Moore, M.-L.; Shaw, K. and Castleden, H. 2018.
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Water Alternatives 11(1): 142-162

# "We Need More Data!" The Politics of Scientific Information for Water Governance in the Context of Hydraulic Fracturing

**Michele-Lee Moore**
Department of Geography, University of Victoria, Canada; mlmoore@uvic.ca

**Karena Shaw**
School of Environmental Studies, University of Victoria, Canada; shawk@uvic.ca

**Heather Castleden**
Department of Geography and Planning, Queen's University, Kingston, Canada; heather.castleden@queensu.ca

ABSTRACT: Proposed and actual developments of hydraulic fracturing, as a high-volume water user, have proven contentious in recent years. However, one point of agreement has emerged amongst all actors with regards to water use and hydraulic fracturing: we need more data. This consensus fits with a longstanding reification of the role of data in water governance, and yet we argue it hides a politically contested terrain. Based on a literature review, an empirical Delphi study and a workshop with a diverse array of participants from across Canada, we explore the data needs related to water governance and hydraulic fracturing. We then investigate three areas of deficiency that point to a lack of trust and oversight as well as the exclusion of community and Indigenous knowledge. We argue that in an era of neoliberal approaches to water governance, issues of trust, accountability and transparency all link back to a diminished role for data management within existing water governance arrangements. The challenge is that simply collecting more data will not help decision-makers navigate the complexity of water governance. Our findings suggest a growing call by participants for greater engagement by governments in data collection and knowledge management, new funding mechanisms for data collection and re-thinking how and what to monitor if including multiple ways of knowing and values.

KEYWORDS: Hydraulic fracturing, neoliberalism, Indigenous peoples, water governance, accountability, data, science policy, Two-Eyed Seeing, Canada

## INTRODUCTION

While hydraulic fracturing[1] for natural gas has been developing for decades, exploration and activity erupted on the global extractive energy scene in the mid 2000s due to shale gas abundance, technological advancements and the globally high pricing for natural gas as a fuel source, which made it economically viable. Almost immediately, concerns about its effects on water sources, climate change and human health were raised. Controversy ensued, and nowhere has this been more apparent than in Canada, where 'fracking' and pipeline politics have made national and international headlines.

[1] Hydraulic fracturing, or 'fracking', is an extractive technique that involves injecting hydraulically pressurised liquid into shale rock in order to fracture it and release the natural gas inside (Gregory et al., 2011; Vengosh et al., 2013). The process often relies on significant throughputs of water, though the volume depends on the specifics of the operation and the individual shale gas play.

In 2014 we conducted a national online Delphi study, followed by a small-scale, face-to-face workshop of invited experts in Victoria, Canada, on 'Water Governance and Hydraulic Fracturing'. Our goal was to solicit a range of perspectives from participants engaged in the conversation about water and hydraulic fracturing development to address two questions: what the key knowledge gaps are regarding water and hydraulic fracturing and what decision challenges should be a priority. Unsurprisingly, in addressing these questions we collected diverse viewpoints. Some participants opposed the use of water for hydraulic fracturing outright, citing a range of concerns including inadequate assessments, fears of water contamination and the production of greenhouse gas emissions during shale gas extraction. Others saw hydraulic fracturing as a new development with significant momentum having both negative and positive potential impacts. Still others indicated that several initiatives already underway in industry and government would improve safety and environmental protection and make hydraulic fracturing viable.

Although divided on whether or not hydraulic fracturing should occur, the views of participants in the Delphi study and workshop appeared to converge around one idea: 'we need more data'. In spite of deeply divided views, this diverse group of actors, which included municipal, provincial, federal and Indigenous governments, academics, non-governmental organisations (NGOs) and industry, appeared unified in their view that decision-making on hydraulic fracturing needed more and better data. As discussed in more detail below, they identified the need for data on baseline hydrological conditions to detect changes and impacts related to water volume and water quality, risks associated with contamination and on the cumulative effects of multiple hydraulic fracturing developments, particularly at the watershed scale. However, while this appears to answer the question regarding priority challenges, in their call for more data these Delphi and workshop participants reflect a constant theme in water governance debates and literature more broadly. The idea that 'we need more data' is repeated so often it has become a mantra and risks serving as a rationale for inertia in decision making. With regards to the use of water for hydraulic fracturing, the need for more data is cited repeatedly as a critical challenge in reports throughout the world (e.g. Krupnick and Gordon, 2015; Reig et al., 2014). In Canada a landmark report (Council of Canadian Academies, 2014: xiii) noted that "the assessment of environmental impacts [of hydrological fracturing] is hampered by a lack of information about many key issues".

The idea that we need more data thus appears as a zone of neutrality, the one point of agreement in the otherwise heated debates about water use and hydraulic fracturing. In this paper, however, we critically evaluate the idea that 'more data' is, or should be, an agreed-upon means to an end in water governance. The repeated use of this mantra seems to indicate that the resolution of water-related conflicts simply rests upon complete and transparent data collection: followed to its logical conclusion, the mantra suggests that diverse actors would – with the right information – agree on the 'correct' path of action, and conflict surrounding water use decision-making would be transcended. Except, based on studies across various environmental controversies, we know this has proven to be untrue (e.g. Sarewitz, 2004; Pielke, 2004). Instead, we argue that the idea that 'we need more data' is an example of the privileging of a certain technical (Western) knowledge – and (Western) solutions – over others, while also concealing fundamental disagreements over not only what data are necessary for consideration but how governance processes can be better organised with more data or how such governance can reflect multiple values and ways of knowing. We also explore why the 'more data' concept is currently so prevalent, examining the relationship with the historical and economic conditions of neoliberalism. Specifically, as governments' capacities shrink, the responsibility for data collection and sharing becomes more diffuse, involving a wider array of actors. Who is responsible for the collection of data, how and for whom, becomes a subject of much debate.

The goal of our paper is to acknowledge, confront and critique the 'we need more data' mantra. To these ends we situate our arguments within the context of hydraulic fracturing developments and the concerns they raise in terms of water governance within Canada. From there we explain the multiple

empirical methods of our study before exploring the politics of data in relation to water and hydraulic fracturing. Specifically, we examine three areas on which study participants and existing literature agreed that 'we need more data': baseline conditions, contamination risks and the cumulative effects of development. Within each area we present statements by participants about data needs in general but also explore their perspectives on specific data collection initiatives. While participants agreed in general and in principle that more data were needed on these three topic areas, once discussion turned to specific programmes they raised critical concerns about how data were generated, shared, owned and used in decision-making processes.

In our final section, we draw out key themes from our analysis, exploring ways in which the call for data represents contested political terrain rather than a scientifically or objectively neutral statement. Consequently, we contend that as participants ask for more information on multiple factors related to water impacts associated with hydraulic fracturing, they call attention to key water governance challenges. Specifically, we suggest that the call for data, at least within the contentious debate over hydraulic fracturing in Canada, reveals three areas of deficiency in water governance: in oversight, in trust and in the authentic and equitable inclusion of community and Indigenous knowledges. We argue that – in an era of neoliberalism – many different political struggles are being articulated within the call for data. Our study shows a growing call by participants for greater engagement by governments in data collection and knowledge management. We also show that new and different funding mechanisms for that data collection and analysis are needed based on the interlinked complexities of trust related to who funds and controls the data, and the increasing costliness of adequate monitoring, particularly if designed appropriately to account for multiple ways of knowing and values, which may mean integrating different forms of monitoring than have been used in the past. There is power in scientific and technical representations of complex socio-ecological problems (Kinchy, 2017). By calling for more data participants in water conflicts are seeking better information while also making intensely political claims about that information.

We suggest that by paying close attention to the diversity of views within the call for more data scholars can better understand how water-related knowledge interacts with attempts to improve water governance. Specifically, we can ask better questions about what data are collected, how data are analysed and why, who should or could share information and how to ensure that the information that is shared can be trusted by all interested parties. By exploring these questions, it may be possible to reveal larger processes of inclusion and exclusion in knowledge-making in water governance, which are often directly tied to issues related to accountability and transparency. This, in turn, should support the development of governance practices that are able to better navigate complex and highly politicised challenges, such as those posed by hydraulic fracturing.

## THE CALL FOR DATA: POLITICAL AND HISTORICAL CONTEXT

We situate the call for data at the convergence of two factors: the dominance of the (Western) natural scientific-technical paradigm within water governance and the change in how data are collected due to neoliberal policy reforms. The former has placed an undue emphasis on scientific data in water governance; the latter has contributed to a situation in which there is no 'neutral' or widely agreed-upon practice of data collection sufficient to build consensus on contentious issues.

### A scientific and technical paradigm

The idea that correct and complete scientific information will maximise social utility and lead to ideal outcomes has a long history in environmental governance writ large. For several reasons this positivist view of the neutrality of scientific information has been widely challenged in all environmental areas, not just water (e.g. Jasanoff, 2004; Rutgers and Mentzel, 1999; Wesselink et al., 2013). Firstly, scholars have recognised that treating scientific data about the environment as though the environment is

separate from humans is problematic. Critics have pointed out that scientific data are socially produced, and for the most part have been defined by Western scientists and institutions that tended towards a reductionism that ignored social-ecological relationships as a complex, dynamic system (Castree, 2001; Miller and Edwards, 2001; Swyngedouw, 1999).

Secondly, beyond the inseparability of science as a socially constructed enterprise, more pointed critiques have highlighted that complex water and environmental challenges are not just technical problems but have numerous political, social and cultural drivers (Turnhout et al., 2007; Kallis et al., 2009; Kirchoff et al., 2013; Skinner, 2017). Therefore, the notion that amassing technical data about the environment and simply disseminating it through one-way communication does not suffice in its engagement with all of those other drivers. Moreover, even when a body of evidence exists regarding the negative consequences of specific activities (e.g. pollution from some form of resource extraction) or from inaction (e.g. on climate change) the advances in scientific knowledge are not necessarily matched with those in the decision-making processes (Sarewitz, 2004; Sarewitz and Pielke, 2007). It has proven erroneous to assume that building a body of technical evidence will somehow lead to institutional change or a shift in governance, no matter the appetite of scientists themselves for such a simple, linear, cause-effect model (Pielke, 2004).

Thirdly, as a consequence of the numerous competing values and interests in any water or environmental issue, even when evidence or data is relied upon in a decision-making process it may be perceived by some as not being the 'right' evidence (Skinner, 2017). The human tendency to seek information from sources we already believe and trust and that which only confirms our own preconceptions, is known as cognitive confirmation bias, and has been well-documented in climate change (Kahan et al., 2011). Additionally, as Heikkila (2017) notes, people selectively use information, sometimes manipulating it, as evidence to reinforce their own policy beliefs or to discredit those who do not share those beliefs.

Beyond the science-policy and science-technology study critiques there is also growing recognition of the problems posed when privileging scientific knowledge over Indigenous and local knowledge and of the need to better integrate diverse knowledges into policy (Tengö et al., 2015). As Castleden et al. (2017b) describe, there is a need for the arrogance of Western expertise to "take a back seat". Going further, calls for innovative approaches to co-learning and the co-generation of new knowledge have become increasingly widespread (Berkes, 2009; Shirk et al., 2012; Bartlett et al., 2012; Bartlett et al., 2015).

Yet, despite the widespread acknowledgement of the problems posed by relying on Western, science-only approaches in grappling with complex environmental challenges, the scientific-technological paradigm persists as the dominant framing within water governance (e.g. Bourblanc, 2017, Crase et al., 2009). The problem with this view is that it locks decision-makers into considering the only possible solutions to any human-water issue as those based on scientific and technological advances (Moore, 2013). Again, scholars have critiqued the reliance on scientific ingenuity, infrastructure foci and mechanistic thinking (Molle, 2009), dubbing it the 'hydraulic mission' (Allan, 2006; Swatuk, 2008). Concerns have been raised that the approach depoliticises water research and debates (Franks and Cleaver, 2007; Furlong, 2006; Mollinga, 2008) and perpetuates the privileging of elite, technical knowledge above all other knowledge inputs (Khagram, 2004). Nevertheless, in practice it is commonplace for communities, NGOs, policy-makers and researchers to continue to emphasise the need for scientific data. At times this can effectively create a 'precautionary principle inertia', given that data are often described as being insufficient for informed decision-making (see, for example, Maguire and Ellis, 2003).

The call for 'more data' has been very pronounced in the recent, rapid expansion of shale gas development and the allocation of water for hydraulic fracturing in Canada. In regions of Canada where hydraulic fracturing has been proposed or used companies and governments have faced a high degree

of public concern in some cases and antipathy in others (Garvie et al., 2014; Moore et al., 2016; Stephenson and Shaw, 2013). In this context of rapid expansion and public opposition the call for 'more data' and a science-led approach appears as a point of neutrality – a shared aim in the context of a highly divisive debate.

**Neoliberalism and water governance for hydraulic fracturing**

Neoliberalism itself is a widely debated concept, and a singular definition remains elusive (Peck, 2010; Springer, 2012). For the purpose of this paper we use Young's (2008, p. 5) definition: "a policy strategy that aims to achieve specific political and economic goals through the partial transfer of authority and/or responsibility from the public sphere (where it is subject to collective political contestation) to private domains (be they corporate, group, and/or individual)". Bourblanc's (2017) analysis of dam building in South Africa demonstrates the far-reaching nature of such goals and the inherent challenges in their implementation. These include the extensive outsourcing of key competencies, which is often done with 'hand-picked' consultancies, thereby reducing the competitive advantages supposedly associated with the neoliberal approach. As Young (2008) also points out, the terms 'market' and 'privatisation' are never sufficient. This is particularly true in Canada, where water does not tend to be treated as a market-based commodity that can be traded as a good, nor are private actors responsible for all aspects of distribution services, with some exceptions existing to this general rule. Instead, in Canada the state is not withdrawing and transferring everything to the private sector so much as reconfiguring its role in water governance processes.

Canadian provincial and federal governments maintain some responsibility for data collection and water monitoring.[2] Overall, however, governments' role in the 'business of research', or knowledge production about watersheds, is decreasing (Buckland-Nicks et al., 2016), particularly with regard to industrial water uses that fall outside municipal boundaries. Instead, provincial and federal governments' roles tend towards streamlining regulations and creating enabling conditions for resource development and for other actors to take on the responsibilities for funding and conducting monitoring (Finewood and Stroup, 2012; Young, 2008). In the context of neoliberalism, government is meant to be a neutral arbiter, though scholars have challenged this idea of regulator impartiality (see Castree, 2006; McCarthy and Prudham, 2004). Therefore, the responsibility and accountability for information gathering is often left in a grey zone: neither provincial nor federal governments take the lead but the degree to which water users assume the responsibility for data collection and reporting is not strictly regulated across the country. The limited data that governments do collect about industrial water use (e.g. volumes of water use and quality of wastewater) are often based on self-reporting by the water users. In theory, self-reporting ensures both that public funds are saved from having to invest in building and maintaining monitoring infrastructure and that water users can adapt their use of water rapidly as they monitor and notice that they are reaching their own maximum allowable volumetric or flow-based limits. In reality, it means that the most advanced knowledge about industrial water users' practices and the associated capacity to enforce regulations is limited to the industry itself, and to actors beyond government.

In many regions of Canada neoliberal reforms have led to the streamlining of environmental regulations and reductions in staff (Ilcan, 2009; Prudham, 2004; Young, 2008). Pared-down agencies are now struggling to keep pace with fast-growing and highly competitive industries, especially hydraulic fracturing with its complex, multi-site infrastructure spread over large geographical areas (Konschnik and Boling, 2014; Willow and Wylie, 2014; Entrekin et al., 2011). As evidence, the Canadian Centre for

[2] Exceptions exist for local governments responsible for supplying drinking water or irrigation water; in such cases data may be collected based on metered use and to ensure drinking water quality standards are met. See Prudham (2004) for a detailed discussion on the impact of neoliberalism on drinking water services in Canada.

Policy Alternatives began tracking the number of unlicensed dams that had been established by hydraulic fracturing companies in the province of British Columbia (Parfitt, 2017). In response, the BC Oil and Gas Commission, responsible for the structures, reviewed the dams and determined after-the-fact whether they met safety standards and necessary conditions, resulting in some being ordered to be shut down (see BC Oil and Gas Commission, 2017). Likewise, it was academic research that demonstrated the links between specific stages of the hydraulic fracturing process and seismic activity, including earthquakes (e.g. Bao and Eaton, 2016), leaving government regulators in reactive positions with little evidence of their own to rely upon.

Recently, and often related to the lack of government capacity or interest in scientific monitoring and research, many groups have begun to undertake their own projects to fill the data-collection gaps in the water sector, such as those led by community-based or citizen-scientist monitoring groups (e.g. Conrad and Hilchey, 2011; Noble and Birk, 2011, Brasier et al., 2017). Yet, as Noble and Birk (2011) also demonstrate, these efforts often amount to little more than 'comfort monitoring' at the community level: the data do not feed directly into a policy-making process about industrial water use, nor do they provide the local knowledge-holders with greater authority or influence in water governance (see also Buckland-Nicks et al., 2016, Kinchy, 2017). Thus, the shift in governments' roles with respect to data collection in the neoliberal era has left a legitimacy gap due to their diminished capacity to collect and analyse data and reduced willingness, related to that capacity, to govern these emerging industries in the public interest.

## METHODS

This paper is the result of a year-long, multi-collaborator, multi-component research study on water governance and hydraulic fracturing in Canada that aimed to identify the key knowledge gaps and priority decision challenges regarding hydraulic fracturing and water governance in Canada. Three primary methods were relied upon: a literature review, a Delphi study and a workshop that drew together diverse perspectives from the primary regions in Canada where hydraulic fracturing is occurring or proposed. The findings from each of these were then coded following Corbin and Strauss (2008) and used to build an empirically grounded 'theory' in keeping with a grounded theory approach. Therefore, our results focus less on the numbers of participants making specific claims and more on the theoretical saturation of concepts. The grounded theory was then 'tested' and reviewed by end users of our data (e.g. government actors, NGOs, Indigenous nations) who were part of an official review process for a number of projects on this topic across Canada that were undertaken at the same time. This provided confirmation of, and feedback on, our understanding of key phenomena. In keeping with Glaser's (2007) approach to grounded theory, 'all is data', which means that "(…) exactly what is going on in the research scene is the data, whatever the source, whether interview, observations, or documents, in whatever combination. It is not only what is being told, how it is being told and the conditions of its being told, but also all the data surrounding what is being told" (Glaser, 2001: 145). The feedback was therefore incorporated as findings given that it shaped the saturation of our key theoretical concepts.

### Literature review

The body of literature that addresses both hydraulic fracturing and water is relatively new, and, although fast growing, remains fairly limited in its analysis of governance. Much of the emerging literature is focused on technical issues or on providing scientific information that demonstrates whether and what types of impacts result from the use of water for hydraulic fracturing. These include the impact on water quality and quantity, air quality and the ecological impacts of seismic events (e.g. Elliot et al., 2016; Rubinstein and Babaie Mahani, 2015; Gregory and Mohan, 2015; Kuwayama et al., 2015; Konschnik and Boling, 2014). As a result, we drew from diverse areas of enquiry, including

environmental engineering, political ecology, environmental justice, Indigenous and environmental governance and general water governance literature in our efforts to understand critical issues and priority areas for decision-making.

### Delphi study

As part of our broader study we conducted a three-part Delphi study. This is a research method used to structure an anonymous conversation involving a group of experts, centred on generating ideas and finding common ground between participants who may (or may not) have similar credentials or perspectives on a particular phenomenon (Plummer et al., 2014). In total, 589 individuals with some form of expertise in hydraulic fracturing and water governance were invited to participate in an online survey. Of those, 112 individuals agreed to participate.[3] In the first round participants were asked to generate statements about the priority challenges facing decision-makers in allocating water for use in hydraulic fracturing. The survey contained four demographic questions and three open-ended exploratory questions. Taken together, the responses from these exploratory questions were analysed using NVivo 8™, a qualitative data management program. For each of the exploratory questions a thematic analysis was performed to identify a number of themes or patterns in the data. In subsequent rounds participants ranked the statements about these themes and patterns and commented on the group median responses.

NGOs represented the largest group of respondents, at 28 percent of the total. Academics were the second largest group of respondents (18 percent). Participation among provincial government representatives (16 percent), industry representatives (12 percent), Indigenous governments/organisations (9 percent) followed in size while local government (4 percent) and federal government representatives (3 percent) were the smallest proportion of the total.

### Workshop

On 16 and 17 October 2014, 25 people from 16 organisations in five regions – British Columbia, Alberta, New Brunswick, the Northwest Territories and Nova Scotia – were brought together for a workshop. A research assistant took detailed notes of the entire discussion, and data from the two days were thematically coded. Themes were used to compare and build upon those previously established through the Delphi so that theoretical saturation could be determined (see Corbin and Strauss, 2008). The purpose of the workshop was to build a shared understanding, through discussion and debate, on key challenges and knowledge needs related to water governance and hydraulic fracturing. We worked to identify priority decision challenges and key knowledge gaps, but also to map and understand regional differences. As we drew together these diverse actors, we found that participants often articulated larger challenges to water governance through a call for data, echoing sentiments issued during the Delphi.

[3] An expert was defined as any individual recognised publically or by peers as having knowledge and experience related to hydraulic fracturing and water governance in Canada (Mullen, 2003; Baker et al., 2006). Experts were identified by scanning relevant scholarly publications, conference proceedings, listserves and personal networks, as well as through a search of academic, government, private and non-governmental organisation websites. The purposeful selection of experts allows for the inclusion of 'information-rich cases', namely those who have relevant information and knowledge about the subject and who may be most likely to influence the ongoing discussions and decisions about water governance and hydraulic fracturing. To facilitate peer recruitment, and following Baker et al. (2006), individuals were invited to share our survey invitation and link with other potential experts. To help maintain participation over the course of the multi-stage survey, those who completed all three rounds were entered into a draw for US$250.

## RESULTS: AREAS OF DATA NEED

### Categorising data needs

As described above, the political discourse around water governance and hydraulic fracturing is often highly polarised. This has been reflected in calls by some groups to impose an outright ban on the technology and its water use, while others continue to propose new or intensifying developments of shale gas plays using the hydraulic fracturing extraction method (Stephenson and Shaw, 2013). Despite their diverging views, actors do appear to agree on the point that 'we need more data' in three areas: 1) baseline conditions, 2) chemical additives and risks associated with contamination, and 3) cumulative effects and changes to quality and quantity over time. Within each area we look at specific data collection initiatives and explore study participants' responses to them. Participants' perspectives of specific data-collection programmes reveal complex negotiations regarding water-related decision-making more broadly.

### Baseline conditions

Researchers have noted that the development of hydraulic fracturing often begins before adequate baseline data have been collected, including on nearby groundwater quality and critical wildlife habitat, aquifer mapping and potential contamination pathways (Council of Canadian Academies, 2014; Garvie et al., 2014). In terms of water data, one study suggests that five to six years of reliable flow data would be necessary in order to understand the hydrology of a river (Carey, 2013); however, many developments are allowed to proceed before that amount of data are gathered. Participants in the Delphi study identified the need to establish "consistent baseline and environmental monitoring regimes in the context of hydraulic fracturing and water resources" as a precondition for good governance for hydraulic fracturing. One participant suggested that it was key to establish "baseline groundwater quality data before hydraulic fracturing occurs". Another participant suggested that it was essential to "gather extensive seasonal baseline data prior to industry establishing themselves in areas where development is likely to occur".

Workshop participants expressed concerns that, without baseline data, decision-makers lacked a clear understanding of the potential risks associated with allocating water for this particular industrial use. Moreover, the industry is widely recognised for its rapidly evolving technological advancements for the hydraulic fracturing process. Given the limited capacity within environmental agencies that has stemmed from the deregulation efforts and staffing cuts that each provincial jurisdiction has undertaken in the past decade as part of broader neoliberal reforms (Ilcan, 2009; Young, 2008), participants expressed uncertainty about how governments expected to fully understand the fast-changing operational practices of the industry and how best to regulate those practices. Workshop participants noted that sometimes existing baseline data were wrong or incomplete. Our findings suggest that some regional or watershed-specific monitoring programmes exist but that no systematic or comprehensive programmes have been developed. Delphi participants noted "ongoing project monitoring in areas where hydraulic fracturing is being considered or is occurring" as a key knowledge gap and workshop participants also identified the lack of systemic monitoring as a central issue.

In addition to requiring baseline data about their own watershed conditions, participants identified the need for more general research on the volume-related impacts of hydraulic fracturing (i.e. how water quantity changes from the baseline due to this use). Concerns surfaced in the Delphi and workshop data that with the nature of the industry's large scale and rapid development, and in the context of a rapidly changing climate, sufficient water today does not automatically mean sufficient water tomorrow. While the total water demand for hydraulic fracturing in Canada might be proportionally quite small, the use is intensive and can create water stresses at times of peak demand, and in different seasons, as has been noted by other research (Freyman and Salmon, 2013). Empirical

evidence based on the literature review indicates that there is no simple answer to participants' questions about how much water is being used and what that volume means. The volume of water used in hydraulic fracturing operations varies widely, depending on the operating strategy of the company working on a specific shale play and the nature of the shale gas play itself (Chen and Carter, 2016; Rivard et al., 2014; Nicot and Scanlon, 2012). In Canada as in other regions of the world shale gas development is often proposed in areas where it will inevitably compete with other water uses (Reig et al., 2014; Rivard et al., 2014). Thus, at a more fundamental level, participants at the workshop reflected on the broader question about whether water use for hydraulic fracturing could ever be considered the 'best' use in a watershed, or whether there should be a threshold or limit to how much could be available for this one particular use, when demand for other water uses is increasing (such as for agriculture in light of growing concerns about food security) and given that flows may decline in some regions due to climate change. This consideration hinted at the normative values behind the claims for 'more data'.

**Contamination risks and transparency**

Hundreds of chemical additives are known to be used in hydraulic fracturing, from acids that can help initiate cracks in the rock to biocides that bond to pipes and prevent corrosion, and these chemicals have been linked to a range of human health effects (see e.g. Colborn et al., 2011; Elliott et al., 2016; Kassotis et al., 2013). Our literature review found that the use of these chemicals creates risks for human and ecological health and creates concerns about: leaks directly from the wells, surface management of flowback water, groundwater contamination and the altered structure of microbial communities that results from the fracturing process (Chen and Carter, 2016; Gregory et al., 2011; Llewellyn et al., 2015; Osborn et al., 2011). Our Delphi study and workshop findings demonstrated that the lack of transparency in terms of the identification of both the type and the volume of chemicals used in hydraulic fracturing was the challenge that participants ranked highest overall. When we asked the Delphi participants for the most critical knowledge gaps, many respondents mentioned (as did one representative with both provincial government and NGO affiliations) "chemical additives currently in use and their fate in the environment". An academic Delphi respondent said that knowing the composition of the fluids used in hydraulic fracturing was essential, particularly because the effects of such fluids are the "unknown consequences of trade-secret chemical sauces".

One workshop participant directly linked the lack of data on contamination risks with broader political questions: "we do not know the long-term consequences for groundwater and surface water (often we do not even know the pathways of contamination) and we do not know how to place these risks in economic terms that politicians and the media can respond to". Workshop participants thus echoed water quality – related concerns widespread among researchers from our Delphi study and in all regions where hydraulic fracturing has occurred (see for instance Freyman and Salmon, 2013; IEA, 2015).

In practice, some jurisdictions in Canada, including British Columbia, Alberta and New Brunswick, require the industry to report their chemical use to a chemical disclosure registry known as Fracfocus.ca. The site is modelled on a similar website in the US and is a partnership between government and industry intended to provide "objective information on hydraulic fracturing" and to avoid any "'spin' or political commentary" (FracFocus.ca, 2014, para 1). Members of the public can search the site by region, well or operator to find out the chemical mixes and concentrations in the fracturing fluid of specific wells. These registries are industry self-reporting programmes that *appear* to provide greater transparency regarding chemical additives.

Yet, several workshop participants – many of whom worked full-time on issues related to water and shale gas development – had not heard of the FracFocus registry in the autumn of 2014. The fact that the information about the website had not been effectively disseminated, however, was only one of

several challenges related to this chemical disclosure process. The data on the site proves to be very difficult to synthesise and interpret in ways meaningful to water governance (see also Goss et al., 2015; Ryan et al., 2015). For example, users of the database cannot bulk download data in a readable format for searching. Neither can they search by known city names; rather a visitor to the website must know the operator name or the well. Furthermore, scientific understanding is limited regarding the interaction of these chemicals and their additive or compounding effects on water quality; thus, no information regarding those concerns is included. In addition, an entirely separate, private reporting process exists for chemicals that operators consider to be trade secrets, meaning companies can apply for exemptions and ensure their data are not made publicly available.

We contend that while projects such as FracFocus may appear to be aimed at increasing transparency regarding chemical additives, a database that (i) allows exemptions to the very reporting it is intended to track, (ii) is not well known to those involved in decision-making about the issues, and (iii) is not user friendly, does not meet any goal related to transparency. The appearance of transparency and evidence-based decision-making is different from the practice of being transparent, and, in an era of 'greenwashing', the public is savvy enough to recognise the distinction (Dauvergne and Lister, 2012; Walker and Wan, 2012). The risk with transparency measures that fail to meet expectations is that the industry and government instead exacerbate perceptions about 'regulatory capture' – that is, a sense that governments will protect businesses' economic interests above all other public values and that industry has undue influence over what is regulated.

### Cumulative effects

Workshop and Delphi participants repeatedly made the call for more data on cumulative effects. They noted, for example, that permits for shale gas development are often issued for each small part of a hydraulic fracturing project (e.g. each road or well pad) rather than for a project as a whole (see also Garvie and Shaw, 2014). This piecemeal permissions process is far from what participants from NGOs, Indigenous nations, academia and some government staff wanted to see: large-scale, long-term assessment of changes in landscapes and hydrological systems. As one representative of an Indigenous organisation said in response to the Delphi, "cumulative impact assessment should also be a consideration in developing an overall plan for hydraulic fracturing activities rather than looking at regulating industry on an application-by-application basis".

With increasing awareness about the need for cumulative impact considerations the provincial government of Alberta launched a pilot project to test a 'play-based approach' to governing energy-water use. This requires full projects to be assessed across a shale gas play instead of the site-specific and well-by-well approach that has traditionally been used (Alberta Energy Regulator, 2015). It is still too early to determine the effectiveness of the approach, but without well-established baseline and long-term monitoring programmes it will inevitably meet challenges. Indeed, as noted earlier, the inadequacy of water monitoring has long been recognised in Canada (see, for instance, Office of the Auditor-General of Canada, 2010; Buckland-Nicks et al., 2016). One attempt was made to develop comprehensive environmental monitoring for another energy industry (the oilsands development in the Athabasca River Basin) and was deemed a failure during an independent review process due to a lack of accountability, dysfunctional partnerships and an inefficient use of funds (Boothe, 2015; Olszynski, 2014). The consequence is that in the northern parts of British Columbia and Alberta, where hydraulic fracturing and oilsands developments are occurring along with other resource-extraction activities, urban developments and agriculture, no type of monitoring has been established to effectively gauge cumulative effects at a regional scale over time. It is a challenge that also presents an opportunity to employ not only a Western approach to measuring cumulative effects but also to ensure Indigenous peoples' knowledge systems are equally shaping the development of the scope of indicators and methods of measuring such effects on water (Castleden et al., 2017a, 2017b).

Additionally, workshop participants raised complex and fundamental considerations regarding the types of data that would be meaningful for decision-making. For example, participants suggested that more data were needed to ensure that environmental flows (i.e. the basic amounts of water needed to maintain a range of ecological processes and services) were protected before withdrawals began. One Delphi participant, a representative of the provincial government, suggested "slowing things down until things [are] better understood when it comes to water use and hydraulic fracturing".

## THE POLITICS OF DATA DEFICITS: THREE KEY AREAS

The previous sections' findings indicate that, indeed, more knowledge is needed regarding baseline issues in watersheds and the potential changes over time related to hydraulic fracturing. However, this represents a paradoxical tension that was revealed through further analysis – more data was needed, but more data would not resolve the key governance challenges and priority decision issues. In this section, we draw out additional findings regarding the key governance challenges, demonstrating three themes in particular: lack of oversight, lack of trust and a lack of inclusion of community and Indigenous knowledge – the latter often excluded from debates focused on scientific 'data needs'. The fact that data needs are articulated within certain technical parameters reveals the ongoing emphasis of technocratic thinking in water governance for hydraulic fracturing. We assert that actors use the call for data to access the power of 'neutral', scientific, technical knowledge, but this masks the broader concerns about water governance processes and imbalances.

### Lack of oversight

Workshop participants noted that in cases when the baseline data that Delphi participants had stated were needed did actually exist, they had been generated by different groups, with different purposes and frames of reference. The multiple origins of baseline data meant that no one group or set of actors had access to all of the information, nor was one data set comparable to another. This problem has been demonstrated by other watershed monitoring studies (e.g. Buckland-Nicks et al., 2016, Kinchy, 2017).

The call for baseline data, the monitoring of cumulative effects, and for the consideration of social and cultural values within data collection sounds like a technical proposition. Yet, we argue, it is intensely political and strongly related to governance issues, such as transparency, accountability and the need to re-think how water monitoring is conducted. In effect, participants were making a call for government to exercise its agency more strongly to provide oversight and to assess social and ecological change at a scale beyond individual developments or projects and in different ways from those seen previously within the existing governance regime. Delphi participants identified regulators as key players in addressing important hydraulic fracturing and water governance issues, and workshop participants echoed this result. The calls for regulation, enforcement, data collection and overall engagement with a broad range of actors appeared to suggest reinstating the authority and governing activity from which the provincial governments have retreated through neoliberal adjustments. Yet these calls also entailed the creation of innovative governing mechanisms that could address the new activities and concerns related to the proliferation of hydraulic fracturing while including values that have been marginalised or entirely excluded in water governance since long before the neoliberal reforms.

In line with that noted in our review of the literature, some study participants expressed concern that the industry was left to monitor itself and submit its own reports. Industry self-reporting fits with a neoliberal approach and the associated concepts of Corporate Social Responsibility (CSR) that have been extended to other environmental and water issues (e.g. Gunningham and Rees, 1997; Jenkins and Yakovleva, 2006). Criticisms of self-reporting typically relate to questions of legitimacy – for example, whether it is acceptable that a licensee is the one that reports that it is meeting all of its licensing and

wastewater permit conditions in the absence of independent verification. However, participants acknowledged a counter argument: that the industry has the financial means to install, maintain and operate sophisticated monitoring systems to meet its reporting responsibilities. Therefore, it makes sense that the financial burden does not fall on the taxpayers within the watershed. Participants also acknowledged though that in some cases industry may collect data that is of interest to other users and the public but that it may not be publicly available. Thus, the desire for transparent data still pointed towards a model in which government holds responsibility for overseeing what and how data are collected and ensuring that the public has access to that information.

**Lack of trust**

Directly related to the issues of oversight, the reality that few other actors beyond industry have the resources or capacity to conduct adequate monitoring only concentrates power in the hands of one group of actors and water users: the hydraulic fracturing industry. Regardless of how sophisticated the data collection and reporting is, a lack of trust often surrounds such a circumstance. Thus, the very notion of self-funded monitoring and self-reporting can contribute to less certainty and it could be hypothesized that this possibly leads to less power for industry. Delphi participants identified as a priority the need to "fund research conducted by independent organisations, including academically led research teams".

In the absence of government capacity, funding and oversight, or in the absence of a neutral party to fund and operate the monitoring, workshop participants acknowledged that no actor in the system deems anyone else to be sufficiently accountable, transparent or trustworthy. Yet, as with the failure of a disclosure registry such as Fracfocus to improve perceptions of transparency, this means that investing in 'more data' without first building trust will not resolve the tensions at the heart of the water governance conflicts. This finding highlights the important point that the sequencing of actions must be considered: address the governance processes and relationships embedded within them before focusing on the data collection.

Participants noted that many actors – academics, Indigenous governments/organisations, environmental NGOs – were conducting monitoring for their own purposes, but none of the data were shared or linked together for decision-making. The extent to which these efforts overlap is unknown and was, to some extent, of less concern to the groups. Rather, participants agreed that the major concerns are two-fold. Firstly, given that many private actors do not share data publicly, none of the data are subject to review. Secondly, concerns recurred about the funding behind all data collection and analysis. Workshop participants agreed that current funding options lead the public to assume that the data are biased; for example, if research is paid for and collected by an NGO, others (e.g. the industry, government and some members of the public) do not trust it. If data collection is paid for by industry, then many Indigenous nations, NGOs, members of the public and others assume it is biased. Participants revealed that even if the data are collected by an NGO or community-led group, if the study is funded by industry or government, Indigenous and non-Indigenous community groups alike have faced criticism for accepting the funds. Their group and the data are then perceived as biased, rather than serving as a third-party verification system.

Some people realise that data and statistics can be manipulated to tell specific stories. Therefore, even where standard protocols were followed, as established by government and scientists (based on Western science), they would assume bias in the manner of data collection. Empirical evidence from other environmental issues, however, shows that this may be more a problem of confirmation bias – trusting evidence only from certain sources and tending to discredit those with whom we disagree (Heikkila, 2017). Moreover, Wynne (1992) describes how historical social experience among actors can shape whether information is trusted. For example, the longstanding and ongoing colonisation of Canada’s Indigenous peoples, including broken treaty promises, has shaped their relationship to water

(see Moore et al., 2016; von der Porten and de Löe, 2014). It is therefore reasonable to expect that any provincial or federal government-funded data may be rejected by some Indigenous communities.

Taken together, we contend that our findings regarding trust reveal that the challenge of integrating evidence into decision-making is both a social issue (i.e. whether the actors understand each other and the context of their historical experience of one another) and also directly tied to the way data and knowledge management are funded within the existing water governance structures. The financing of knowledge creation is too often neglected in discussions of the need for 'more data' as well as in broader critiques of the integration of science into policy. Together, the lack of transparency and the concerns about funding lead to a bigger question of data ownership and influence: 'whose data' are being used to inform decisions in the current governance context, and why?

**Lack of inclusion of community and Indigenous knowledge**

Some (but certainly not all) non-Indigenous participants noted the need for the greater inclusion of civil society and/or Indigenous governments/organisations, while Indigenous participants were consistent in identifying this issue.

Indigenous and local knowledge are finally being recognised in academic and other areas of scholarship as critical to an understanding of social-ecological systems. Given the complexity of most water governance challenges these days, it has been suggested that we need other knowledge systems to help us ask the right questions in order to find the right answers (Castleden et al., 2017a McGregor, 2008, 2012; White et al., 2012). In the Canadian context, we would argue that this is not only essential as some 'nice' principle of inclusion, or practice to enhance diversity, but is a legal obligation in the protection of the constitutional rights of Indigenous peoples. This obligation extends to engaging in government-government relationships and in meeting Truth and Reconciliation Commission (2015) recommendations for action, as well as the UN Declaration on the Rights of Indigenous Peoples that is now supported in Canada without qualification (see Promislow [2013], Sossin [2010] and Lawrence and Macklem [2000] for a more complete discussion of these issues). However, the provincial and federal government's fulfilment of these legal obligations has often been deemed lacking (Natcher, 2001; Ritchie, 2013). Moreover, often data from other ways of knowing do not 'count' because they are not collected using Western scientific data monitoring networks and do not fit well with the dominant scientific-technological paradigm within water governance.

We have learned from many Indigenous Elders and scholars that Indigenous knowledge is action-oriented, participatory and relational (see Bartlett et al., 2012 and Bartlett et al., 2015). It is often place-based, culturally specific and imbued with emotion and spirit (Battiste, 1998). Indigenous knowledge is generally derived from direct physical and mental observation but is also embedded in emotional and spiritual experience, and often best shared through oral tradition (Tobias and Richmond, 2014; McGregor, 2012; Simpson, 2004). However, certain participants noted that scientific data are not collected for this broader set of values related to health, culture, sense of place and ways of knowing. Consequently, Indigenous knowledge, local knowledge and data that are beyond conventional natural scientific parameters are not taken into consideration by decision-makers in the water governance context, concerning hydraulic fracturing or other water allocations.

We suggest that there is often an inherent assumption that, when the need for more data is observed, this refers only to Western scientific data about the biophysical or chemical properties of large bodies of water or aquifers. But, given the range of values that lie within a community, Indigenous or otherwise, for which data are not generally collected (e.g. the impact on health, social and social-ecological relations, and the economy), concluding that risks do or do not exist to those other values becomes extremely challenging. Moreover, we follow the argument of Ottinger (2013) and suggest the discontentment over the lack of inclusion of Indigenous and local knowledge systems may be linked to a deeper challenge regarding the temporality of procedural justice. Claims are often made about the

need to include other forms of knowledge in decision making, but, for issues such as water quality degradation, the damage will already have been done by the time local or Indigenous knowledge can demonstrate it. That is, the knowledge of local impacts is not available by the time projects are proposed, since it can only be gained after the fact. Yet, workshop participants noted that little recourse was possible in halting water use for hydraulic fracturing once a project was approved and in operation.

Indigenous and local knowledge systems need to be brought into the water governance conversation on equal terms, not as anecdote, folklore or tokenism, and not only 'after the fact'. It has been acknowledged that new models are required in the generation and application of knowledge for water governance (von der Porten and de Loë, 2013; Sanderson et al., 2015). Indeed, new integrative frameworks have been developed, including Tengö et al'.s (2014) multiple evidence base and Mi'kmaw Elder Alfred Marshall's Two-Eyed Seeing (see Bartlett et al., 2012 and Bartlett et al., 2015). Two-Eyed Seeing attempts to consider a wholistic (not holistic) view of 'the problem' first (in this case hydraulic fracturing) and then to engage Indigenous and Western knowledge systems in co-learning about the problem in order to come up with wholistic solutions. However, such frameworks have not yet been widely adopted by those responsible for governing water in Canada (see Castleden et al., 2017c). Importantly, Indigenous peoples are at the vanguard of reconciling our relationship to water.[4] Existing water governance processes need to play catch-up in adopting integrative models and shifting the values that will be prioritised in water governance – before simply moving to collect more data.

## CONCLUSION

One of the most significant challenges facing those responsible for water governance is to create processes that are capable of building and maintaining public trust in the decisions that are taken. Hydraulic fracturing within the Canadian context has revealed the deep and problematic nature of achieving this in an era of neoliberalism. This context is not specific to hydraulic fracturing or to Canada. The consensus that surrounds the claim by all actors that we need more data is not as straightforward as it may appear. The need for data has instead become a source of leverage and a source of contestation, as actors formulate their arguments either for or against the use of water for developments such as hydraulic fracturing based on the lack of evidence of its impact. No single actor has sufficient data to support their argument, whether the actor wishes to prove that deleterious impacts have or have not occurred, and a lack of trust exists regarding the conclusions even when claims are made. By focusing on the idea that we need more data, without paying close attention to the political struggles within the call for data, scholars and other actors risk perpetuating the assumption that data-driven approaches are the only or best way forward, in this way reinscribing the dominance of the scientific-technical paradigm.

We do not argue that data are *not* needed for hydraulic fracturing and water issues. Rather, we have demonstrated that only collecting more scientific data will not equate to necessary and sufficient transparency and accountability. Therefore, we argue that, unless the governance challenges are confronted first, or at the very least simultaneously, any investment made in collecting data and publicly reporting results is unlikely to yield governance changes or resolve the politics and contestation underlying the calls for more data. This situation differs from many previous discussions on the challenge of integrating science into policy, for in many environmental issues there is what Sarewitz (2004) refers to as an 'excess of objectivity'. Such excess means that more scientific data has been

[4] We recognise that Indigenous peoples' water rights is a topic very much applicable to the conversation on governance; however, we feel it is beyond the scope of this paper and instead refer readers to Castleden et al., 2017a, 2017b; Moore et al., 2016; Castleden and Skinner, 2014; Sam, 2013; Phare, 2009.

generated than people can make sense of or apply. The belief is that this has created space for data to become politicised. We contend that the politicisation occurs before data collection starts because of who funds, collects, owns, and has access to the data.

Moreover, in direct response to the processes of regulatory streamlining, staff cutbacks and the diminished role of provincial and federal governments in conducting their own data collection and knowledge management, our study showed participants generally calling for greater provincial and federal government engagement. Rather than hearing any participant say that these governments need simply to 'get out of the way', there is growing agreement that without tougher regulation and enforcement mistrust develops and questions around legitimacy surface, particularly about industry actors.

Alongside stronger engagement by provincial and federal governments is the need to find integrative models for the collection and application of the multiple ways of knowing, recognising these as essential rather than merely investing in and perpetuating the hegemonic Western-engineering and natural-science forms of water monitoring and valuation. These new frameworks must be embedded in a governance process that considers procedural justice, so that the information on specific values is generated and considered before projects become operational. These processes are necessary not only to ensure diverse values are considered, which will be more likely to yield a wholistic understanding of complex social-ecological dynamics, but also because, in Canada, federal and provincial governments have formal and informal obligations that require them to honour government-to-government relationships and commitments with Indigenous nations.

The proposed changes to water governance, which indeed could be far-reaching, also require a re-thinking of the financial arrangements for such processes. It seems counterproductive for the funding to come from a single actor given the mistrust that exists as a consequence of the historical relations between the actors involved. Scholars have highlighted the negative impact that neoliberalism has had on water governance and management (e.g. Smith, 2004; Prudham, 2004; Cohen, 2012). Our findings point to the challenges that have emerged as a consequence of cutbacks and the shift to industry self-reporting water-use data. However, the results of our workshop go further to reveal that questions remain about the alternative funding models that would resolve the mistrust amongst actors and ensure equal access to data and information that represents multiple values and ways of knowing. It would be necessary to accomplish this without setting up situations where powerful actors could co-opt or discredit the data so as to avoid reinscribing the politicisation that already exists.

Ultimately, we contend that the reification of the need for more data has masked the political contestation of what and whose data counts in decision-making. Consequently, the debate appears value-neutral and based upon quantifiable and technical concerns rather than fundamental disagreements over governance processes related to accountability, transparency and the associated trust. When diverse actors make calls for more data, we contend that they are reflecting the diffusion of the responsibility for data collection that has come to exist in a context of neoliberal governance, as well as the ongoing marginalisation of any way of knowing that does not fit neatly into the dominant, Western, technical approaches. The existing governance processes need to be reconfigured so as to be able to handle contentious topics. One part of achieving this will involve the way that data are governed.

## ACKNOWLEDGEMENTS

We would like to thank the Canadian Water Network for their financial support of this project. We also thank Megan Kot, Rosanna Breiddal and Mathew Murray for their active involvement in different phases of the literature reviews and data collection. Special thanks go to Joanna Reid for her editorial expertise and to Raul Pacheco-Vega and Jeremy Schmidt for their organisation of the American Association of Geographers' Annual Conference panel on water governance, which contributed to the formulation of these conclusions.

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