Norms in multilevel groundwater governance and sustainable development

Conti, K.I.

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Chapter 10. Towards a Normative Architecture for Groundwater Governance

10.1 INTRODUCTION

Building on the conclusions in Chapter 9, this section elaborates on the key elements of a normative architecture for sustainable groundwater governance. Each section will begin by briefly highlighting the shortcomings of the existing architecture, particularly with respect to the conceptual framework and the debates in the literature as relevant. Then it will discuss how these aspects of the framework can be strengthened.

10.2 BUILDING A SOLID FOUNDATION: DEFINITIONS, SCOPE, DATA AND OWNERSHIP

Institutions are the first element of the conceptual framework. Strong institutions are built on strong foundations. Unfortunately, my analysis shows that the basic elements necessary for groundwater governance, particularly according to the legal literature, are not robustly present or that actors include them in the frameworks differently. I consider the foundational elements for groundwater governance as an institution to be (1) how groundwater is defined in the scope of groundwater frameworks, (2) how groundwater data and hydrogeology inform these definitions and the selection of principles, and (3) how groundwater ownership is addressed in the frameworks.

10.2.1 Defining Groundwater in Governance Frameworks

There are two definitional shortcomings in the existing framework (see 5.3.1, 6.3.1, and 7.3). First, actors operating across geographic levels do not agree on which groundwater units should be included in groundwater governance frameworks: at the global level, hydrogeology has not been taken into consideration in all governance texts; at the regional-transboundary level, new groundwater units are introduced (e.g. groundwater bodies) and groundwater is often grouped with river basins even if not hydrologically connected; at the national level, frameworks rarely incorporate hydrogeological knowledge but rather apply all the principles equally to surface and groundwater regardless of differences between the resources; and in the Stampriet, all countries focus on the river basin scale whilst large areas of all three countries do not have surface water. Having these plural definitions is problematic if trying to solve groundwater governance problems through a legal lens because it fragments the foundation of the system.

Second, the frameworks focus on groundwaters' storage characteristics for the purposes of allocation and prevention of anthropogenic pollution, but do not give much attention to the effects of land use strategies, climate change, groundwater flow and pressure dynamics or geogenic quality – all of which may have consequences for ecosystems services (see 3.5). When the intrinsic physical characteristics of groundwater are not accounted for in a governance framework, this can introduce challenges with regard to the identification of drivers, ecosystems services, and selection of counter-balancing principles.

Based on these findings, I argue that the normative architecture for groundwater governance needs to operate according to a standardized and guiding definition of groundwater resources.

Standardization can be achieved through an ISO standard (for instance, as is done for the term 'soundscapes') or through global guidelines (such as the UN WHO water quality guidelines). Countries or groups of countries may further refine this framework definition for their particular context. I argue that the definition should include, at a minimum, the following elements:

(1) An explicit identification of the type of groundwater unit being governed - noting that both literature and empirical analysis indicate that using aquifers is becoming best practice and that the term aquifer also needs an agreed upon definition in the context of groundwater governance;

(2) Acknowledgement that the selected groundwater unit has specific hydrogeological characteristics including storage volume, flow directions and patterns, ability or inability to recharge, pressure dynamics, and inherent geogenic quality that need to be taken into consideration in the implementation of the framework;

(3) Acknowledgement that the groundwater unit has specific ecosystems services that should be maintained or bolstered;

(4) Acknowledgment of the relationship between the groundwater units and related water and land resources and the impacts of climate change; and

(5) Acknowledgment of the relationship between the groundwater and administrative boundaries.

10.2.2 Groundwater Data Dilemma and Governing Under Uncertainty

Although the lack of data is not an inherent shortcoming of the normative architecture for groundwater governance (and will always be a challenge for governance in all fields), a common concern among actors in groundwater governance is a lack of groundwater data – mainly due to a lack of monitoring infrastructure. My analysis also shows that there is a lack of coherence in the data gathering principles that are currently included in groundwater governance frameworks. This shows that lack of groundwater data stems from both a governance challenge and a technical challenge. "You can't manage what you don't measure" is a common idiom in the groundwater epistemic community. While this can be viewed as a call to action, in fact, it implicitly suggests that actors should not begin to govern groundwater until they have sufficient data to fully understand the resource. However, this does not lead to a practical way forward in the case of groundwater governance. The reality is that the global community might be decades and billions of dollars away from having a comprehensive understanding of the world's groundwater resources. As was clearly demonstrated by the Stampriet case, even a rather large quantity of data can be insufficient to fully characterize a groundwater resource. Nevertheless, scientists are moving into new frontiers, even discussing the possibility of exploring off shore aquifers. Yet the current normative framework is poorly suited for the challenges faced on land. Thus, the precautionary principle needs to be translated into precautionary action that governs for uncertainty. Further, governing under uncertainty should be centered around existing and functioning land, water and mineral resources governance tools that can be bolstered to the benefit of groundwater, even without detailed hydrogeological knowledge. This is a critical component of adaptive governance (Huitema et al. 2009; Hurlbert and Gupta 2016; Pahl-Wostl et al. 2010) and building adaptive capacity.

In order to ensure that the normative framework for groundwater governance is complete and sufficiently addresses different aspects of inclusive development, this research indicates that we may need to re-open the perspective through which we view groundwater resources. The politics of science has clearly influenced how groundwater resources are defined spatially. Additionally, lack of communication between groundwater scientists and policymakers has resulted in the norms relevant to groundwater governance largely reflecting those applied to surface water. Groundwater-specific characteristics are not always taken into account. In many cases, groundwater is approached as though it is a 'bath tub,' a tub of water with both taps open - steadily refilling and draining. However, there many tools available to both hydrogeologists and policymakers that can provide insights into the basic characteristics of groundwater resources. General flow patterns, directions, and depth to water tables can be estimated by hydrogeological models and maps, which are available for most locations in the world; otherwise topographical maps can be used as an estimation. There are also maps widely available indicating the potential for naturally occurring contamination and prospects for geothermal energy.

Technologies such as mapping and remote sensing are advancing rapidly for the analysis of groundwater depletion (e.g. NASA Grace). Modeling can combine and optimize this data in order to provide estimates about the state of groundwater resources and its vulnerabilities (e.g. Famiglietti 2014; Famiglietti et al. 2011; Rodell et al. 2009). By stepping beyond the aquifer concept and taking advantage of data (both in-situ and modeled) that is available, uncertainties in groundwater governance frameworks can be reduced, even without the necessary political will and financing for drilling monitoring wells and establishing robust groundwater monitoring networks.

The widespread lack of groundwater data has two key implications for the normative architecture. First, each framework should as far as possible incorporate and take into account the hydrogeological knowledge available. For example, the precise location of a groundwater recharge area may not be delineated, but hydrogeological maps give a general indication. In such cases, larger protected areas can be created (and perhaps linked to other environmental resources) until a more precise area is identified. Second, however in the absence of comprehensive and conclusive data regarding the state of the groundwater resources, a governance framework should be designed, first and foremost, to cope with uncertainty and encourage precautionary action. Knowledge construction and management is also critical to integrating knowledge from indigenous and rural communities into technical understandings (Baud et al. 2014; Bruckmeier and Tovey 2008). Further, groundwater governance should include procedural and financing mechanisms to increase data availability, access, exchange and assessment and to accommodate changes in hydrogeological knowledge through an scientifically informed implementation process. Third, this process should take into consideration the veil of ignorance. Namely, it should accept that there is insufficient knowledge and focus on a fair normative framework considering intra- and inter- generational needs as well as the ecosystem. Unfortunately, in many places, the status quo situation is simply to not allocate or regulate uses at all. Thus, I contend that the issues of financing, procedural bodies, and precautionary allocation and protection are cornerstones of a normative groundwater governance framework. I argue that the following elements should be included to govern groundwater under uncertainty:

(1) Exchanging, consolidating and assessing all available information related to groundwater resources including changes in groundwater-dependent ecosystems, flow patterns, and local/indigenous knowledge;

(2) Integrate tenants of adaptive governance at all geographic levels, focusing on community-level resilience and support;

(3) Put in place procedures and financing mechanisms for increased groundwater data acquisition and improved access to data;

(4) Use the ‘veil of ignorance’ to adopt equitable means of allocation and protection considering intra- and inter- generational equity and ecosystems needs.

10.2.3 Groundwater Ownership

Both groundwater governance literature and the groundwater governance frameworks analyzed give significant attention to allocation and distribution of groundwater resources. But, few explicitly discuss the issue of groundwater ownership. This is a highly contentious issue that warrants its own body of research. Nevertheless, I will address it briefly here.

There has been significant discussion among countries regarding ‘ownership’ of groundwater in transboundary aquifers. So much so that the term ‘shared’ groundwater resources is considered controversial in some circles. This is in part, because of groundwater flow dynamics wherein groundwater may recharge primarily in one country and primarily be stored in another (i.e. the Mountain (Western) Aquifer). Also at the national level, many (ground)water laws explicitly establish the state as the custodian/steward of water resources. Yet, the remaining countries do not explicitly

delineate their ownership regime in their groundwater law. Further, there are some countries where groundwater below a certain depth is considered a mineral resource under their mining law. And other countries still, where groundwater ownership is based on land ownership (e.g. several states in the US and India) and these are not subject to the formal water laws in many cases. These disparate treatments of groundwater ownership are critical shortcomings of the groundwater governance frameworks. Legal literature indicates, that at the very least, water and land rights should be separated and that concerns regarding the constitutionality of dispossession and claims for compensation when these rights are separated are typically rejected (Burchi 1999; Burchi and Nanni 2003). I also contend that groundwater laws and policies should explicitly state how groundwater custodianship is structured. However, further study is necessary to present more specific and robust guidance. I argue that the groundwater governance architecture should addressed these issues with regard to groundwater ownership:

(1) Establish the state, or a group of states in the case of transboundary aquifers, as the custodian of groundwater resources;

(2) Separate land and water rights, if feasible when costs of expropriation are considered; and

(3) Consider the relationship between the surface and groundwater ownership regimes and bring them into alignment, in so far as is feasible.

10.3 SELECTING PILLARS: MATCHING PRINCIPLES AND DRIVERS

Once a clear foundation is designed, the normative architecture needs to establish the key pillars upon which it will be built, namely the principles. These principles are the core supportive structures that determine the overall shape and purpose of the groundwater governance framework. The selection of principles should meet two broad criteria. First, they should address all the relevant drivers of groundwater problems to ensure sustainability or, in the case of non-recharging aquifers, equitably planned depletion. This would ensure that they are contextually relevant. Second, they should provide a clear framework for allocating groundwater resources to all relevant stakeholders through a combination of rights-based, focused on HRWS and marginalized groups, and equity-based approaches, focused on allocation to all stakeholders, and commensurate with the established ownership structure. But as demonstrated in the STAS case, without an equitable land tenure structure, a properly designed water ownership regime may be undermined; hence the redesign recommendations 10.2.3.

10.3.1 Addressing the Drivers of Groundwater Problems

My analysis reveals that a key shortcoming of the existing frameworks is that they only address a few of the drivers of groundwater problems at various geographic levels. The existing principles in the framework have the potential to cope with a wide range of challenges that groundwater governance is facing. Yet the legal pluralism analysis indicates that these norms are often excluded from the framework or placed together in a disjointed way that would not sufficiently cope with key drivers. These include dealing with the trade of groundwater intensive products (and the potential consequences for marginalized groups); climate change; demographic shifts; consideration of non-groundwater policies; geogenic contamination; impacts of invasive species; as well as the development of groundwater technologies and their potential impacts on communities. How each of these drivers can be more thoroughly addressed is discussed briefly below.

Globalization and trade: Based on common responses applied in other resource trade regimes, groundwater governance responses could include integrating the actual cost/value of groundwater in product prices or export taxes or creating product certification schemes that promote water efficiency and good land management. But costing this resource correctly is data intensive and costly, and thus, may not be the most efficacious first step towards countering this driver in certain contexts. In others, it may be the optimal next step in the governance framework.

Climate Change: Governance responses to climate change should require or incentivize 'climate proofing' groundwater resources (Cooley and Gleick 2011; Tarlock 2004). Such climate-proofing entails (1) protecting vulnerable areas in order to maintain or enhance groundwater recharge capacities, (2) supporting technologies such as managed aquifer recharge, (3) public engagement around climate change and groundwater that promotes resilience at the community level, and (4) creating special considerations for groundwater resources that are the source of large-scale water transfer schemes. At the same time, the major impacts on water must call for reducing greenhouse gas emissions world-wide.

Demographic Shifts: There is increasing urbanization throughout the world, but cities are not necessarily located in areas with abundant water supply. Therefore, governance responses should incentivize people to locate to areas with greater water availability. Development programs targeted in more temperate areas is another response option. If groundwater transfers are required to sustain growing cities, the equity concerns of the population where the groundwater originates need to be evaluated and taken into account. At the same time, groundwater governance may need to adapt to the needs of growing populations by calling for strong conservation strategies.

Non-groundwater policies: In order to address the effects of non-groundwater policies on groundwater resources, education for policymakers and mechanisms for inter-ministerial natural resources management are requisite responses. Further, agriculture policy should ensure that crop production is consistent with sustainable water availability to ensure long-term food security. Energy should be evaluated as a potential mechanism to control pumping rather than allowing it to grant unfettered access to groundwater (e.g. India). Also, renewable energy policy should address the potential consequences of geothermal energy use. Tourism facilities should be carefully licensed and groundwater monitoring and metering should be required. Co-implementation of land management and grazing practices with agriculture and forestry as well as incentives and education for water efficiency should be considered. These would to some extent address drivers related to migration and spread of invasive groundwater-dependent flora and fauna, as was found in the STAS case.

Geogenic contamination: Geogenic contamination constrains the viability of additional groundwater use and must be a major consideration when designing a governance regime. Since the contamination is an intrinsic characteristic of many aquifers, rather than an anthropocentric phenomenon, the governance mechanisms must be shifted accordingly. Further, poorly regulated well construction, localized over-abstraction, and a lack of monitoring can allow anthropogenic pollution to exacerbate geogenic contamination. Thus, water and wastewater discharge regulation and implementation of water quality standards are secondary and highly important in recharge areas.

Invasive Species: For relatively shallow unconfined groundwater resources, especially in semi-arid areas, groundwater governance needs to respond to the threat of invasive species. Multiple approaches may be necessary such as combining special land management and natural resource management techniques. Nevertheless, the groundwater governance framework should contain specific provisions in this regard.

10.3.2 Allocating Groundwater Resources

Given that approaches to allocating groundwater resources are a key area of contradiction in the existing groundwater governance frameworks, it is also highlighted here as a shortcoming. The reasons groundwater allocation has not been taken up more actively is likely attributable to a combination of incongruent principles and approaches to allocation as well as a lack of data regarding groundwater availability. For example, the analysis at the transboundary level shows that at the time most of the governance frameworks were created, groundwater depletion was not a concern - either because abstraction was in line with recharge or because the resources were so vast that even large abstractions did not have noticeable effects. In other cases, there was insufficient data about the resource and/or capacity to assess it, in order to design a detailed allocation regime.

Based on these findings, I would envision a two-pronged approach to groundwater allocation. In the first prong, rights-based approaches (HRWS and rights of marginalized groups) would be explicitly included and perhaps even, what South Africa calls, a 'social reserve' would be integrated. The social reserve would ensure that sufficient groundwater is set aside to meet the basic needs of the population while the rights-based approaches would ensure minimum access to all persons, including indigenous peoples. It may be necessary to couple this with provisions regarding geogenic contamination to ensure a certain level of groundwater quality. Further, ensuring efficiency and maintenance of water services infrastructure (especially in rural areas), creating capacity building programs and accountability structures, such as benchmarking, for services providers could also be necessary.

Using the second prong of equity based approaches would situate the rights based approaches in the broader context of stakeholders. A priority of uses should be established and integrated into the licensing and permitting system. If, such a system is infeasible due to high cost, an emphasis should be placed on community-based groundwater management arrangements. However, there must be a means to coordinate with authorities at other governance levels for issues of access, allocation, public participation, and conflict resolution. Additionally, evaluation and monitoring of water services providers, limitations on maintenance response times, coordination with planning authorities for siting well fields and waste water facilities, as well as mechanisms for providing alternative water resources where the quantity or quality of groundwater is unreliable are potential responses. Financing for water services provision, especially in areas with groundwater that is difficult to abstract, is absolutely necessary. However, actors need to be diligent about how much of these costs are passed on to water consumers from different categories of use. As such, general guidelines regarding water tariffs that emphasize the needs and rights of the poorest of the poor can ensure that the normative framework provides a clear inclusive platform for reconciling these issues.

10.4 ROOMS, HALLWAYS, STAIRS AND ELEVATORS: LEGAL PLURALISM AND MULTILEVEL GOVERNANCE

The conceptual framework (see Table 2.1) facilitated the analysis of the state of groundwater governance through the concepts of multi-level governance and legal pluralism. Within the metaphor of normative architecture, I consider legal pluralism to be like rooms, where a single governance architecture having multiple rooms would constitute a legal-plural architecture. Thus, each legal system (or room) may serve a slightly different purpose or be designed in a slightly different way, but they are all part of the same structure. Hallways would represent the connections between legal systems operating at the same geographic level of governance. The stairs represent multilevel governance, allowing actors to access and interact across different levels. Elevators represent the politics of scale, wherein actors can easily move issues up and down to suit their interests. According to the conceptual framework, the architecture for groundwater governance should be designed in such a way that it would effectively address all the drivers of groundwater problems across all geographic levels. It further acknowledges that this may be achieved through a combination of multiple governance frameworks operating at different geographic levels. However, the analysis reveals that one key shortcoming of the existing framework at present is the disjointed approach to groundwater governance within and across geographic levels. These disjointed outcomes have partially resulted from the historical influences of global environmental law and policy as well as epistemic communities that focus on water policy.

For example, the global environmental governance community's increased attention to issues like desertification moved forward groundwater governance in Lake Chad. The push for formation of international River Basin Organizations; promotion of the IWRM discourse, particularly in sub-Saharan Africa; and the call for increased cooperation and research on transboundary aquifers have moved forward particular transboundary governance frameworks. In the cases of the Nubian Sandstone, Guaraní, and Northwestern Sahara, and Iullemeden aquifers, this scaling down approach has resulted in formal agreements. Yet, after initial cooperation states have stalled these issues as demonstrated through

the lack of ratification and implementation. Hence, multi-level governance and the scaling up and down of issues can have a paralyzing effect on groundwater governance, especially if countries believe they lack the necessary data and capacity to fulfil their obligations. Further, this indicates that moving groundwater governance forward through formal channels is particularly of interest to international donor organizations, but may be less so to national actors where political will is lacking or other non-water governance challenges take precedence.

A second key shortcoming is the incoherence and contradictions arising from legal pluralism and the resulting potential for forum shopping. The STAS case represents an example of how this challenge can work across multiple geographic levels. All three countries are considering whether and how to create a joint framework for groundwater governance. There appear to be five options: (1) to do so under the provisions of the UN Watercourses Convention; (2) join the UNECE Water Convention and form a joint body; (3) form a sub-agreement under the SADC Revised Water Protocol; (4) form a joint technical body under the Orange-Senqu River Basin Commission; (5) form a self-standing, groundwater-specific governance framework. As discussed in Section 8.3.2, countries participate in the existing frameworks to varying degrees and some frameworks involve additional actors that do not share the aquifer (e.g. Lesotho in the Orange-Senqu River Basin). In essence, multi-level legal pluralism has produced the enabling conditions for forum shopping as not all three countries have formally committed themselves to the same principles and approaches to (ground)water governance. The STAS countries are currently working together to develop a joint governance approach through the UNESCO/SDC GGRETA project; however, the process is underlain by a complex mixture of each countries' existing obligations; their underlying interests; as well as a lack of conclusive groundwater resource characterization. This situation is likely highly representative of the majority of the world's 596 transboundary aquifers.

Despite these two shortcomings, I argue that a multi-level approach to groundwater governance is necessary given the increasing glocalization and regionalization of groundwater resources due to climate change, trade and even large scale groundwater transfers (e.g. Masheng transfers in Botswana, Great Manmade River in Libya, and Disi Pipeline Project in Jordan). I also contend that it is not necessary to have identical principles at all levels of governance but principles and approaches that when applied lead to a coherent result in terms of the achieving the ultimate goals of a country or context. In other words, legal pluralism can be healthy, except when there are major contradictions which allow powerful actors to exploit these differences in their own favor. To this end, I argue that legal pluralism in groundwater governance presents more opportunities than challenges. However, pluralism needs to be used to allow countries to tailor their governance regimes to their particular needs rather than to facilitate the cherry-picking of principles that do not give them substantial obligations to sustainably and inclusively develop their groundwater resources. The analysis indicates that at the national level, some countries are taking the lead in bringing their national law and policies into alignment with the state-of-the-art of the global groundwater discourse (e.g. Zambia and Yemen) as well as increasing attention to indigenous knowledge systems and how they can build knowledge regarding groundwater resources and governance, particularly in rural and remote locations (e.g. in Botswana; cf. Baud et al. 2014). Resources should be dedicated to further support bringing these policies into practice. At the transboundary and global level, the attention that is currently diverted towards theoretical issues around sovereignty can be redirected. Rather than asking countries to explicitly limit their sovereignty, lawyers in particular, can help politicians see that sovereignty is inextricably linked to the countries' ability to provide their citizens with the basic resources they need for their livelihoods; thus, drawing attention toward practical issues such as virtual groundwater trade, climate change, and the human right to water, and away from theoretical legal debates. Capitalizing on efforts to increase publicly available environmental data would halt some countries' movement towards making groundwater their last state secret. All of these steps can be achieved through legal plural approaches wherein (1) existing groundwater laws and policies are linked and become supportive of

each other and (2) non-groundwater laws and policies are bolstered with the intent of positively affecting groundwater governance.

Furthermore, groundwater governance needs to be cognizant of the bigger global picture. For example, it needs to take the effects of climate change into consideration both in the UNGA and in the design of new boreholes for water supply.

Finally, it is inevitable that in a democratic world which allows for participation, there will be fragmented water law. Such fragmentation may be necessary to take into account contextual differences in groundwater hydrogeology, perceptions and actions. But this fragmentation should take place within a groundwater constitutional framework of principles (cf. Gupta and Sanchez 2012). Hence, this thesis proposes the following principles for groundwater governance as forming a constitutional framework for all countries.

Table 10.1 Principles for a groundwater governance constitutional framework

PRINCIPLES TO BE INCLUDED *PRIMA FACIE* IN REDESIGN
POLITICAL
Notification of emergency situations
Notification of planned measures
Common but differentiated responsibilities and respective capabilities
Obligation to cooperate
Peaceful resolution of disputes
Sovereignty (Limited)
Exchange of information
Human right to sanitation
ENVIRONMENTAL
Aquifer/basin as unit of management
Conjunctive use and management
Environmental Impact Assessment
Pollution prevention
Protection and preservation of ecosystems
Protection of recharge and discharge zones
Subsidiarity
SOCIAL
Capacity building
Equitable and reasonable use
Human right to water
Intergenerational equity
Poverty eradication
Prior informed consent
Priority of use
Public access to information
Public education and awareness
Public participation
Responsibilities towards women, youth and indigenous peoples
ECONOMIC
Polluter pays
PRINCIPLES NEEDING MODIFICATION IN REDESIGN
ENVIRONMENTAL
Best available technology/technique, *considering increased potential for over-exploitation and inequitable access*
Invasive species, *specifically addressing groundwater dependent specific and ecosystems*
Monitoring, *including procedural and financing mechanisms*
Open international economic system, *subject to integrating the full social and environmental costs of groundwater use for products and services*
Precautionary principle, requiring precautionary action that governs for uncertainty and builds adaptive capacity
Protected areas for groundwater, *explicitly considering groundwater resources in the delineation of the area*
Water as a finite resource, *considering adaptation to/ limitations during natural changes in groundwater quantity*
ECONOMIC
Water as an economic good, *subject to inclusive development criteria*

NEWLY EMERGING PRINCIPLES
POLITICAL
Clear definition of groundwater resources in the scope of agreements
Groundwater custodianship with the state
Separation of land and water rights
ENVIRONMENTAL
Climate proofing groundwater management
Conservation and efficient use of groundwater resources
Inter-ministerial coordination regarding groundwater use and protection
Land management and agricultural efficiency to prevent over pumping and over grazing
Land use planning considering groundwater characteristics and uses
Managed aquifer recharge guidelines
Precautions regarding energy use (geothermal and fracking)
Preventing mobilization of geogenic contamination
Regulation of groundwater transfers taking into account social and environmental concerns
Remediation for users of groundwater with geogenic contamination
SOCIAL
Integrating indigenous knowledge management systems
ECONOMIC
Incentives to live in water-secure areas

10.5 WINDOWS INTO OTHER FIELDS: LOOKING BEYOND THE AQUIFER

The selection of groundwater governance frameworks and the analysis of the drivers reveals that a key shortcoming is the weak linkage between groundwater governance frameworks and the governance of other closely-related issues (e.g. land use and urban planning, agriculture, mining and minerals extraction). As such, I contend that the normative architecture for groundwater governance should include windows through which groundwater-related issues in other fields can be addressed. In the analysis, non-groundwater policies were considered drivers. But here, I propose to also consider them structural components of the architecture that supports groundwater governance, especially when governing for uncertainty.

My research indicates that water-specific governance frameworks at the global level have stalled or lack participation. At the transboundary level, they are very slow to develop. National actors give groundwater the most attention; however, this is mostly by way of dealing with other related resources. Given this dynamic, it is worth considering merits of and possibilities to (re)scale up (ground)water governance in the context of existing and operational environmental governance regimes. There are two ways in which this could be approached.

The first would look at existing environmental governance regimes with high levels of country participation as ‘low hanging fruit’ and to move towards making groundwater governance more prominent in existing frameworks. At the global level, this scaling up would encourage the secretariats of the UNFCCC, UNCBD, UNESCO Ramsar Convention, and UNCCD to dedicate specific attention and funding to groundwater. This could be done through a program analogous to REDD+ for forests or through specific task forces dedicated to advancing groundwater knowledge, disseminating it to the conventions’ parties and funding country-specific or regional programs. Parallel efforts could be made in transboundary river and lake basins with existing multilateral agreements. For example, protocols could be adopted to expand their scope to groundwater. This would shift the focus from trying to persuade countries to divert additional resources specifically to groundwater but rather include it in ongoing activities.

The second would be to begin to advance governance in new fields and geographic locations based on the understanding of the drivers of groundwater problems. Previous approaches, particularly from international donors, targeted aquifers based on size (i.e. larger is better or more important) even if severe problems of transboundary pollution or depletion had yet to occur. Newer projects like the GEF

transboundary aquifer assessment program have inventoried aquifers to assess which one are under the most pressure. But going forward, and especially in the context of the SDGs which take a systemic approach, drivers can be useful for understanding where future problems will most likely arise. As such, integrating groundwater concerns into the trade regime through the WTO; making it a key issue of concern in the planning and development of mega-cities; addressing groundwater and the role of disaster recovery and preventing climate refugees are new avenues that must be pursued.

10.6 A ROOF OVER EVERYONE'S HEAD: CONTRIBUTING TO SUSTAINABLE AND INCLUSIVE DEVELOPMENT

There has been a marked increase in aquifer-specific governance frameworks as well as the solidification of sustainable development as a key norm in international policy. My analysis indicates that the adoption of the 2015 Sustainable Development Goals is another significant paradigm shift that may affect groundwater governance. As such, we have entered a fifth phase of groundwater governance - governing groundwater in the context of sustainable and inclusive development. Thus, sustainable and inclusive development is the architecture's roof, under which all groundwater governance would occur.

The research has revealed a number of strengths and weaknesses of the existing groundwater governance framework, when analyzed from the perspective of sustainable development. However, the core weakness is the absence of an overarching norm. I used the theoretical and conceptual framework to position sustainable and inclusive development as the key norm in global environmental governance, while viewing it as an aspirational norm in groundwater governance. I also used various methods to test the extent to which the current groundwater governance frameworks match up with the key tenants of this norm. Now, I will reflect on the opportunities that could await groundwater governance if sustainable and inclusive development are taken on as its overarching norm.

10.6.1 Achieving Sustainable Development for Groundwater Law and Policy

I have shown that groundwater law and policy, or the absence thereof, has a relationship with human behavior and attitudes toward groundwater as well as the state of groundwater resources. I have also shown that the existing framework has critical shortcomings with respect to sustainable and inclusive development because of a lack of principles to counter the focus on building wealth and to refocus these efforts on "human and natural capital, population, institutions and time;" environmental inclusiveness because of a lack of attention to non-provisional ecosystems services, precautionary action, and intergenerational equity can permanently damage the storage, flow, pressure and quality characteristics of a groundwater resources; and relational inclusiveness because of incongruent approaches to water allocation. This begs the question: how can a perfect groundwater governance framework be designed? And what would it mean for sustainable and inclusive development? Following the IDGEC framework (Young et al. 2005) indicates how this can be achieved.

First, the redesign requires examining the existing institutions, addressing the problems at compatible scales; ensuring the scope fits with the hydrogeological nature of the resources (i.e. flow, storage, pressure and quality); that critical ecosystems services are accounted for; and that it provides operational linkages to other related instruments especially in the face of uncertainty and data scarcity. Part of linking with existing institutions includes re-introducing groundwater in the context of IWRM, which is actively used to guide water governance in river basins world-wide. In all hydrological contexts, redesign requires that flow, storage, pressure and quality are prioritized through basic field reconnaissance, even without detailed in-situ data, as was shown in the case of the STAS. Taking this initial design step would ensure that issues related to environmental sustainability of the resource and its ecosystems services receive focused attention.

Second, the identification of context-relevant drivers and actors can give indication of the priority principles; the need for new principles i.e. for climate change, globalization, demographic shifts and

land use; and the need to reconcile existing principles. This can also clarify the opportunity to bolster existing laws and policies by integrating the social, economic and groundwater-specific environmental principles, that lack attention in the existing framework. This would mean re-focusing on issues such as land ownership, the human right to water and sanitation, honoring the rights of the marginalized, operationalization of public participation, access and education. Thus, the "background" of the neo-liberal economic system and the driving forces of the anthropocene are directly addressed in this framework, enhancing the potential to achieve hard sustainability as well as inclusiveness.

10.6.2 The Sustainable Development Goals: An Opportunity to Enhance Sustainable and Inclusive Groundwater Governance

Regardless of whether groundwater governance frameworks are repositioned such that sustainable and inclusive development are the guiding norm, groundwater resources will undoubtedly be affected by the implementation of the 2015 Sustainable Development Goals. As discussed in Section 5.2.2, the SDGs lay out 17 Goals pursued and monitored through a network of hundreds of targets and indicators. Goal 6, 'the dedicated water goal,' only includes one specific mention of groundwater but will nevertheless rely upon it to achieve the goal. Further, it is linked with over 120 other targets from other goals including but not limited to food and energy security, sustainable cities and human settlements, and climate change. As such, it is likely that in many countries, the SDGs will exert more of an influence on groundwater governance than groundwater governance will exert on the SDGs due to the numerous behavioral and policy changes that will be triggered. Thus, potential advancements that could be made in the context of the SDGs to be as follows.

First, increased characterization and monitoring of groundwater resources under Goal 6 has the potential to challenge the common assumptions about groundwater as an underground bathtub, and re-characterize it as complex, dynamic, and vulnerable subsurface resource. New hydro(geo)logical information can help replace common misconceptions about groundwater with simple, understandable fundamentals about their dynamics. Approaching groundwater as an appendage to surface water, which is the historical approach in policy circles, can be revamped and better informed.

Second, challenges regarding technical capacity and manpower can be taken seriously, for the purpose of facilitating better and more equitable access to groundwater resources for the culturally and geographically marginalized. This can be accompanied by a shift towards a conservation mentality in lieu of relying purely on technological solutions such as metering and telemetry which can be prone to vandalism and incur significant costs to regulators.

Third, the practicality of aquifer-only governance approaches can be re-evaluated through the process of dealing with interlinked goals and targets. The importance of adequate land, forest, waste, wastewater, hazardous materials and of course surface water management practice and their relationship to groundwater resources can be further emphasized.

Fourth, the issues surrounding trade of groundwater intensive products represent new groundwater flows and can potentially be addressed through the SDGs process. Where groundwater-dependent products compose a main source of trade revenues, the issues of 'ownership' and protection of water resources can be drawn out, albeit indirectly. Further, the consequences of land grabbing can be evaluated and carefully considered.

Fifth, I believe that the SDG process can significantly improve access to groundwater resources for the poor and marginalized. It can make clear what social, cultural and technological advancements are required to increase intra/inter-generational and international equity as well as cope with changes to geogenic groundwater quality and natural fluctuations in quantity.

My redesign of principles support the achievement of the sustainable development goals by providing a normative framework for groundwater governance that can address the multi-level and pluralistic nature

of governance; takes into account the dynamics of the physical resources; and bolsters the political, environmental, social, and economic principles based on the understanding of the drivers of groundwater problems. It focuses on human rights and social, relational and environmental inclusiveness so that the poorest of the poor and marginalized are not left behind in SDG implementation. And further, it provides clear opportunities to work through interlinkages to other areas of environmental governance, which are related to other goals, in order to further the aspirations of Goal 6 and progressive developments in groundwater governance.

10.7 REFLECTIONS ON THEORY AND METHODS AND KEY RECOMMENDATIONS FOR FURTHER RESEARCH

My research sought to create a big picture view of groundwater governance in the context of an institutional approach. I now reflect briefly on my theoretical and methodological choices; how they affected the outcomes of this research; and what opportunities they have revealed for further research.

Reflections on Theory

I used Earth System Governance as the guiding ontological and epistemological framework for my research. This not only allowed me to use an interdisciplinary, multi-level, mixed methods approach to explore and analyze the existing and documented groundwater governance frameworks world-wide, but also situated sustainable and inclusive development as the guiding norm for my analysis. This approach was beneficial as it brought forth findings that a specific geographic or disciplinarily focus would not have led to, for example the need to understand the role of trade and the neo-liberal paradigm in groundwater problems and groundwater governance.

Using sustainable and inclusive development as the guiding norm was useful for analyzing the groundwater governance frameworks in terms of political, environmental, social and economic dimensions. One of the common critiques of the sustainable development concept is that it is poorly bounded and lacks parsimony. But in my research, I found the breadth of the concept advantageous. The four dimensions themselves were sufficiently bounded without being overly narrowed. The concepts of sustainable and inclusive development allowed the relevant groundwater governance principles to be analyzed for their normative content (including incoherence and contradictions) and to be understood beyond their legal-technical status. All together, these approaches facilitated the content analysis and legal pluralism analysis and took groundwater governance beyond their current foci (i.e. ecosystems protection, water cooperation, and equitable allocation) and into a more concrete and inclusive understanding of sustainable groundwater governance.

I also chose to engage with the concept of legal pluralism to better understand the interaction between legal and policy frameworks addressing groundwater governance. Because legal pluralism was originally used descriptively in anthropological and legal traditions, developing the final approach for the legal pluralism was challenging. There were few existing studies that employed the concept as I chose to in my research. Nevertheless, legal pluralism proved a useful analytical approach to facilitate identification of the patterns, incongruences and conflicts in different groundwater governance frameworks within and across levels.

I used basic understandings of hydrogeology in conjunction with the concepts of drivers and ecosystems services as a means of integrating hydrogeological knowledge into governance frameworks. This choice proved to be highly beneficial as it allowed my analysis to explore the politics behind and implications of technical choices regarding characterization of the resource on groundwater governance. It also showed that identification of drivers as a starting point for design of governance is critical to ensuring that the actual problems are addressed as opposed to only the problem de jour.

Reflections on Methods

I chose to adapt the IDGEC framework to facilitate the institutional analysis and redesign for groundwater governance. This choice was usefully in that it allowed to step beyond a single concept of institutionalism (e.g. historical or discursive) and focus on analyzing institutions' role in combating environmental problems. It also allowed me to integrate the concepts of sustainable development and legal pluralism to deepen my analysis, positively effecting the outcomes of my research. For example, when legal pluralism was placed within the adapted IDGEC conceptual framework and matched with the drivers of groundwater problems, the legal pluralism analysis made clear that there are key elements of the framework missing: (1) robust assessment of the drivers of groundwater problems and (2) in-depth evaluation of the role of water and land ownership in groundwater governance.

I was also able to combine four core methods – content analysis, descriptive statistics, geographic information systems, and qualitative case study – within my conceptual framework. In doing so, the core contents of groundwater governance instruments were synthesized and evaluated quantitatively using descriptive statistics and then visualized using geographic information systems. There are clear limitations to such an approach, where nuance can be lost and contextual factors become secondary. Consequently, the qualitative case study was used to re-introduce these nuances and contextual-factors and lead to a significantly increased understanding of how groundwater governance frameworks can be redesigned.

The way I used these methods could be further improved upon in a few key ways. First, validity in the content analysis could be increased through comprehensive coverage of all countries, regardless of the law's language of publication; having second and third readers/coders comparing results; using official translations of laws or expert legal translators; confirming the current status of laws and policies with local legal experts; and using a scaled rather than binary coding systems. The latter of these would also facilitate the use of more advance statistical techniques such as cluster/factor analysis where there are sufficient cases (n's) to do so. GIS was a valuable visualization tool, but is only as sophisticated as the underlying data and analysis. As such, the current mapping based on descriptive information is highly useful in communicating key elements of groundwater governance and how they manifest spatially. Nevertheless, data on groundwater resources could still benefit from further validation and reconciliation across multiple sources (i.e. raw data reported by countries and/or international organizations as well as modeled data). GIS paired with more advanced statistical analysis would also allow the maps to take on a deeper analytical dimension. The case study was an invaluable method in the research, but a key challenge was gaining sufficient access to key stakeholders in a region where interviewees experience research exhaustion. A key point of reflection for myself and the broader research community should be how to more structurally ensure our research has direct impact or benefit for the stakeholders involved.

I would like to close with some final thoughts on replicability and generalizability. With respect to replicability, I had the honor and benefit of serving as mentor to two early career researchers during my PhD. These researchers - one lawyer, one environmental scientist – both took portions of my analytical framework and content analysis procedure to develop their own groundwater governance research projects. In both cases, I received positive feedback from the researchers that they felt the methods were easy to understand and replicate, but also lent themselves to be adapted to particular geographical contexts or theoretical objectives. The methods were also improved and refined based on their feedback and perspectives. In the end, the greatest challenge they encountered was with a lack of groundwater data in their geographical areas of interest. As such, I hope that other researchers will use and improve upon these methods in order to improve our understanding of groundwater governance. However, exact replicability may be constrained due to the constantly changing legal and policy environment for groundwater governance.

Given the broad scope of my research, generalizability would refer to how my research may be generalizable to the 'wider universe' of global environmental governance on one hand and specific cases of groundwater governance on the other. With respect to the former, the findings regarding groundwater governance could be used to test theoretical ideas about global environmental governance, such as norm cohesion and the role of addressing drivers. For the latter, the research also showed that some generalizations about where patterns occur (i.e. political or climatic regions), at what geographic level they occur (i.e. water as an economic good being common at the national level), in what time periods (i.e. after developments in global environmental and water policy), and how strong these patterns are (i.e. very strong in Europe, not so strong in Asia). Nevertheless, the pattern identification is likely the limit of generalizability for this research, as individual cases of aquifers would need to be appropriately contextualized.

Areas for Further Research

Based on my analysis and my reflections on theory and methods, I proposed areas of further research in groundwater governance that:

(1) Link groundwater governance to global approaches for land, biodiversity and climate governance;

(2) Analyze the role of uncertainty and adaptation in groundwater governance;

(3) Explore the role to data and knowledge construction in groundwater governance;

(4) Systematically select and analyze geographically-specific case studies that can be linked together of generalizable findings;

(5) Complete and contextualize legal analysis and legal field work in groundwater governance;

(6) Apply legal pluralism and analytical analysis to groundwater governance;

(7) Explore the role of politics of groundwater science in our current understandings of groundwater governance;

(8) Assess how *de facto* globalization and economic markets can be countered in day-to-day groundwater governance frameworks, included in the role of ecosystems services valuation; and

(9) Critically investigate the role of groundwater rights and ownership in (ground)water and land governance frameworks, especially in the context of land grabbing.

10.8 CLOSING CALL TO ACTION

This research revealed the ways in which the governance frameworks may need to be bolstered or re-oriented to ensure inter and intra-generational equity. It showed that societies must embrace a precautionary legal pluralism, that focuses on inclusion of the culturally and geographically marginalized and is dedicated to holding those with access to groundwater accountable to the existing norms in their particular context. Societies must also re-envision the subsurface and, in conjunction with groundwater scientists, develop useful conceptual models of groundwater resources that facilitate basic governance frameworks and are not strictly limited by data availability. Governance must focus on what can be done above ground today for the sustainable and inclusive development of groundwater resources and take massive action with the resources, capacities and political will already available.