are generally acknowledged.

4.6 The actors

Governance is about institutions, and governance is about actors. Large infrastructure governance is generally characterised by a large number of actors at multiple levels of governance. This is even true in a hierarchical and centralised system; governance of large infrastructure is always multi-level governance. Also, given the large temporal time scales involved, the importance of different actors changes over time. In the beginning actors who take political decisions, finance, design and build the dams are important – as are local stakeholders – and over time the dam operators become more important. Furthermore, there is substantial variation in the power of actors; some actors have both high power and high interest (ministers, investors, etc.); some actors have low power and high interest (local stakeholders). Finally, actors who have specific knowledge or expertise play a role, as explained in the discussion on knowledge. In addition, actors who are close to the operation of infrastructures play a special role. Line operators in the control room play a critical role, and one that has grown in importance in recent years (Van Eeten et al., 2002). They have tacit or implicit knowledge about what is going on and what operational responses are appropriate.

4.7 The distribution of costs and benefits

At the time of its construction, infrastructure embodies the physical manifestation of societal convictions regarding the control, access to and use of environmental resources. For example, the location of a dam and the associated water delivery system determines who is upstream and who is downstream; who is a victim and who benefits. The building of a dam leads to reallocation of existing (often implicit) rights of access to water. With recent innovations in the contracting forms used for the commission of dams, the creation of a dam also introduces and assigns new positions and pay-off rules: owner versus outsider, who bears costs and who is entitled to what benefits? Over the lifetime of the infrastructure, societal values can alter and this can lead to changes in the operation of the infrastructure. The extent to which the infrastructure shapes the new rules regarding the distribution of costs and benefits depends on the type of governance system in place.

5 The need for research on the governance of large dams

In this paper we have indicated that the governance of large dams differs from governance per se and from infrastructure management. It is also evident that despite the recognition and attention for the problems associated with large dams by the World Commission on Dams in 2000 and beyond, many issues persist and new challenges have arisen in the last ten years (Moore et al., 2010).

It is our contention that by viewing the governance of large dams as a special case of governance, research into the governance of infrastructure can build on existing theories. In particular, research can build on existing theories of governance and institutions. However, as a special case, it needs to complement, extend and modify these more general governance theories and questions, so that they accommodate the specific nature of infrastructures, as human constructs at the interface of societies and their biophysical environments. Clearly, multidisciplinary perspectives are needed in

tackling such complex research, but situated knowledge at the local and the systemic level is also necessary. Accordingly, we argue for a transdisciplinary approach in studying how governance processes shape the large-scale infrastructure of dams and how large dams in turn shape governance processes.

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Table 1: The governance of large dams compared with infrastructure management and governance per se.

		Governance	Governance of large water dams	Infrastructure management
1	Environmental resource to be governed	No direct link	Need to take into account resource limits and ecosystem services Variability	Infrastructure embodies the human intervention to manage the risks of, alter access to and reallocate the resources of the environment
2	Unit to be governed	Not clarified upfront: may be social, physical or both	Physical infrastructure; with – High upfront costs; long-term maintenance costs – Sunk costs; making projects irreversible – Calls for discrete decisions on construction – Path dependency – Separation of costs and benefits – Often high prestige, high security projects – Become symbolic; part of social identity	The infrastructure network, e.g. the road network or train lines. In the case of a dam, barrage or bridge, the management focus is the structure and associated engineering work (such as canals, sluices) itself.
3	Institutions	Shapes and is shaped by governance processes	As with governance, but also: shapes and is shaped by infrastructure: shapes norms, rules and procedures relating to infrastructure; later infrastructure reshapes norms, rules and procedures. Dynamic changes in procedures; accountability diffuse	Shaped by infrastructure. Initially focused at local administration, e.g. dam operator. Later system-wide effects induce upscaling of institutions, e.g. river basin organisations or provincial national road networks. Technical demands of infrastructure still structure management
4	Scale	Any	Large: – Spatial – Temporal – Administrative (multi-level governance) – Often: mismatch with governance scale	Large: – Spatial – Difficulty with extreme conditions such as traffic jams for roads or floods and droughts for dams – Often:localised administration
5	Knowledge	Contained in 'mental models' of actors	Prioritizes technical knowledge; Uncertainty Whose knowledge counts?	Primarily technical knowledge possessed by engineers. Local operators may manage the system differently from the original technical design for management
6	The actors	Diverse, with divergent interests, power, access to resources and knowledge	Large numbers of actors at: – Multiple levels of governance (even in a centralized system) – With changing importance over time – Large diversity in power – With special roles for actors who 'understand' the infrastructure (and its operation)	Primarily public actors such as Ministry of Public Works, or public-private partnerships. Can also be private companies such as rail service companies. Displaced communities.
7	Distribution of costs and benefits	Dependent on the equity of the governance system whether elites benefit or the populace – in democratic societies the distribution of costs and benefits provides a rationale for governance	Changes in the access to and benefit from resources occasioned by the large daminfrastructure. Cumulative effects that manifest over time.	Often inequitable distribution of costs and benefits. Infrastructure management aims at use of infrastructure within constraints of existing policy and decision-making structures.