Applying knowledge governance to understand the role of science in environmental regulation: The case of arsenic in Chile

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A B S T R A C T

The relationship between scientific knowledge and decision-making surrounding environmental issues is complex and represents a flourishing area of scholarship and practice. However, a sense of frustration persists regarding efforts to increase the use of science for decision-making. Regulations of copper smelter arsenic emissions developed in Chile during the 1990s represent a successful example of science informing policy making. The case involved production and use of local science in contrast to the common practice of copying international ambient standards.

In this paper, we investigate arsenic regulation in Chile in the 1990s and focus on the role of the major science intervention during the process, project FONDEF 2-24. The case is examined through the lens of knowledge governance (van Kerkhoff and Pilbeam, 2017). This theoretically-oriented approach guides our critical reflection on the relationship between knowledge and policy making, taking into consideration the formal and informal rules that shape the intervention and the underlying social and cultural patterns. The success of the science intervention's influence on policy is better understood with such a perspective.

We expand the knowledge governance approach by scrutinizing the relations of coherence between levels of analysis to assess their alignment. The approach could be helpful for studying other cases, particularly at times when a new field of policy is emerging.

1. Introduction

Despite advances in explaining how environmental policy decisions are made and what is and should be the role of science in policy making, a need for deeper understanding remains (Kirchhoff et al., 2013; Clark et al., 2016). The knowledge gap is greater in Latin America and other regions of the global south, where little region-specific scholarship has been developed.

A common strategy of developing countries for using science in environmental policy making has been to borrow and copy from the North, for example, by replicating standards proposed by the World Health Organisation (WHO) or the US Environmental Protection Agency (EPA). Adopting international standards saves the cost of developing local research and conforms to global norms. In Latin American history, it has been common to see science as an imported activity (Medina et al., 2014). Also, the scientific community is often small and without enough capabilities to offer responses to the state needs (Barandiarán, 2013).

In contrast to common practice, local science did inform arsenic regulation in Chile in the 1990s. During that decade, the context of a post-dictatorship developing country presented multiple social and political challenges and extreme socio-economic inequality. Environmental policy issues became a clear area of policy making in Chile. Using the definition of Massey and Huitema (2013, 2016), the policy field of environmental management emerged supported by regulations, formal institutions and technical expertise.

In this paper we examine why a purposely developed local research effort was effectively used to develop arsenic regulation, using a knowledge governance perspective (van Kerkhoff and Pilbeam, 2017, 2015; van Kerkhoff, 2013). Specifically, we focus on the largest project in Chile in which science informed arsenic regulation: the FONDEF 2-24, a project developed from 1994 to 1996 as a deliberate intervention with the goal of providing scientific evidence to promote and orient arsenic regulation. Applying the knowledge governance approach reveal the complex interaction among the underlying cultural patterns, the institutions and the intervention of science in policy processes.

The paper begins by introducing the topic, providing the theoretical framework (Section 2) and describing our methodology (Section 3).

Section 4 describes the results for each of the three layers of analysis considered by the knowledge governance approach: the underlying civic epistemology, the knowledge system, and the intervention itself. Section 5 discusses the implications of applying a knowledge governance framework to a Latin American case study, and Section 6 concludes.

2. Theoretical approach: Knowledge governance for Latin America

Knowledge use in policy decisions has been a permanent topic within environmental studies (Cash et al., 2003; Lemos et al., 2012; Kirchhoff et al., 2013, 2015; Clark et al., 2016), most often with a focus on research practices facilitating policy action (Kates, 2011; Miller, 2011). However, recent work (e.g. Miller, 2013; Miller and Neff, 2013; Van Kerkhoff and Pilbeam, 2017) suggests that a more nuanced understanding of the role of environmental science in policy making requires greater attention to social and cultural context along with deeper understanding of the role and practice of scientists within this context. It is a call for bringing sociological approaches into environmental studies, in particular to learn from the critical perspectives of the science, technology and society studies (STS), for example the contributions of Jasanoff (2004, 2005, 2009, 2012) and Jasanoff and Kim (2015). Our work aligns with efforts in this direction.

As actors within the knowledge system, scientists produce and reproduce culture and define disciplinary research trajectories (Jasanoff, 2011), interpreting science-policy goals and values, and integrating these within research agendas. In order to understand the role of science in the policy making process, environmental science-policy scholars need to unpack the social processes involved in defining research agendas, and the processes by which research results contribute to policy outcomes (Miller and Neff, 2013).

The concept of knowledge governance proposed by van Kerkhoff and Pilbeam (2017) builds upon previous research (van Kerkhoff, 2013) and empirical work (van Kerkhoff and Pilbeam, 2015). It offers a conceptual framework for understanding scientific interventions, integrating views from environmental sciences and critical perspectives from STS, which have rarely overlapped (MacMynowski, 2007).

Knowledge governance considers the underlying framework of rules and conventions within which knowledge processes take place. This approach requires a shift "from understandings of knowledge as an *input* to governance of environmental issues … to understanding knowledge as *subject* to governance" (Kerkhoff and Pilbeam, 2017: 32). The framework provides a middle ground where the instrumental goals of environmental science and the reflexive efforts of the critical sciences can complement each other. Fig. 1 depicts the proposed layers of knowledge governance analysis.

These three layers of analysis range from the most evident science-policy interventions to the often invisible, tacit rules underlying the social interactions embedded in knowledge systems and civic epistemology.
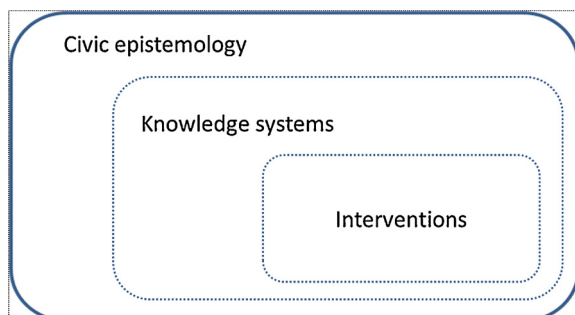

Fig. 1. Conceptual framework of knowledge governance.
Source: Authors, based on van Kerkhoff and Pilbeam (2017:32).

'Interventions' describe goal-oriented actions directly shaping science-policy relationships. Investigations on interventions may be case studies aimed at learning about the particular strategies used for communicating science and the boundary work done throughout the project to close the science-to-action gap. The objective of these studies is often to extract lessons for good practice. The project FONDEF 2-24, for example, was analysed from that perspective by the Global Development Network (GDNet), an international cooperation project, aimed at developing understanding on how Southern research can contribute to development. It named the project FONDEF 2-24 as one of the ten best practices in their program of science-policy interface, from which they extracted lessons for bridging the gap between science and policy making (Brown, 2014).

'Knowledge systems' refer to the institutions providing a framework for the relationship between science and action; these may be legal bodies and formal or informal rules within the science-policy arena. The knowledge systems' approach (Cash et al., 2003) focuses on institutional structures fostering or inhibiting relations between science and action. In this view, science is effective when it demonstrates salience, credibility, and legitimacy. *Salience* refers to the relevance for the action taker, while *credibility* indicates how scientifically sound it is, and *legitimacy* considers whether it is fair to all stakeholders involved. These characteristics are observed in institutional and organisational arrangements and in researchers' practices for communicating their scientific findings and translating them into lay terms, as well as in the work of boundary organisations, acting as brokers, for example between scientists and political actors. Knowledge systems move beyond a particular intervention to reflect on the modes of governance shaping research programs. It has been an influential approach in environmental science, giving place to numerous studies investigating science-policy relationships (e.g., Lofmarck and Lidskog, 2017; van Kerkhoff and Szlezák, 2016; Cornell et al., 2013).

'Civic epistemology' represents a broader concept involving social, political and cultural rules governing which practices are possible within specific historical circumstances. Jasanoff (2005) developed the concept while comparing the "ways of knowing" about the risks and harms of controversial life sciences in the U.K., Germany and the U.S. Jasanoff proposes six aspects of analysis, which van Kerkhoff and Pilbeam (2017) translated into questions to be asked. The areas of inquiry to characterize civic epistemologies in a field of study are: i) the observed styles of public knowledge making, ii) the ways knowledge is made accountable, iii) the foundations for expertise, iv) the demonstration practices of knowledge effectiveness, v) the transparency of expert work, and vi) practices for securing objectivity. Civic epistemology is an approach focused on features of societies generally related to cultural patterns, mentalities, and collective behaviours. It provides an entry into the underlying cultural and political patterns supporting institutional arrangements, complementing the focus on action-oriented interventions and knowledge systems of environmental science frameworks.

Knowledge governance integrates these previous approaches and positions interventions within institutional rules and organisational practices, uncovering the socio-cultural patterns that constitute civic epistemology. It examines the conformity of interventions with existing rules and ways of knowing.

In this paper, we systematically apply the three layers of the knowledge governance framework (civic epistemology, knowledge systems and intervention) to the case study of airborne arsenic regulation in Chile. Our aim is to try out theory in practice (Bourdieu and Wacquant, 1992).

Although we focus on Chile in the 1990s, insights can be applied to other cases. For example, relevant social and cultural changes occurred in the 2000s in Latin America and resulted in an increased role of civil society in environmental policy making (Castro et al., 2015). Effective climate change policies will require the integration of these shifting roles. The potential emergence of climate adaptation as a policy field