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Global climate change and global groundwater law: their independent and pluralistic evolution and potential challenges

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ABSTRACT

Although the climate and groundwater systems have close links, the international climate change regime and global groundwater laws have developed independently, despite being negotiated within a few years of each other. Hence this article addresses the question: Do global legal instruments on climate change and groundwater consider the geophysical links between the two systems, and how can their legal frameworks be improved? It argues that there are six geophysical links between groundwater and climate change which are presently inadequately accounted for in the legal regimes and there are four key contradictions between the two legal systems. It makes four recommendations to enhance the linkages between the systems.

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Groundwater governance; climate change governance; legal pluralism; politics of scale

Introduction

Climate change and groundwater problems are closely linked (Bates, Kundzewicz, Wu, & Palutikof, 2008; Jiménez Cisneros et al., 2014), but their international governance has evolved independently. It is then natural to ask: Do global legal instruments on climate change and groundwater consider the geophysical links between climate change and groundwater, and how can their legal frameworks be improved? To address this question, this article (a) analyzes the literature on geophysical and related aspects of climate change and groundwater; (b) undertakes a content analysis of the relevant global laws; and (c) uses legal pluralist, politics of scale and hydro-hegemony theories.

The article focuses on groundwater rather than freshwater for two reasons. First, groundwater is 97% of available freshwater (Margat & van der Gun, 2013), which itself is a small percentage of total water. The volume of groundwater recharged is thrice that of total surface water flows over the last 50 years (Gleeson, Befus, Jasechko, Luijendijk, & Cardenas, 2015), and its abstraction is rising by 3% annually (Wada, Wisser, & Bierkens, 2013). In 2010, it provided 50% of potable water (Margat & van der Gun, 2013) and 40% of irrigation needs (Döll et al., 2012; Siebert et al., 2010). Second, there is a tendency for

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governance to focus only on fresh surface water and incidentally on groundwater. Specifically referring to groundwater may make the 'invisible' more 'visible'.

The analysis uses legal pluralism, the politics of scale and hydro-hegemony theories. *Legal pluralism* (Von Benda Beckmann, 2001) refers to different rules emerging from (in) formal actors at varying governance levels applying to the same jurisdiction (Zips & Weilenmann, 2011). This can lead to contradictions, when multiple systems coexist, or fragmentation, when it evolves in a bottom-up manner or because top-down consensus reaches an impasse (Koskenniemi & Leino, 2002; Tamanaha, 2008). A *politics of scale* lens helps examine why states may or may not scale up an issue and its sub-parts to the global level (Gupta, 2008), while *hydro-hegemony* scholars further explain why and how powerful states use their power to control the shape of water agreements, their interpretations and their ratification (Mirumachi, 2015; Nicol & Cascão, 2011; Zeitoun & Allan, 2008).

This article first examines the physical relationship between climate change and groundwater, then their governance and their normative and political contradictions, before drawing conclusions and offering recommendations.

Physical relationship between climate change and groundwater

Climate change drives changes in the hydrological cycle and is exacerbated by how groundwater is used. Further, these relationships exist in complex self-reinforcing ways at multiple levels.

Climate change affects the hydrological cycle and its management

Climate change affects the hydrological cycle through greater evaporation, sea-level rise, melting glaciers and ice caps, changing rainfall patterns, and extreme weather events (Bates et al., 2008). The impacts on groundwater quantity and quality are uncertain because of the multiple feedback effects (Jiménez Cisneros et al., 2014) – depending on the magnitude, intensity, seasonality, frequency and location of precipitation, types of ground cover, existing soil moisture, and geological setting, combined with physical and human interference in water flows – affecting groundwater recharge. Thus, greater rainfall does not necessarily increase recharge. Sea-level rise can influence groundwater quality through saltwater intrusion (Nicholls & Cazenave, 2010). Changes in groundwater levels and recharge mechanisms can mobilize new contaminants from the (sub)surface and release them into aquifers (Green et al., 2011). Furthermore, climate change will affect hydropower, flood defences, irrigation and water supply systems (Bates et al., 2008).

Groundwater use can exacerbate climate change

Groundwater use can also exacerbate climate change. First, energy production and land-use changes emit greenhouse gases (GHGs) and use water. Firewood uses the most water, followed by hydropower, nuclear, oil, coal and lignite, geothermal, natural gas and solar, with wind energy's footprint being marginal (Mekonnen, Gerbens-Leenes, & Hoekstra, 2015). Land-use change through deforestation and draining of wetlands can simultaneously emit GHGs and affect groundwater. Second, the water sector uses energy (e.g., 20–30% in California); groundwater pumping, long-distance transfers, and desalination use mostly fossil-fuel energy (Hanak & Lund, 2012). Third, when

groundwater is pumped and discharged from non-recharging aquifers, it eventually contributes to sea-level rise – possibly about 0.25 mm between 1990 and 2000, and potentially 0.87 mm by 2050 (Wada et al., 2012).

Groundwater and climate change at multiple geographic levels

The climate and hydrological systems are global, with effects that manifest or are reinforced locally; their mutual relationship is influenced by geography, geomorphology, and policies and practices at multiple governance levels. At the regional level, the Sahel, Siberia and the western US may have more groundwater recharge, while southwest Africa and southern Europe may have less (IPCC, 2007). Water stress could increase in West and South Asia (especially India), Southern and North Africa, Central America, and much of Europe. Under all climate scenarios, all regions will lose groundwater resources, except North Africa because of the great depth to groundwater there (Ranjan, Kazama, & Sawamoto, 2006).

At the national level, groundwater-dependent countries such as the US, India, Australia and several West Asian and African countries use managed aquifer recharge techniques to store excess surface water or treated wastewater. This capitalizes on groundwater's buffering capacity, increases reliability of supplies, and combats contamination (Margat & van der Gun, 2013). Small island states may be flooded by sea-level rise, while saltwater may enter groundwater in low-lying coastal areas (Treidel, Martin-Bordes, & Gurdak, 2011). At the local level, differentiating between management- and/or climate-induced impacts is important for appropriate adaptation responses (Heuvelmans, Louwyck, & Lermytte, 2011).

Inferences

Table 1 sums up the above key links between climate change and groundwater and their implications for governance.

Relationship between climate change and groundwater governance

This section examines the global co-evolution of climate change and groundwater law (Figure 1) in terms of history, architecture, goals and process.

Climate law history and integration of water issues

Climate change entered the global scientific agenda in 1979 and the global political agenda in 1989. Governance responded to a science-driven process. Within two years the United Nations Framework Convention on Climate Change (UNFCCC, 1992) was adopted; it is now universally adopted and in force. Thus, global climate policy preceded and shaped national climate policy (Bodansky, 1993; Gupta, 2014a). Global climate governance occurs under the Climate Convention, its annual Conference of the Parties, and its decisions (i.e., the climate governance regime), the most prominent of which are the Kyoto Protocol of 1997 (in force), with emission targets for developed countries for 2008–2012, the Doha Amendment of 2012 (not yet in force), with targets

Table 1. Implications of the links between climate change and groundwater for law.

Systems	Issues	Implications for law
Climate change impact on groundwater	Quantity of recharge and impact on flows	Needs to create adaptive policies accounting for climate change's influence on flows and recharge patterns; revise spatial planning to maximize recharge; use groundwater as a buffer; enhance transboundary governance arrangements
	Inundation, saltwater intrusion, and indirect impacts on water quality through impacts on quantity	Needs to link with coastal defence and agricultural policy to manage and reduce saltwater intrusion; needs to anticipate other quality impacts and take action accordingly
	Intensity and frequency of extreme weather events	Needs to link up with disaster risk reduction policy at the global level and integrate into drought and flood strategies using groundwater as a buffer
Groundwater impact on climate change	Energy use in water extraction and use	Needs to make policies to reduce the energy intensity of water uses
	Extraction leading to sea-level rise and changes in groundwater quality	Needs to ensure that policy keeps groundwater recharge in line with extraction to maintain water quality and quantity
	Water dependency of energy production	Climate and groundwater law needs to ensure water accounting in energy policy

for developed countries for 2012–2020, and the Paris Agreement of 2015 (in force), with bottom-up targets for all countries which need to be ratcheted up every five years. Desertification was left to the Convention to Combat Desertification (UNCCD, 1994), and deforestation only became part of the climate negotiation process after 2005. The

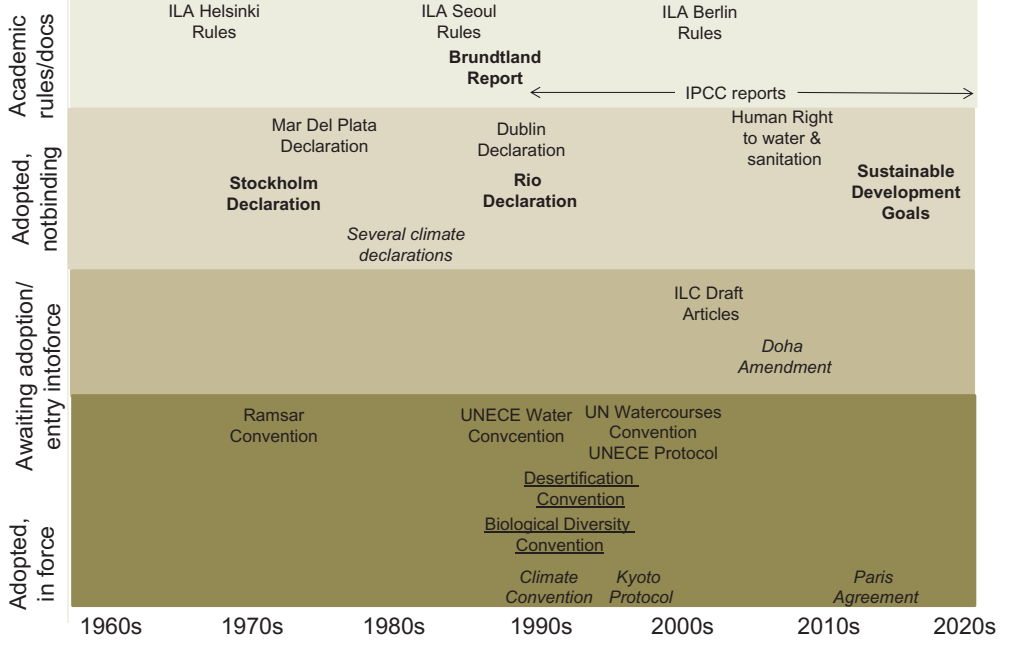

Figure 1. The evolution of climate change and groundwater-related agreements at the global level (normal text represents agreements on water; italic, climate change; underlined, environment; bold, environment and development).

climate regime includes measures on energy, but scarcely mentions water governance regimes despite the contemporaneous adoption of the regional United Nations Economic Commission for Europe (UNECE) Water Convention in 1992 and the UN Watercourses Convention (UNWC, 1997) in 1997. But since 2003, there has been heavy lobbying to include water issues more explicitly, given the clear physical linkages between the two (Gupta, 2014a).

The climate regime aims to stabilize atmospheric GHG concentrations so that they correspond to an average global temperature that is no more than 1.5–2 °C above pre-industrial levels and thereby implicitly aims to reduce the impacts on the global water system. It includes targets, policies and measures that emerge from the principles under the Climate Convention (see below). Countries prepare relevant national policies consistent with their obligations under the convention, which they report on in their National Communications. However, they focus on energy rather than water policies. Although the climate regime is perhaps one of the most centralized, especially in comparison to the energy or water governance arenas, some scholars have described it as fragmented (Van Asselt, 2014).

The climate regime is dynamic, with five bodies, annually recurring meetings, a strong secretariat and ever-evolving institutions engaging the market and funding mechanisms (Gupta, 2014a). It is actively supported by science from the Intergovernmental Panel on Climate Change (IPCC), within which the legal epistemic community plays a minor role.

Water law and integration of climate change issues

Unlike climate change, water law has developed over centuries through customary rules, religious rules institutionalized in domestic legal systems, which were then exported through conquests and colonization processes and subsequently increasingly affected by the growing number of bilateral and multilateral water agreements on transboundary waters, jurisprudence, and global discourses over communism, environmentalism and neoliberal capitalism (Caponera, 1992; Dellapenna & Gupta, 2009). There has been a continuous interplay between the various levels of water governance, but it has always been an area of heavy politics, as those who controlled water controlled power. At the global level, water law was influenced by the International Law Association's (ILA) Helsinki Rules on the Uses of the Waters of International Rivers (International Law Association [ILA], 1966) and its Seoul Rules on International Groundwaters (ILA, 1986); the Ramsar Convention (1971) on Governing Wetlands of International Importance (hard law, universally binding); the UNECE (1992) Water Convention (hard law, now global, 38 parties) and its follow-up Protocols; the UN Convention on the Non-navigational Uses of International Watercourses (UNWC, 1997 – hard law, legally binding, 35 parties); the United Nations Millennium Declaration (United Nations General Assembly [UNGA], 2000), with its water targets (soft law, but actively implemented); the ILA's Berlin Rules (ILA, 2004 – academic codification of customary law); the ILC Draft Articles on the Law of Transboundary Aquifers (ILC, 2008; UNGA, 2008), the UN General Assembly and UN Human Rights Committee Resolutions on the Human Right to Water and Sanitation (UNGA, 2010; UNHRC, 2010 – soft law, now possibly customary law); and the Sustainable

Development Goals (UNGA, 2015 – soft law) (Conti & Gupta, 2015). Most of these dealt more with surface water than with groundwater and did not deal with climate impacts. The Draft Articles appear to have reached an impasse in the General Assembly as governments do not feel they have sufficient knowledge regarding transboundary aquifers to determine their final legal form (Eckstein & Sindico, 2014) and because the International Law Commission's substantive work and its role in promoting consensus is falling short of what is needed (Stoa, 2014). Further, these texts include groundwater in their scopes to varying degrees, and the in-force UNWC does not include all types of transboundary aquifers.

The legally binding agreements focus on transboundary water governance issues and domestic water issues when they are of international importance. The human rights documents focus on domestic access to water and sanitation services. The Berlin Rules and the Sustainable Development Goals draw on human rights and other bodies of international law to go beyond transboundary issues to also address issues that fall within domestic purview. However, none of these governance texts deal with climate-proofing water governance from a mitigation or an adaptation perspective. The Sustainable Development Goals do make an effort in this direction in that they require that the indivisible Goals are dealt with in an integrated and interrelated manner. Indirectly, other international treaties also discuss various aspects of groundwater governance – such as the Desertification and Biodiversity Conventions.

The UNWC is a static, one-time agreement without operational bodies such as a secretariat. It cannot continuously amend itself based on new scientific knowledge or legal progress. Although the now-global UNECE Water Convention and its secretariat could perhaps step into the breach, this may be less legitimate since non-UNECE countries' inputs did not shape the text. In fact, water governance is undertaken by many UN and non-UN bodies (Pahl-Wostl, Gupta, & Petry, 2008) and loosely coordinated by UN-Water (Baumgartner & Pahl-Wostl, 2013). Further, water policy and law are strongly influenced by epistemic and professional communities, such as the International Law Association and the World Water Council, and development banks, who have their own investment approaches for water.

Inferences

This section has shown that international climate and water laws have been independently negotiated and have not built on each other or the substantive relationship between the issues they deal with. While climate law regulates GHG emissions and thereby implicitly the impact on the global water system, water law does not explicitly consider the energy use of water or the way water may influence GHGs. Climate change has only recently been included in groundwater law through managed aquifer recharge provisions; other issues have scarcely been taken up.

There are also major architectural differences between the regimes. While the climate regime has global scope, because the Climate Convention and the Kyoto Protocol have near-universal ratification and the Paris Agreement has entered into force, the water agreements (barring Ramsar) have been ratified by less than a quarter of UN member states. While the Climate Convention is a framework allowing for dynamic evolution within its various bodies, the water conventions have patchy coverage, and the UNWC is

a static law. While climate law explicitly focuses on both inter-state and domestic responsibilities, international water law is dispersed in different regulations, focusing on transboundary responsibilities, wetlands of global importance, and meeting the human right to water and sanitation, and is indirectly influenced by treaties on desertification and biodiversity. Climate law is internally consistent across levels, since countries are implementing it, although in a common but differentiated manner which is increasingly taking on a bottom-up approach, as in the Paris Agreement. However, the global groundwater laws are inconsistent horizontally and vertically at the different levels, creating plural approaches to water governance, which have been extensively discussed in other papers (Conti & Gupta, 2014; Gupta, Hildering, & Misiedjan, 2014; Obani & Gupta, 2014).

Key discursive, normative, substantive and political challenges

Introduction

This section compares the global climate and transboundary water law regimes in terms of discursive, normative, substantive and political challenges.

Discursive, normative and substantive challenges

We first discuss the 'global' nature of the two issue areas. Climate change was framed as a global issue from the start and has evolved into a globally steered multilevel regime. But historically, water was seen as a local issue, then as a national issue, later a transboundary issue, and only more recently as a global issue. While countries appear willing to discuss transboundary aspects, neither of the treaties on transboundary sharing have been ratified by more than a quarter of the world, and those ratifying are mostly downstream or European countries. While academic and policy documents increasingly treat water as a global concern, some countries are reluctant to deal with water as part of a global-level cycle, to address the physical differences between groundwater and surface water resources, and to regulate it in accordance with some globally decided principles. However, their universal acceptance of the Ramsar, Desertification and Biodiversity Conventions implies that they need to address water issues in the context of these treaties.

If climate change is a globally steered multilevel issue, and affects water, then why did water not get as much attention within climate change? This is because while mitigation was framed as a global challenge, adaptation (which is more closely related to water) was defined as a local challenge in the Climate Convention (Bodansky, 1993). This was done to reduce rich countries' liabilities in relation to adaptation (Gupta, 2014a), and water users and the perceived impacts of use are primarily local (Alston & Whittenbury, 2011). This arguably led to water's receiving significantly less attention within the climate change regime and groundwater receiving only a small share of the attention within that.

Furthermore, while most discourses view climate change as a common concern of humanity, groundwater is usually seen as a shared resource by lawyers, as an economic good by development banks and policy makers (International Conference on Water and the Environment, 1992), as a human right by the human rights community (UNGA, 2010), as a gift from God in Islam, and as a heritage by the European Water Framework

Directive. These discursive differences underlie diverging approaches to water governance.

While the Climate Convention only explicitly mentions sovereignty in its preamble, international customary water law has been largely structured around sovereign rights. This has changed, as the UNECE Water Convention makes no mention of sovereignty and the UNWC recognizes only sovereign equality and territorial integrity of states, i.e., that downstream states have the right to receive the waters they have always received in the past. However, the Draft Articles explicitly recognize sovereignty over transboundary aquifers and aquifer systems, subject to the principles of cooperation, equitable and reasonable use, and not causing significant transboundary harm (Eckstein, 2007; Sindico, 2011; Stephan, 2011). There is thus concern that the draft rules signal a return to sovereignty (McCaffrey, 2011, 2013; McIntyre, 2011; Stoa, 2014).

The Climate Convention addresses equity through the principle of 'common but differentiated responsibilities and respective capabilities', which requires all parties to take responsibility relative to their different GHG emissions and their different capabilities in reducing them. It gives special attention to especially vulnerable countries. In contrast, the UNECE, UNWC, and the Draft Articles include the principle of equitable and reasonable use; the latter two elaborate on factors and weights to determine countries' share of water. However, the UNWC explicitly denies that any use of water has greater priority than any other. The Draft Articles do not explicitly negate priority of use. Both give special regard to vital human needs. The UNECE does not elaborate any priorities or factors.

Regarding the environment, the Climate Convention adopts the precautionary principle, which paved the way for the long-term objective under the Paris Agreement. The UNECE Convention includes the precautionary principle, best available technologies and environmental impact assessment in a transboundary context. The Watercourses Convention does not adopt the precautionary principle but has rules on protecting and preserving water ecosystems, controlling pollution, preventing the introduction of alien species, and protecting the transboundary marine environment. The Draft Articles protect groundwater recharge and discharge zones.

The Climate Convention amends the UNGA Declaration on the Right to Development into a right to and responsibility for promoting sustainable development; the Water Treaties do not refer to development. With respect to international trade, the UNFCCC explicitly allows an open international economic system. The UNWC and UNECE Convention do not do so, but clearly function within the context of global trade and investment and thus operate *de facto* within such a system.

Why are there such differences?

There are clear discursive, normative and substantive differences within and between the legal regimes. This occurs partly as a result of the historical evolutionary processes and the interactions between actors, including scientific actors, engaged in them. But it also occurs because of the politics of scale. States may scale up issues to the global level (1) to enhance problem understanding (i.e., the nature of the global system, the indirect causes of the problem, the global thresholds and impacts, the underlying discourses); (2) to enhance policy effectiveness (i.e., to determine international responsibility, protect the common good, mobilize the international community); (3) to serve domestic interests (i.e., avoid

domestic measures); or (4) for strategic extra-territorial reasons (i.e., access resources or create markets, control resources, bypass an agency) – see Table 2.

However, countries may also scale down issues, (1) to enhance problem understanding (especially the link to local perceptions, factors, impacts and context); (2) to enhance policy effectiveness (i.e., to mobilize local people); (3) to serve domestic interests (i.e., to protect national security, manage without interference, avoid international liability or pressure); and/or (4) for strategic extra-territorial interests (i.e., to divide and control/include or exclude, to avoid losing control over natural resources, to bypass another country's agency) – see Table 3.

We support the arguments for taking a multiscalar approach to climate and water which call for coherent global-to-local institutionalized approaches that continuously feed each other (Gupta & Pahl-Wostl, 2013; Pahl-Wostl et al., 2008; Vörösmarty, Hoekstra, Bunn, Conway, & Gupta, 2015). However, many powerful states behave as hegemons on transboundary water issues, prioritizing their own narrowly defined national water interests in transboundary agreements (Zeitoun & Allan, 2008; Mirumachi, 2015; Nicol & Cascão, 2011; cf. Pahl-Wostl, Gupta, & Bhaduri, 2016). This, in addition to the inherent weaknesses of the conventions (Stoa, 2014), explains countries' reluctance to ratify the UNWC (Gupta, 2016) and come to agreement on the legal form of the Draft Articles, which both push for equitable sharing rather than unilateral power politics.

Do such differences matter?

We identify thus four contradictions. (1) The links between climate change and groundwater, although academically explored (see point 2, Table 1) have yet to be incorporated substantively in either regime, and both ignore each other (see point 3). (2) The two problems are framed differently in terms of the administrative level at which they should be addressed and in terms of whether they are seen as public or private goods, and affecting human rights or property rights. Maintaining a stable climate is an issue of global concern requiring multilevel action. While there is increasing recognition of the need to address groundwater as a global concern, groundwater tends (more than other freshwater) to be seen as a local, national, or transboundary, but not global, issue. While a stable climate is generally seen as a public good, maintaining the hydrological cycle or preventing excessive discharge from non-recharging aquifers that could contribute to sea-level rise is not yet defined as a public good. Both areas are also affected by the growing neoliberal capitalist approaches that allow the privatization of and trade in water resources and carbon credits (Bernasconi-Osterwalder & Brown Weiss, 2005; Klijn, Gupta, & Nijboer, 2009). (3) There are also key differences in the way sovereignty – the right to sustainable development, equity, and environmental harm – is dealt with. (4) Finally, there are significant differences in procedures and subsidiary bodies, as well as the incorporation of scientific knowledge, making it challenging to develop good links.

Still, a key question is, do such differences matter? In the context of the Anthropocene, it is increasingly important to also have a global perspective on climate change and water problems, not least because of the reasons listed in Table 2. Both a stable climate and a

Table 2. Reasons for scaling up climate change and groundwater.

	Argument	Climate	Groundwater
1	Global systemic links	A global climate system linked to the hydrological system	A global water cycle, including non-recharging aquifers, linked to the climate system
	Indirect causes/drivers	Production, consumption, deforestation, water use	Production, consumption, trade, investment, climate change
	Global impacts and thresholds	Climate change; 1.5–2 °C threshold	SDG targets/indicators; indirect targets from climate, biodiversity, transboundary wetlands (Ramsar)
	Level playing field	Through common principles, targets, policies and standards	
	Increase negotiating space	E.g., link climate to other global issues	E.g., link groundwater to other issues
	Global discourses	Climate as common concern within neoliberal, anarchic global order prioritizing sovereignty; SDGs	Water as commodity, human right/security within a neoliberal global order prioritizing sovereignty; SDGs
2	Determine international responsibilities	Common but differentiated responsibilities and respective capabilities principle; right to sustainable development; protection of vulnerable countries	Equity principles for water sharing, including for non-recharging aquifers; no-harm principle; quality protection; data sharing
	Protect the common good	Prevent dangerous climate change; protect stable climate	Protect the functioning of the global water system; address nexus with other issues
	Mobilize international community	International climate industry, NGOs, civil society, UNFCCC; int'l financial institutions?	International water industry, traders, NGOs, civil society, UN agencies; int'l financial institutions?
3	Avoid unilateral domestic measures	E.g., through conditionalities in Doha and Paris targets	E.g., on water supply and sanitation by calling on international support
4	Access resources, create markets	E.g., emission credits through the Clean Development Mechanism / emissions trading	E.g., water through allowing land purchase/grabbing that includes groundwater rights or through public–private partnerships
	Control resources	E.g., energy policies of other countries	E.g., groundwater management by other countries
	Avoid bilateral policy influence	E.g., through transnational networks	E.g., through aid agencies

Adapted from Gupta and Pahl-Wostl (2013), Gupta (2014b).

healthy hydrological system should be viewed as global-to-local public goods for which states need to be held responsible, individually and collectively (cf. Kaul, Conceicao, Le Goulven, & Mendoza, 2003). Second, there are clear links between climate change and groundwater, and if the groundwater-related regimes do not actively explore the options for climate-proofing their policies and activities, the latter will be out of date and ineffective (Heather & Gleick, 2011). Third, there is a need to revisit the notion of sovereignty: transboundary and global challenges call for limiting absolute territorial sovereignty by requiring states to share resources, to limit transboundary harm and to equitably share related responsibilities. However, the ILC Draft Articles and their return to sovereignty may once more legitimize the politics of downscaling issues and taking a nationalistic, securitization perspective that goes against an understanding of the nature of the water and climate system. The differences in process and how groundwater is included in the scopes of the agreements makes it very difficult to build bridges between the governance frameworks for the two issue areas because there is no clear focal point in the water world except perhaps the coordination role of UN-Water.

Table 3. Reasons for down-scaling climate change and groundwater.

	Arguments	Climate change	Groundwater
1	Local system links	Downscaled models relevant for local adaptation	Aquifer or sub-aquifer level is most important
	Local driving factors	Differ in each context	
	Local impacts/thresholds	Local impacts and thresholds need identification	Aquifer or sub-aquifer needs and standards critical
	Local frames	Subsidiarity, decentralization	Subsidiarity, decentralization
2	Protect local communities	Need for local vision	Need for watershed vision, community-based orgs.
	Avoid int'l responsibilities	To avoid reducing emissions or pay for impacts elsewhere	To avoid sharing water and paying for harm caused
	Mobilize local people	Mobilize local people to reduce emissions and adapt	Mobilize local people to conserve groundwater, pollute less, and adapt
3	Protect national interests without interference	Protect oil export/use interests, national energy security	Protect 'national' water interests
	Avoid int'l liability	For causing transboundary harm	
	Avoid collective pressure	E.g., to implement targets	E.g., to change behaviour or share data
	Use of comparative advantages	E.g., in exporting products using local technologies	E.g., on managing groundwater; in trading products using groundwater
4	To divide and control or include and exclude	Disengaging from Kyoto Protocol allowed US to explore bi/multilateral relations	Disengaging from treaties allows non-parties to follow selective cooperative/hydro-hegemonic strategies
	To bypass an agency	Allows some to bypass UNFCCC	Allows aid agencies and industry to market ideologies (e.g., privatization, cost recovery) without global consensus

Adapted from Gupta and Pahl-Wostl (2013), Gupta (2014b).

Another key point is that even though water law does not talk about the value of water, the banks and policy processes have framed water as an economic good, leading to its privatization, hoarding and trading. Groundwater law has yet to deal with whether privatization is compatible with an understanding of the hydrological system or with the notion of water as a human right. If climate change massively influences the distribution of water, then, indirectly, the rules regarding water access and ownership may further exacerbate the negative impacts of climate change on humans.

Conclusion

This article has examined the relationship between international laws on climate change and groundwater and identified four contradictions: (1) lack of links between the agreements, despite the close substantive relationship between climate change and water; (2) differences in framing the climate and water problem; (3) differences in key norms; and (4) differences in process. Such contradictions arise through historical evolution shaped by the politics of scale, the way hegemons try to shape institutions, and how institutions subsequently restrain hegemonic activity. Countries that wish to focus on national short-term development interests may decide to ignore global rules on climate and water.

We now consider how these challenges can be addressed. First, we recommend collaboration between the IPCC, the World Water Development Reports, the International Law Association and the Global Environmental Outlook to improve understanding of climate, water and related law. Such collaboration should complement

the existing IPCC Report on Climate and Water (Bates et al., 2008), which does not discuss the water and climate governance regimes. Second, we recommend using the IPCC's relationship with the Climate Regime to formally integrate the water dimension into the climate change treaty process, building on the ideas in Table 1 and making barriers to sea-level rise, promoting spatial design that encourages groundwater recharge, promoting managed aquifer recharge and geothermal techniques, wet-proofing (making space for extra water without allowing the land surface to be washed away), and enhancing adaptive capacity (Van Vliet & Aerts, 2014).

Third, we recommend collaboration between the Climate Secretariat and UN-Water as the key authority on global water issues, possibly through a formal memorandum of understanding. Although the power, resources and mandate of the two bodies are not comparable, UN-Water's members represent most of the global actors on water. Fourth, there needs to be more academic and political debate on the relationship between sovereignty and transboundary-to-global public goods; on exploring the content of the right to sustainable development; on assessing and analyzing how the differential treatment of equity in the two regimes can be harmonized; and on how the precautionary principle and the idea of not causing harm to other countries can be further explored. This brings us to the economic component of sustainable development. Given that within the neoliberal capitalist context there is an ongoing process to privatize land, water and carbon, it may be necessary to begin academic debates regarding whether and under what conditions the trade, investment and private international law regimes counter the idea of a stable climate and a healthy water system as global-to-local public goods that should be available for all. Such discussions could be further developed in the context of the implementation of the interrelated, interconnected and indivisible Sustainable Development Goals.

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