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Reconceptualising Water Quality Governance to Incorporate Knowledge and Values: Case studies from Australian and Brazilian Indigenous Communities

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ABSTRACT: This paper examines the significance of knowledge and values for water quality and its governance. Modernist approaches to the governance of water quality in rivers and lakes need to be reconceptualised and overhauled. The problems include: perceiving water only as a physical and chemical liquid, defining quality in narrow terms, rendering water knowledge as invisible, boiling down water values to uses of presumed economic importance and limiting how and by whom objectives are set or actions taken. In addressing the need to reframe water quality governance, and as a counter to the objectification of water quality, we propose a framework that explicitly recognises the significance of knowledge and values relating to water. While our framework could apply to other contexts under the influence of modernist water-management regimes, here we pay particular attention to the relevance of the water knowledge, values and governance of water quality by Indigenous people. In the second half of the paper we address issues related to Indigenous water-quality governance in two countries, Brazil and Australia, showing some of the ways in which, despite enormous obstacles, Indigenous communities re-work governance structures through their engagements with water quality and pay attention to water knowledge and values.

KEYWORDS: Indigenous peoples, water quality management, Australia, Brazil

INTRODUCTION

Water has always been implicated in the social, economic, political, ethical and spiritual dimensions of human history and development. In attending to how relationships between societies and waters are structured, a number of scholars over the past couple of decades, including Abbott (1999), Swyngedouw (1999), Hamlin (2000) and Linton (2010), have taken up the question 'what is water?', which we take as a point of departure. Yet, here our concern is not so broad as to include everything about water. We limit ourselves to the smaller but still significant sphere of water quality along with its

governance.¹ While seemingly straightforward, water quality and its governance are more complex than initial appearances because both depend upon interactions between humans and environments that are context dependent and grounded in cultures, geographies, histories, technologies, politics, sciences, economics and materialities. Consequently, we envision water quality and water-quality governance as joined hand-in-hand, such that tackling one requires addressing the other.

An example underscores some of the complexities along with the broader implications associated with water quality and its governance. Abbott (1999) reminds us that "many kinds of things, including babies, chickens, and tomatoes, contain higher proportions of water than Utah's Great Salt Lake" (145). But while people may speak about the water quality of the Great Salt Lake, it would seem odd to talk about the water quality of babies, chickens or tomatoes. This is because only the lake is recognised to be water, despite a name that clearly identifies it as being something more than simply the compound, H₂O. The distinction is whether the non-water components are known and valued as essential elements or are instead judged to be impurities (Abbott, 1999). Despite being watery, babies, chickens or tomatoes are known and valued as things that are *not* water – recognised as entirely separate things with different names. By contrast, in the second case the interpretation is made that as a lake, the Great Salt Lake is water; materials within the lake are recognised as being external to water, and at times are devalued and controlled as impurities, while at other times these same materials may be seen as extractable commodities (e.g. table salt). Such interpretations are premised on what is known about attributes related to water (water knowledge) and are also based on the attributes of water that people care about, including their determination of quality (water values). So, unlike the first case (pertaining to babies, chickens or tomatoes), the second case (a lake as a body of water) produces a set of issues that are recognised as being related to water quality and its governance.

This article intends to open up conversations and assessments about the water quality in rivers and lakes² and its governance. Our specific concern in this paper is the current definition and assessment of surface water quality and its governance, which we argue has often been narrowly applied in ways that ignore variations in the cultural politics of water. This narrow application intrinsically marginalises Indigenous perspectives and experiences with respect to water.³ We propose a framework that explicitly recognises the significance of water knowledge and water values that, among other things, can facilitate governance of water quality by Indigenous communities. We also provide an overview of the situation of Indigenous communities in Australia and Brazil with respect to water quality and its governance, with an emphasis on how water knowledge and water values have been or could be addressed.

MAKING SENSE OF WATER QUALITY AND ITS GOVERNANCE

While there is widespread agreement about its significance, water quality has no straightforward definition, nor one that is universally agreed upon. It is not difficult to have people agree upon the natural and human-driven processes that influence surface water quality, which include evaporation and wind deposition associated with the atmosphere, erosion and weathering associated with the

¹ We use the term 'governance' to mean the broad variety of formal and informal processes, institutions and practices employed to measure, regulate, transport, utilise, manage, control and appreciate water quality.

² This article focuses on the quality of surface waters, in particular rivers and lakes, although much of what is discussed may be relevant to other waters as well.

³ While there is no ideal term, or one that is universally agreed upon, throughout the article self-identified groups of Aboriginal, First Nations, Indian, Indigenous, Native or Tribal peoples are referred to as Indigenous peoples or communities. We adopt the definition used by Gupta et al. (2014): "Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing on those territories, or parts of them" (p. 26).

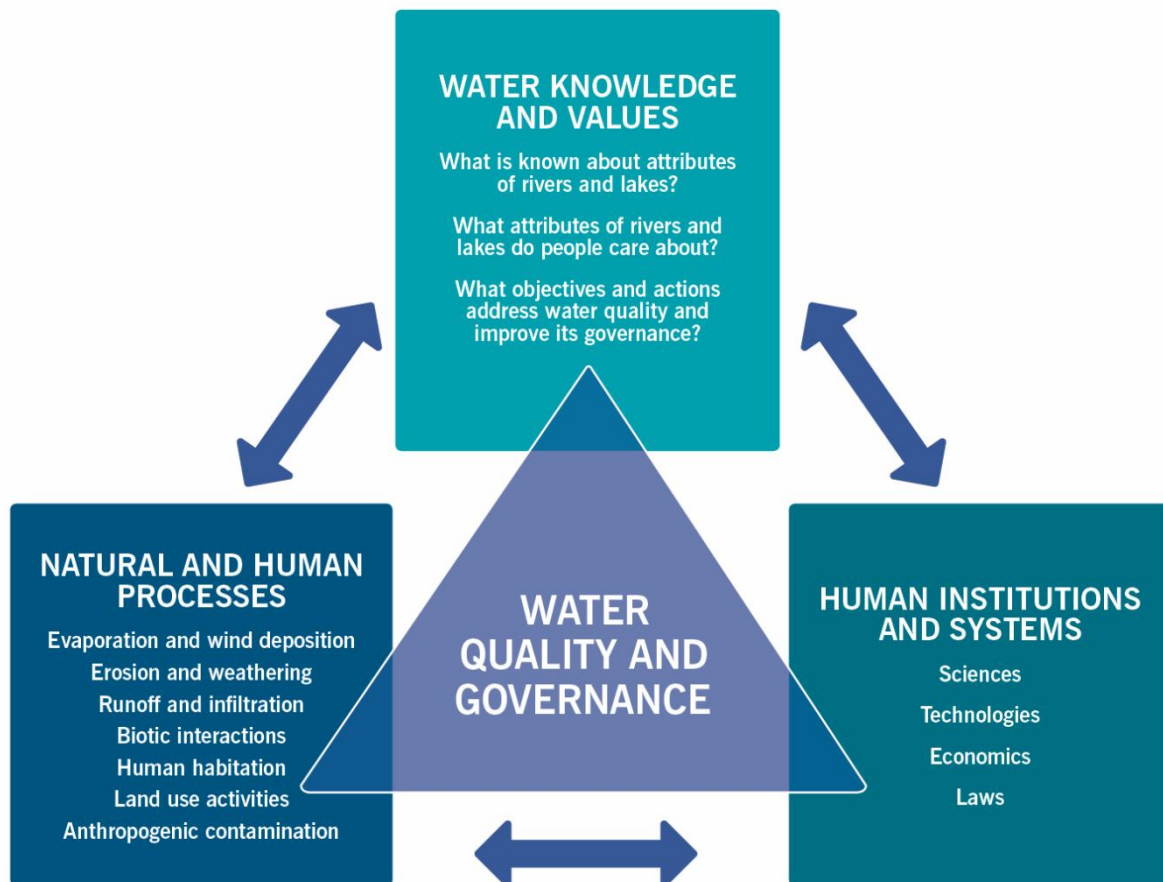
geosphere, runoff and infiltration associated with the hydrosphere, biochemical and physical dynamics associated with the biosphere, and human habitation, land use and other activities contributing to the anthropogenic impacts on the hydrosphere (UNEP, 2006). These processes (often dynamically coupled with one another) influence the properties of surface waters; in other words, they affect water quality. Yet, water quality encapsulates more than these processes, resultant inputs and properties. Human institutions and systems are clearly influential as well. The types and availability of sciences, technologies, economics and laws may influence, for example, the capacity to detect contaminants or the ability to implement a specific policy.

However, making sense of what constitutes pure or high-quality water also involves drawing upon one's knowledge system, along with assessments of quality mediated by a value system. Consequently, we argue that understanding water quality and realising the scope of water-quality governance involves tapping into a third realm – one that is no less important than the others: water knowledge and values. Water knowledge refers to what is known about the attributes of rivers, lakes and other waterbodies; water values are the attributes of rivers, lakes and waterbodies that people appreciate and care about and includes how quality is determined (through perception, assessment and valuation). So, water quality is more than a set of objectified physical processes, inputs and properties to which human institutions and systems respond. We posit that water quality and its governance should thus be recognised as encompassing what is known about the attributes of rivers and lakes, should reflect those attributes of rivers and lakes that people value and address objectives and actions associated with significant water knowledge and values (see Figure 1).

Water knowledge and water values are actively constructed within larger social dynamics referred to as the cultural politics of water. Cultural processes have a direct bearing on what people know and how they care about/for water, which underscores the importance of attending to ontological understandings about both water and quality as well as human relationships with waterbodies (Jiménez et al., 2014; Liedloff et al., 2009; Jackson, 2006). For example, broad-based sensory indicators of water quality, such as smells, may be relevant conditions that contemporary Indigenous peoples of New Zealand, the Maori or *Tangata Whenua*, detect, respond to and value. Maori also use language that encompasses qualitative distinctions between certain types of water quality degradation (Tipa and Tierney, 2006; Tipa, 2009). Water values and knowledge are of course dynamic, changing with time. In pre-reformation Ireland and England, for example, certain springs were identified as sacred, taking on unique water qualities that were instrumental in designating particular places, and influenced subsequent political and cultural dynamics (Walsham, 2011).

Figure 1 illustrates these three realms associated with water quality and its governance. Our focus in this paper draws attention to the top realm – water knowledge and values. While we are especially interested in its significance to Indigenous water-quality governance, this framework applies to water quality and its governance in all settings, beyond those pertaining to Indigenous community contexts. Not only have water knowledge and values generally been overlooked when defining and assessing water quality but we believe that recognising and incorporating water knowledge and values has the potential to facilitate more meaningful governance of water quality by and for Indigenous communities and, indeed, for all social relations with water.

Figure 1. Three interconnected realms that influence water quality and its governance.



Water knowledge

Knowledge about the attributes of water – in other words, answers to the first question in Figure 1 "what is known about the attributes of rivers and lakes?" – implicitly recognises that what is in rivers and lakes is not simply the standardised chemical compound, H₂O. Despite being labelled simply as water, rivers and lakes have long been known (and by a wide variety of societies) to contain more than just hydrogen and oxygen molecules.⁴ Yet, what is recognised about waterbodies varies; for example, different people may understand different things about the same river or lake (Oberkircher et al., 2011). In other words, knowledge about water varies between peoples and across space and time. Hamlin (2000), for example, reminds us that premodern European societies had richer qualitative vocabularies about water than those of today's industrialised West, indicating a depth of lay knowledge that has declined as scientific modes have come to dominate ways of knowing water.

Knowledge about the attributes of water is important in part because it provides a bridge between, on the one hand, the processes, inputs and properties of rivers and lakes and, on the other hand, human systems and institutions, such as sciences, technologies, economics and laws. Attributes related to water come in different forms, including a wide variety of chemical, biological and physical constituents that individually or in combination have become commonplace in describing water quality

⁴ For more on the history of chemistry and physics related to water(s) see Linton (2010).

(such as turbidity or total phosphorus) in contemporary modernist systems. While there are tens of thousands of constituents for which scientific measurements could possibly be made, in any given river or stream only a few or a few dozen are targeted. Under contemporary approaches to water management, identifying and deciding which constituents to address tends to rely on a specific type of water knowledge. Constituents deemed important to measure may shift with changes in scientific knowledge about water quality conditions or in conjunction with societal shifts in economics, laws or technologies. We can see this, for example, in the recent emergence of contaminants of emerging concern (CECs), which as this term suggests are newly recognised as potential pollutants of surface water. The results of scientific studies, as well as the availability of technologies and financing, influence what is known about these types of measurable constituents in water.

Relevant here is Barber and Jackson's (2015: 121) expansive notion of what knowledge is: "principles and truths acquired from other sources (people, written records, music, etc) and/or generated from analysis and reflection, but which also incorporates physical skills acquired through experience and practice – knowledge does not lie on one side of the distinction between mind and body, or between an individual and a collective". Such an expansive view is especially important for water knowledge connected to Indigenous peoples (Wilson, 2014; Barber and Jackson, 2015). In the water-focused society of Baucau in East Timor, for example, spring water is known to be a critical element of the supra-social landscape, one "where the social is not confined to the domain of human beings" (Palmer, 2015: 1).

Water knowledge in all societies is mediated through cultural contexts and political practices that connect to specific ontological frameworks. Whether looking at the attributes recognised in water or how a body of water is characterised, water knowledge is distinguished or aggregated in ways that reflect ontological frameworks, cultural contexts and political practices (Abbott, 1999; Hamlin, 2000; Linton, 2010). Consequently, the water-quality knowledge of diverse groups should not be taken for granted; differences as well as similarities are worthy of recognition and analysis. As Mistry and Berardi (2016) put it, "all forms of knowledge, including scientific knowledge, are produced by socially situated actors and are value-laden" (1275). Although not often acknowledged, water quality only becomes knowable and governable through social processes operating within specific cultural contexts and political practices that are couched within ontological frameworks.

Water values

Water values link what is known about water (water knowledge) to social processes associated with the determinations of quality and importance. The second question posed in the top realm in Figure 1 is about water values: "what attributes of rivers and lakes do people care about?" As we use the term, water values include what is important to people about water. Nonetheless, many contemporary practices associated with determining the quality of water tend toward the utilitarian, often premised on chemical, physical or biological analyses and classification schemes in which prospective water uses are substituted for water values. For example, Indonesia has drafted a classification scheme in which Class I waters are the least contaminated waters in the country (waters that might be used for drinking), while Class IV waters represent the most contaminated waters (waters that could only be used for irrigation and industry) (UNEP, 2014). Classification schemes such as Indonesia's rely on a limited number of classes of water, each of which is identified by the potential suitability for particular uses and is commonly incorporated into governance schemes. These classification systems are currently being used in Brazil and the United States (US) as well as other parts of the world (Porto and Kelman, 2000; US EPA, 2015). Such modernist classification schemes based on water uses are necessarily generalised, and these generalisations are extended to the waterbodies to which they are applied. Water uses, however, are not the same as water values. Reliance on economic and ecological uses rather than water values that incorporate what people care about confuses purportedly objective water uses with necessarily subjective determinations about what matters to people. Yet substituting water

uses for water values is hardly the only approach. A contemporary example comes from the Maori who value a characteristic called *mauri*, a binding force that connects physical materiality with spiritual being, which they find in varying degrees in different waters (Morgan, 2006).

Objectives and actions

The third question posed in the top realm of Figure 1 is: "What objectives and actions address water quality and improve its governance"? Under many programmes for managing water quality, once waters are classified the next step is to uniformly apply numerical standards. Context is often viewed as irrelevant, although the ability to finance water-quality programmes is frequently a consideration as well. Quality is typically gauged against pre-determined, standardised constituent limits that address specifics about the type and amount of chemical, biological and physical materials dissolved or suspended in a sample of water (often at given points and time periods). Linton (2010) points out that a presumption behind such physical and chemical measures of water quality is the notion that such analyses have the capacity to disclose the full range of distinctions within water quality. Ironically, such constituents are largely conceived in quantitative terms, based on numeric values associated with field data monitoring and laboratory processing, rather than as more nuanced and complex qualitative characteristics as one might expect to see incorporated in determinations of *quality*. Standards for water quality are often premised on available scientific evidence (for example, the results of scientific research on the public health effects of certain levels of nitrate) and on technologies that influence the capacity to define and detect particular constituents (Getches et al., 1991). Scientific legitimacy is promoted when these approaches are projected as objective, precise and rigorous (Mistry and Berardi, 2016).

While public comments are sometimes accepted and in certain cases more participatory approaches are included (see Bunn et al., 2010 for an example from Australia), typically a narrow spectrum of people make decisions about water quality actions – usually scientists and government officials. The rationale is that these individuals have privileged understandings about the sciences, technologies, economics or laws that matter in determining water quality objectives and actions. Yet, by perceiving the water of rivers and lakes only as a physical and chemical solution, defining quality in narrow terms and limiting who makes the determinations, decisions about water values are boiled down to uses of presumed economic importance and limits placed on how and by whom objectives are set or actions taken. Such approaches to water-quality governance simplify different kinds of water, in contrast to valuations, knowledge and classifications that are contextual, complex, contested and/or sometimes ambiguous. Despite the prevalence and perceived legitimacy of these modernist practices, there are other alternatives. We believe that water values, along with water knowledge, have the potential to assume more meaningful roles in water quality and its governance for many different peoples.

We focus on water quality and its governance along with the significance of water knowledge and values for Indigenous peoples in the next section. Centuries of colonisation, economic exploitation of water and national and state governments asserting primacy in jurisdiction over water have weakened water governance by and for Indigenous communities (Berry, 1998; Corpuz, 2006; McGregor, 2012). A crucial facet of marginalisation involves not only limited access to supplies of high-quality water for agriculture, fisheries, environmental sustenance and domestic and traditional uses but also broad-based constraints over governing water (Boelens et al., 2006). Indigenous people have been excluded or discriminated against in many national and local institutions that determine water access, distribution and control, and Indigenous water governance is rarely recognised in national legislation or policies on water (Boelens, 2002; Boelens, 2009; Jackson, 2017). Yet under the conditions of legal

pluralism⁵ that characterise the postcolonial contexts in which many Indigenous communities now live, freshwater resources are often regulated under divergent sets of codes, laws and principles (Norman, 2015; Bavinck and Gupta, 2014). Thus Indigenous communities are frequently involved in water governance through social and legal arrangements consisting of dynamic, communal and internally oriented systems that interact and overlap with other public and private governance regimes.

INDIGENOUS GOVERNANCE OF WATER QUALITY

With an estimated population of 370 million worldwide, Indigenous peoples are culturally diverse yet remain among the most marginalised peoples in the world (World Health Organization, 2007; Pan American Health Organization, 2008). One manifestation of this marginalisation is a distinct disparity in the coverage of drinking water service between Indigenous and non-Indigenous peoples. In a recent review of the literature on Indigenous peoples and water, sanitation and hygiene services, Jimenez et al. (2014) found that higher proportions of Indigenous populations correlated with lower levels of access to water and that barriers to accessing clean water jeopardised the health of Indigenous peoples. Many Indigenous communities and reserves in Canada, for example, have endured the effects of inequities in the coverage of drinking water supplies. One hundred and seventy-seven First Nation communities/reserves in Canada were under a drinking water advisory in August 2015, meaning they were advised not to consume or use water in their households without boiling it first (Perry, 2016). During the decade between 2004 and 2014, over two-thirds of all Canadian Indigenous communities/reserves were on a boil-water advisory at some point. Such is the case of the Anishinaabe of Shoal Lake (Shoal Lake 40), who have been on a boil-water advisory and without a source of potable drinking water for the past two decades as residents of Winnipeg rely on the waters of Shoal Lake for their municipal water supply (Perry, 2016). Drinking water connects Indigenous bodies to infrastructure and governance (Budds and Sultana, 2013). On the one hand, modernist systems of infrastructure and governance may be discriminatory or hostile to Indigenous water rights (or neglect service provision to marginalised Indigenous communities), while on the other hand, Indigenous customary systems of localised governance may conceive of and value water quite differently.

Nonetheless, an increasing number of Indigenous communities around the world have crafted (or re-crafted) approaches to governance to address surface water quality issues more broadly. Contrary to a common assumption underlying national water policies, legislative frameworks and water reform programmes, water management institutions are not exclusively framed and enacted by state or market actors (Boelens and Vos, 2014). Indigenous governance often involves engaging in collective action to develop processes, rules and institutions appropriate for their own community/ies. Indigenous initiatives have gained greater visibility and traction at a variety of scales through actions taken during the past couple of decades (Jackson, 2017; Gupta et al., 2014). Below we draw attention to some recent Indigenous-led initiatives to protect surface water quality, showing the ways in which legal and political avenues were pursued to challenge state and private sector actions jeopardising waterbodies.

In 2011 the United Nations Permanent Forum on Indigenous Issues passed a resolution stating that access to clean water and sanitation should be regarded as a human right (United Nations, 2011). This global standard built on water-related declarations made by Indigenous peoples, such as the Indigenous Peoples' Kyoto Water Declaration (2003) that drew attention to the hegemonic role of scientific knowledge production processes. Viewing such practices as impediments to "the full and equal participation of Indigenous Peoples to share our experiences, knowledges and concerns", it also argued

⁵ Defined by Boelens and Vos (2014) as those contexts where rules and norms of different origin and legitimisation co-exist and interact in the same water territory.

that "the indiscriminate and narrow application of modern scientific tools and technologies has contributed to the loss and degradation of water" (cited in Boelens et al., 2006: 177).

The Yukon River Inter-Tribal Watershed Council, composed of 70 tribes and First Nation communities, is an exemplar of Indigenous-led activity in an international river basin. It has identified water quality concerns and standards for the Yukon River and engaged with the state of Alaska, the Yukon Territory and agencies in the Canadian and US governments to discuss and negotiate the regulation of water quality (Shurts, 2014). Protecting the quality of the river is central to the shared governance objectives of the First Nations of this region to enhance understanding, promote education, foster stewardship, apply standards and develop organisational capacity, all of which are designed to protect the peoples, river and watershed (Norman and Bakker, 2013). Nationally, arrangements in the US under the Clean Water Act acknowledge tribal jurisdiction over water quality and initiated a system designed to support tribal governance of water quality. In 2012 48 US tribes had approved water-quality standards and plans, some of which included protections for ceremonial, religious or cultural water uses (Berry, 2012).

In some situations, Indigenous peoples' pre-existing and adaptive customary systems of water governance may adopt different approaches, employ different structures, involve struggles for recognition or be at odds with the statutory systems of the national or state/provincial governments (Champagne, 2005). For example, in March 2016 Indigenous leaders of the Yinka Dene 'uza'hné of Nadleh Whut'en and Stelat'en communities established their own water policy with the goal of maintaining, protecting and enhancing water quality and flows (Hoekstra, 2016; Yinka Dene 'uza'hné, 2016). In declaring the validity of their laws, the hereditary leaders cited the Canadian Supreme Court's Tsilqot'in Aboriginal rights decision of 2014. This expression of self-determination has the potential to influence water-quality governance in the surrounding province of British Columbia and throughout Canada more broadly.

Numerous studies have focused on the water knowledge and values of Indigenous communities (Boelens et al., 2006; Langton, 2002; Strang, 2013). For instance, it has been noted that Indigenous people often describe water as embodying a life force – as *living water* (Berry, 1997; Toussaint et al., 2005; Weir, 2006). Free-flowing rivers often hold special significance for Indigenous peoples (Anderson and Veilleux, 2016; Jackson, 2006; Tipa, 2009). The Shawi of the Amazon River basin bathe in rivers to gather strength from the water carried down from mountains and from their ancestors (Anderson and Veilleux, 2016). In Australian Indigenous societies taking care of water sites also implies a responsibility to those living downstream because water is part of an interconnected series of surface and subterranean flows that mediates social relationships (Barber and Jackson, 2011). In researching the Anishinaabe, Deborah McGregor found broadly based water knowledge and values, observing that Indigenous people bear the responsibility to care for and sustain the waters upon which they depend for survival and which support the continuation of life (McGregor, 2012).

Yet, despite the attention to water knowledge and water values, until quite recently there has been little scholarly attention or popular media coverage that connects governance of water quality by Indigenous communities with knowledge and values. This has started to change with the advent of recently inspired Indigenous activism to protect water. The Indigenous women's leadership project, for instance, links the knowledge and values of Indigenous women leaders with initiatives to protect water (Ornelas, 2011). Furthermore, the 2016-2017 Indigenous-led movement of water protectors at the Standing Rock Sioux Reservation in the US against the Dakota Access Pipeline (No DAPL) has, among other things, sparked scholarly interest in the significance of Indigenous knowledge in maintaining connectivity within the Missouri River basin (Veilleux, 2017). Our goal in the following section is to demonstrate the relevance of a framework that incorporates knowledge and values with the

governance of water quality of Indigenous communities. We do this by examining the situations within the countries of Australia and Brazil.

WATER-QUALITY GOVERNANCE AND AUSTRALIAN AND BRAZILIAN INDIGENOUS COMMUNITIES

While different in many ways, Australia and Brazil are both globally important democracies with expanding economies. They are both economic powerhouses, in 2013 generating the largest gross domestic products within their respective regions, and the economic exploitation of natural resources has played a key role in each country's development trajectory (United Nations, 2013). Each is also a former colonial country that forcibly dispossessed its Indigenous populations with a settlement and development process that dramatically transformed the land and waterscapes of Indigenous territories, in many places contaminating or degrading them irreparably (Getches, 2010; Jackson and Barber, 2016). As federations, waters in these countries are shared across multiple political jurisdictions; yet Indigenous forms of territorialisation and political representation are rarely taken into account. Nonetheless, there are some cases where water knowledge and values are being articulated and instances where governance by and for Indigenous communities is being re-worked in ways that relate to water quality.

Australia

The Indigenous peoples of Australia have a large stake in water-resource management arising from customary land and resource rights, long traditions of water-resource management and an extensive and growing land base. Following the introduction of statutory mechanisms to restore land to Indigenous peoples in some Australian jurisdictions in the 1970s, and common-law recognition of native title in the 1990s, Indigenous peoples claim ownership rights to a very large proportion of the Australian land mass (Altman and Jackson, 2014). It is estimated that just over 20% of the land mass is held under exclusive possession native title or land rights regimes, while non-exclusive (shared) native title has been recognised over a further 10%. The Indigenous estate is likely to grow as claims work their way through legal processes and new claims are lodged. The law of native title in Australia now commonly recognises Indigenous rights to take and use water for personal, social, domestic and cultural purposes.

Given their substantial land holdings and traditions of environmental management, in the future Indigenous Australians will likely have a stronger role to play in tackling national and global environmental problems and finding solutions in both the Indigenous and public interest (Altman and Jackson, 2014). As Australia moves from an era of ancestral lands being claimed (1970s – 1990s) to the contemporary reoccupation and management of very substantial territories, water issues can be expected to become increasingly important to Indigenous communities who have already established their commitment and ability to contribute to national environmental challenges (Hill et al., 2012; Ens et al., 2012). However, the situated, emplaced nature of Indigenous knowledge, which is sensitive to spatial differentiation in landscapes that are described foremost as cultural, has yet to attract the interest of researchers concerned with water quality (Gratani et al., 2016).

Australia is both an arid country and a continent characterised by highly variable rainfall. It is the driest continent to support a permanent population. Much of the country's interior receives less than 500 mm of rainfall – a low rate that is exacerbated by high rates of evaporation (Godden, 2005). Australia experiences cycles of drought and flooding, and its geographic and seasonal distribution of rainfall is highly variable. Ancient landforms with fragile soil profiles exhibit high levels of salinity, yet groundwater remains a vital source of water for inland uses (Godden, 2005). The significant potential to harm the quality of groundwater with mineral processing agents has generated conflicts, particularly given the large size of the Australian mining sector and the geographic concentration of mineral development activities in remote areas belonging to Indigenous peoples. In terms of surface water,

many of the country's 246 river basins have intermittent, rather than permanent, flow regimes. For much of the settler history of the country the emphasis has been on water-resource development and river regulation. Over the past 100 years water policy in Australia has been shaped by the imperative to supply water for irrigation. Since the 1970s more scrutiny has been applied to irrigation, which remains a major water use, especially in those regions in the southeast where waters had been over-allocated, their quality degraded and some lands rendered saline (Tan and Jackson, 2013). Land degradation process and events, such as sedimentation, algal blooms and nutrient pollution, have also seriously comprised river water quality in parts of southeast Australia.

Indigenous people in the Murray-Darling Basin aspire to a standard of water quality that enables their communities to drink water directly from the river (Weir, 2006). It is both a value for water quality and a standard based on longstanding knowledge that has been applied for thousands of generations, according to Behrendt and Thompson (2006). Differences between Indigenous and non-Indigenous knowledge and values associated with water quality arise from different ontologies of water and different cultural practices. Australian Indigenous ontologies are characterised here by Indigenous geographer Marcia Langton (2002: 43):

Aboriginal waterscapes are construed not only as physical domains, but also as spiritual, social and jural spaces, according to the same fundamental principles as our affiliations to places in the landscapes. The dialogic relationship in indigenous thought between the ancestral past and its effect on human existence derives from the Aboriginal understanding of the transformative powers of the spiritual beings that inhabit those places. Their legacy to us is both the nature of our being and the nature of our relationship to place, be it a waterscape or a landscape.

In relating to a river, wetland, billabong or spring, Indigenous people make a connection between their wellbeing and the perceived health of landscapes and waterbodies. The nexus between human health and landscape health is encapsulated within the popular and persuasive Indigenous expression "healthy country – healthy people". A "healthy, living river" is one that has natural flows and cycles and sustains its human communities; it is, according to Indigenous leader Monica Morgan, "integral to the cultural, social and economic health of Indigenous communities" (Morgan et al., 2004: 14).

Poor water quality, therefore, reflects damaged social relationships in Australian Indigenous ontologies (Muir et al., 2010). As Muir et al. (2010: 259) argue in relation to Indigenous ecological perspectives in the north of the Murray-Darling Basin:

A river is like a mirror: it reflects the care given by people whose lives depend upon it. A scald on red ground or the slow death of a river reveals more than troubled ecological relationships – they are signs of broken social relationships. How people take care of social relationships and how they take care of ecological relationships are the same question.

Similar views hold in the Basin's south, at the mouth of the River Murray, where the Ngarrindjeri nation has advocated for improvements to the environmental condition of their estates in the face of severe depletion upstream to such an extent that it has imperilled their estuary and coastal lagoons with salination, as well as their health:

Too much water has been diverted from the river system and not enough water now reaches the Lakes and Coorong. The quality of the water has also fallen. The water is cloudy, polluted and not fit for drinking. The Murray, the Lakes and the Coorong are no longer environmentally healthy and this is partly why the Ngarrindjeri people are not healthy. The Ngarrindjeri know that the Coorong, Lakes and River are dying (NRWG 1999: 5 as cited in Hemming and Rigney, 2014).

In response, under the umbrella of the Ngarrindjeri Regional Authority, this nation is working towards the co-management of its water and land territories (Hemming and Rigney, 2014). To this end, the Authority has negotiated an agreement with the state government to develop a "cultural knowledge

protection regime" and has built the capacity of its members to engage in water-related research, policy development, planning and management.

The dialectic relationship between health and water, where a value of water quality is as an indicator of societal health and not merely an input or precondition to human survival, is asserted by other Indigenous people, including Phillip Sullivan from the Darling River region:

The environment is a reflection of who we are as human beings, and the environment is in a crappy way. And you know why it's in a crappy way? Because we're in a crappy way. That's the bottom line. The environment is terrible. The river is terrible. The water's still there, but the river's terrible. And it's in a crappy way because we as a people are in a crappy way. And when we get that right, when we get that relationship right, without forcing our issues on each other, I believe that the river will be right (Phillip Sullivan cited in Muir et al., 2010: 262).

Within the same broad region Indigenous groups have expressed concerns about numerous water quality issues. Large dams have been built on almost all the tributary rivers in the Murray-Darling Basin and many of the main rivers are regulated by weirs. In combination, such storage has a number of environmental impacts, including the reduction of water temperatures – a condition referred to as 'thermal pollution' – and the creation of many large still and permanent pools of water in which pest fish and algae can flourish (Behrendt and Thompson, 2006). Weir (2006: 34) describes the effect of the temperature change: "This causes fish kills and yabbies [freshwater crustaceans] to crawl up tree trunks out of the water because they can't live in the river anymore".

With significant changes to the hydrology, pest fish, such as carp, have crowded out the habitat of native Murray cod and have eroded the banks, changing the river's colour and sediment balance. Older traditional owners recall the clearer visual quality of the river before carp were so dominant (Goodall, 2008). Weirs and dams also obstruct the movement of fish and other aquatic life that is highly valued by Indigenous peoples. Morgan et al. (2004: 35) quote an Indigenous elder: "Fish traps are being destroyed due to constant high levels of water, and [we are] not being able to maintain the fish traps as we used to do".

Partly in response to these environmental threats, but less so the despair lying behind them, Australia's system of water governance has slowly been transforming over the past 25 years. Reforms to water governance, particularly to the institutions that allocate water, have focused on the sustainability of water use and water quality improvements. Nonetheless, Indigenous groups were not involved in the national water reform agenda until it had been underway for more than a decade (Tran, 2009; Jackson and Langton, 2012).

Over the past ten years Indigenous peoples have been increasingly active in articulating their knowledge, values and interests in water, while highlighting the difficulties created by inappropriate water developments and management systems. Australia's premier water policy, the National Water Initiative (NWI) (Australian Government, 2004), explicitly recognises Indigenous interests in water, although the rights acknowledged are limited (Tan and Jackson, 2013). In signing up to the NWI in 2004 all Australian jurisdictions agreed that their water access entitlements and planning frameworks would provide for Indigenous access to water resources through planning processes and the inclusion of Indigenous customary, social and spiritual objectives in water plans. Yet, to date, plans have rarely specifically addressed Indigenous requirements. Instead, drought, competition among non-Indigenous water users, and water scarcity have been the key drivers, with little attention paid to Indigenous rights or matters of water quality. Where Indigenous knowledge and values associated with water quality have received attention the focus has been on distribution and access rights (see McAvoy, 2006; O'Donnell, 2013; Jackson and Langton, 2012), reflecting a bifurcation in Australian water governance that treats water quality separately from water quantity.

There has been even less engagement of Indigenous people in Australia's national framework for water quality management, the National Water Quality Management Strategy of 2000 (NWQMS). This

process of water-quality governance is based on national guidelines that are implemented at state, regional and local levels. The NWQMS set water-quality objectives "required to sustain current, or likely future, environmental values [uses] for natural and semi-natural water resources". The environmental values are: the protection of aquatic ecosystems, recreational water quality and aesthetics, primary and secondary contact, visual appreciation, raw water for drinking water supply, agricultural water use and industrial water quality. While there is no specific guidance within the NWQMS for recognising Indigenous cultural knowledge and values (Collings, 2012), the guidelines are currently being revised and these are expected to be considered. Indigenous lawyer Neva Collings (2012) advises Australian water-quality managers to engage in full consultation and cooperation with Indigenous peoples so as to decide how best to account for their values and knowledge within their own governance frameworks. In working towards that goal in a region with a relatively large Aboriginal population, the Wet Tropics of North Queensland, researchers found only three published Australian case studies of freshwater monitoring activities involving Indigenous communities from which to build their efforts (Gratani et al., 2016). The paucity of scholarly work points to a critical need to examine Indigenous water knowledge and values associated with water quality.

Brazil

On 5 November 2015 two dams in the Brazilian state of Minas Gerais failed, releasing the contents of their reservoirs into the Rio Doce – a river central to the livelihoods of the Krenak Indigenous community. The river stretches approximately 850 kilometres through the states of Minas Gerais and Espirito Santo on its way to the Atlantic Ocean. Local riverine communities were exposed to more than water, as the dams were designed to contain tailings ponds loaded with toxic debris from the Samarco Company's mining operation – a subsidiary of the multinational corporation Vale and Australian-owned BHP Billiton. A state of emergency was declared by President Dilma Rousseff, with nine people confirmed dead and at least 19 missing as a consequence of the toxic discharge and associated mudflows. The full scope of long-term consequences is uncertain, but it is clear that more than two decades of social mobilisation focused on bringing people and institutions together around the river to improve water quality (Bueno Guerra and Torres, 2012) was instantly undermined. The cost of the clean-up may exceed US\$ 1 billion and some observers estimate that the ecological recovery of the river will take many years. In the immediate aftermath hundreds of thousands of people along the river's corridor were without drinking water, needing potable water transported to them. Many other residents along the Rio Doce were forced to disperse to neighbouring towns (Saunders et al., 2015; Douglas, 2015). The Krenak community, who had already been forced to live on reserves that were less than one-tenth of the homeland they formerly occupied, were compelled to leave their lands and lives along the river (Stewart, 1994). Along with other Indigenous peoples in Brazil, the Krenak do not have strong control over their resources because federal agencies make many decisions for and about their waters and lands. As the incident in the Rio Doce illustrates, the Krenak, along with many other Indigenous peoples in Brazil, remain vulnerable to the effects of upstream contamination and are challenged by problematic governance structures.

The result of more than 80 years of formal water laws and regulations in Brazil has been to encourage federal, state and, more recently, watershed-level governance but with little recognition of the impacts on Indigenous communities or potential incompatibilities with their governance initiatives, water knowledge or values. Brazil's first water legislation was promulgated in 1934, primarily to regulate economic uses of water and to encourage water for hydropower production, but provisions to control water contamination were never effectively enforced (Porto and Kelman, 2000; Cunha Libanio, 2014). More than 50 years later social demands for greater accountability in water governance resulted in major revisions to the national constitution in which jurisdiction over water-quality management was split between the federal and state governments (Porto and Kelman, 2000; Cunha Libanio, 2014). These changes resulted in waterbodies being classified with different economic uses and priorities, water-

quality standards being designed to accommodate each type of economic use, and state and federal governments granting permits for activities that degrade water quality according to the priority of use. In 1997 new national legislation stressed integrated water-resource management (IWRM) and with this came the development of watershed-level organisations along with additional participatory requirements (Engle et al., 2011; Siegmund-Schultze et al., 2015). In the São Francisco watershed, for example, Indigenous representatives were added to a watershed committee, but they made up less than 5% of the committee and it is not clear that their participation was meaningful, reflected Indigenous governance or communicated their water knowledge and values (Siegmund-Schultze et al., 2015). More recently the National Water Pact was launched as a means to improve cooperation between states and the federal government and to allocate federal funds for water initiatives. By 2014 22 out of 26 states had signed up to the Pact so as to receive federal funding, but Indigenous communities were not included (Cunha Libanio, 2014). In general, Brazilian water management has been guided by the view that water is a resource with economic value, especially for commodity production (Global Water Partnership South America, 2013). Water has been instrumental in a nationalistic drive towards modernity that has privileged economic and political development and, in many instances, contributed to the marginalisation of Indigenous peoples.

While Brazil lays claim to 12% of the world's fresh water, the distribution of water throughout the country is spatially uneven, with nearly 70% of the water in the Amazon Basin where less than 10% of the population lives. But even where there is an abundance of water, safe use can be compromised by contamination. Brazil is no exception as it has a variety of serious water-quality problems (Viega and Magrini, 2013), many of which pose threats to water quality on Indigenous reserves and around Indigenous communities that have long been recognised by United Nations agencies (UN Economic Commission for Latin America & the Caribbean, 1990). Across the country about half the population, including many living in formally recognised Indigenous territories, lack access to sewerage; poor land management, especially deforestation and the resulting soil erosion, has led to intractable water-quality problems (Cunha Libanio, 2014). Indigenous communities are affected when state and local governments, as well as corporations and non-Indigenous settlers, encroach on Indigenous lands and contaminate their waterbodies (Getches, 2010). Such land grabs, along with illegal logging, are common within and around Indigenous reserves and are associated with waste disposal in rivers and the degradation of waterbodies due to the settlers' land-use activities. Another surface water-quality issue is the increasing amount of CECs in Brazilian rivers, including instances of extremely high levels of the pesticide heptachlor. Often used to combat disease in 'public health' programmes, in the case of the Ipojuca River heptachlor was found to exceed the legal limits by over five times during the mid-1990s (Allsopp and Erry, 2007). Residual mercury from former mining is a further water-quality issue affecting some Indigenous reserves (Forline and Assis, 2010).

Despite a recent move toward greater decentralisation in Brazil, Indigenous communities are conspicuously absent from formal systems of water-quality governance, and Indigenous initiatives tend to be constrained by government actions and inaction. Research, institutions, regulations and financing that would assist with water-quality governance for/by Brazilian Indigenous communities have been extremely limited. Moreover, the water knowledge and values of Indigenous communities have generally been ignored by governments, scholars, activists and the media in Brazil. This is not to say that they do not exist but rather that the water knowledge and values of the Indigenous communities are underappreciated in a country where issues linked to land are a priority and where water is perceived as abundant and free for all. There are exceptions, of course. An example of water knowledge that defies simplistic characterisation are rivers identified as either white water or black water, often situated within close proximity to each other within Amazonian Brazil. Distinguished not by specific chemical constituents or physical water-quality parameters, white-water rivers and black-water rivers are known and valued based upon their seasonal fluctuations, productivity and the presence of particular species (Gragson, 1992; Moran, 1993).

Examining history and geography helps to explain how the formal governance structures of the nation and state became associated with the subjugation of Brazilian Indigenous communities. Post-independence Brazil sought "defensive dominion over the prized but 'empty landscape' thus fashion[ing] Native peoples as one of many material resources to be exploited in the interest of technological progress, national security, and economic development" (Devine Guzmán, 2013: 109). A century ago a civil code was enacted that legally established Indigenous men and women as minors under federal government supervision and even to this day federal policies paternalistically classify Indigenous people as 'tutees', who, under the law, are considered to be relatively incapable (Brazil UGPO, 2006; Devine Guzmán, 2013). In the 1940s national policy dialogues identified the 'problems' of Indigenous people, who were viewed as 'needing development', and went further by conflating Indigenous peoples with long-standing battles between Brazilians and the environment (Devine Guzmán, 2013). By the middle of the century the efforts of federal agencies to educate Indigenous peoples were linked to new territorial ideologies that resulted in establishing parks, such as Xingu National Park, which simultaneously contained Indigenous peoples while serving as a strategic military buffer (Devine Guzmán, 2013). At the same time, agriculture, especially the rearing of livestock, was advocated by the federal government as a means to tame the environment and extend settlement, and had a devastating impact on numerous Indigenous communities. Several subsequent legal swings have made matters worse.⁶ In 1973 Brazil's Indian statute reinforced the exclusion of Indigenous peoples from full citizenship. Fifteen years later a constitutional provision weakened institutionalised anti-Indigenous discrimination by recognising that Native peoples could simultaneously be Indigenous and Brazilian. In 1993 it was ruled that Indigenous territories, or reserves, be delineated. Under the revised constitution external entities, such as mining companies, would only be granted use of the water associated with these designated territories following a legislative hearing in which the affected communities participated (Brazil UGPO, 2006). However, this resulted in a decree by the national government in 1996 that delayed the delineation of some Indigenous reserves (Getches, 2010).

As a consequence, Brazil's Indigenous people "struggle against the perception that 'Indianness' is something one must abandon or overcome in order to play a productive role in modern society or deserve the full rights of national belonging" (Devine Guzmán, 2013: 164). This colonialist perspective continues into the 21st century through popular culture as well as in policy and tends to force changes to Indigenous communities' governance, which may also undermine their water knowledge and values. Many Indigenous communities, for example, are being encouraged to form a constitutional style of organisation and decision-making to facilitate external recognition of their jurisdiction and receive support from NGOs and sympathisers (Forline and Assis, 2010). Although a constitutional style of organisation fits better within the mainstream society's political and legal frameworks, and facilitates mechanisms to administer funding and programmes, this can often be challenging for Indigenous communities as it does not fit well into longstanding models of social organisation and political administration, which tend to employ consensus models for internal decision-making (Salazar, 2010). It remains to be seen whether recognition and incorporation of cultural knowledge and values within water-quality governance will become more or less challenging under newer forms of organisation.

In recent decades Indigenous water governance, knowledge and values may be most visible in the opposition to the development of dams for hydropower – now Brazil's primary source of electrical energy (de Sousa Junior and Reid, 2010). For over 30 years Indigenous leaders from the Munduruku, Kayapó and other Indigenous communities have spoken out and organised protests against proposed dam projects and their effects on their communities (Pereira, 1993; Brysk, 2000). Oppositional politics,

⁶ In 1967 the military regime dismantled the SPI (*Serviço de Proteção aos Índios* or the Indian Protection Service) and in its place established the *Fundação Nacional do Índio* or National Foundation for Indigenous People (FUNAI), which today deals directly with Indigenous communities, although in recent years *Fundação Nacional de Saúde* or National Health Foundation (FUNASA) has also dealt with some water-quality issues.

which incorporates cultural dimensions as well as alliances with non-Indigenous people and groups in opposing hydropower development, seems well on its way to becoming a new approach in governance for Indigenous communities in Brazil. Many existing and proposed dams for hydropower generation are in the Amazon region, situated in or around communities with large Indigenous populations and Indigenous reserves. The numerous ramifications of hydropower development include changes to water quality, which are associated with increases in infectious disease, harm to fisheries and even the degradation of culturally significant sites on rivers (Fearnside, 2005; Fearnside, 2015; de Sousa Junior and Reid, 2010). The proposed São Luiz do Tapajós dam and reservoir, for example, would change water conditions and result in the Munduruku people losing a site where they catch an abundance of fish during the *piracema* – an annual mass migration of fish up the tributaries of the Amazon River (Fearnside, 2015). Filling this reservoir would also inundate with water of questionable quality another highly respected site where it is believed an ancestor with supernatural powers, Karosakaybu, created the Tapajó River. Faced with potential losses, Munduruku leaders articulated insights into their water knowledge and values as they voiced their opposition to the proposed project (Fearnside, 2015).

The Indigenous communities' water knowledge and values have proven a strategic asset in their opposition to proposed dam and hydropower projects. In one instance two Kayapó leaders travelled to the US to speak out against dams planned for the Xingu River in the late 1980s. The leaders complained to World Bank officials that they had not been sufficiently consulted and that, among other things, their water knowledge and values were being ignored. The leaders convinced the World Bank to suspend loan payments to the Brazilian government for these dams (Forline and Assis, 2010). Although the leaders ultimately only succeeded in delaying the plans, their actions managed to bring about a slight shift in the framework surrounding water governance. Questions were raised about legitimate participatory governance and how to recognise and address the water knowledge and values of these Kayapó leaders and other Indigenous people within the larger social context in Brazil where Indigenousness has long been disparaged. More recently the Belo Monte dam project, which is expected to affect water quality due to a shift to a lentic environment with less oxygen (de Sousa Junior and Reid, 2010; Hall and Branford, 2012), has elicited over three decades of opposition from many Indigenous leaders. The project not only jeopardised their communities but was seen as emblematic of what had gone wrong with the federal policies towards Indigenous people (Hall and Branford, 2012; Devine Guzmán, 2013). In 2010 the populist president Lula da Silva promised to listen. On hearing of the water knowledge and values of the Indigenous people concerned about the project, he stated that "no one cares more about taking care of the Amazon and our Indians than we do". However, he simultaneously argued forcefully for the viability of the Belo Monte dam and denied the potential for negative effects (quoted in Devine Guzmán 2013: 185).⁷ Participatory forums were arranged but turned out to be largely perfunctory. Indigenous leaders were excluded from meaningful dialogue about the proposals and were unable to share or act upon their water knowledge or values in ways that would support water quality and their own governance (Forline and Assis, 2010). The dam's inauguration in May 2016 was a significant blow for the Indigenous leaders and communities who opposed the Belo Monte project.

Indigenous opposition to proposed dams in Brazil has not been limited to concerns about water quality. Water-quality issues associated with major dam proposals have often been overlooked or subsumed into land issues that take centre stage – not only by government officials but even by non-Indigenous activists, scholars and media working in support of Indigenous communities. This could be attributed to non-Indigenous people failing to appreciate the water knowledge and values of the

⁷ Lula da Silva's administration was not alone in adopting such tactics, in characterising Indigenous and other opponents of the Belo Monte project as obstructionist or in steamrolling proposed hydropower projects. For more about the approach taken by Dilma Rousseff's as well as earlier administrations, see Hall and Branford (2012).

Indigenous communities they work with, to a lack of attention to water-quality governance by/for Indigenous communities and/or not recognising the connections between water quality and governance and water knowledge and values, as we suggest in our framework. Thus, in the case of the opposition to the Belo Monte project, although the water knowledge and values of Indigenous peoples were not heard or taken seriously, the fact of speaking out against the negative effects of dams and hydropower projects raised significant issues around water quality. As such, we suggest that Indigenous protests against Brazilian hydropower development may be seen as an emerging form of governance – one which raises questions as to who should have a voice in the decision-making surrounding developments that would alter water quality and how to appropriately address Indigenous water knowledge and values.

CONCLUSIONS

Given that water quality and governance are coupled we address them jointly in this article. We argue that water quality and its governance are not only influenced by natural and human processes (such as evaporation, wind deposition, erosion, weathering, runoff, infiltration, biotic interactions, human habitation, land-use activities and anthropogenic contamination) or human institutions and systems (such as science, technology, economics and law) but, equally, that these are connected to water knowledge and values (such as what is known about the attributes of water, which attributes people care about and what objectives and actions address water quality and improve its governance). Water quality becomes knowable, valuable and governable through social processes operating within specific cultural contexts and political practices, which are couched within distinct ontological frameworks. As such, water knowledge and values vary between peoples and across space and time and thus should not be presumed to be consistent or constant.

We have chosen to focus on water quality and governance as they relate to Indigenous communities, particularly in Australia and Brazil. Knowledge and values generated within Indigenous communities, which tend to be holistic rather than reductive, have the potential to make important contributions to governance (Brondizio and Le Tourneau, 2016; Mistry and Berardi, 2016), especially that of water quality. Incorporating such perspectives is not an insignificant undertaking, given the divergence between systems that explicitly recognise water knowledge and values and those that do not:

A major reason for the limited engagement with indigenous knowledge is the persistence of epistemological differences, and the associated politics of representation, within the social and governance context. Local ecological knowledge is seen as subjective, arbitrary, and based on qualitative observations of phenomena and change. Scientific knowledge, by contrast, is viewed as objective and rigorous, with precise measuring and empirical testing of events and trends confirming credibility and legitimacy (Mistry and Berardi, 2016: 1275).

Notwithstanding the enormous obstacles, water quality and its governance are being reworked by Indigenous peoples. In Australia changes made to national laws in recent decades recognise Indigenous rights to use water. While frequently ignored or rebuffed in past dealings with federal or state agencies about water and water quality, Indigenous communities are now better positioned both to respond to Australian national, state and local government water initiatives and to develop their own strategies for governing water quality. In Brazil a long history of paternalism and exploitation of Indigenous people, in combination with the federal government's aspiration for growth, development and geopolitical recognition, has led to the contamination of rivers and lakes associated with Indigenous communities and their reserves that has mostly gone unchecked. With the proliferation of major dam proposals in Brazil, new formulations of water governance are emerging as Indigenous leaders actively oppose proposed reservoir development that would degrade water quality along with many other negative effects on their communities. Such restructured water governance pivots around strategic alliances and

protests against government decision-making, occasionally in international venues. In both Australia and Brazil Indigenous governance initiatives must attend to the existing formal institutions and systems adopted by federal and state governments, as well as the cumulative effect of natural and human processes that contribute to the degradation of water.

We illustrate the connections between water knowledge and values and water quality and its governance by Indigenous communities in Australia and Brazil. For many Indigenous people in Australia their water knowledge and values serve both as a motive for contributing to more effective governance and as an indicator of good governance. For example, in some Australian Indigenous communities being able to drink directly from a river is an important water value but it is also known to be an indicator of social wellbeing, with poor water quality understood to represent damaged social relationships. For their part, many Brazilian Indigenous leaders have tried to have their water knowledge and values taken seriously and addressed by the state through a different approach to governance, oppositional politics and alliances. The examples from Australia and Brazil suggest some ways in which water knowledge and values can be central to making sense of water quality and its governance, particularly for Indigenous communities.

In closing we want to emphasise that there has been little recognition of or scholarly research into the significance of the knowledge and values of Indigenous communities with respect to water quality. More work is needed, and we hope that our framework (as shown in Figure 1) may prove useful in this regard. The framework additionally suggests ways to reconceptualise water quality and its governance more broadly by elevating the importance of social, cultural and political processes for non-Indigenous communities.

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