

Trajectory of a divided river basin: law, conflict, and cooperation along Chile's Maipo River

Sophia Borgias* and Carl J. Bauer

School of Geography and Development, University of Arizona, ENR2 Building, South 4th floor, P.O. Box 210137, Tucson, AZ 85721, USA

**Corresponding author. E-mail: sborgias@email.arizona.edu*

Abstract

The historical trajectory of the Maipo River basin offers critical insights into current and future challenges in Chile's internationally famous model of water management. We highlight the legal dimensions of the trajectory, looking beyond the 1981 Water Code and water market debates to some of the underlying principles of Chilean water law that shape river management. In particular, we focus on a legal-administrative rule that splits rivers into multiple, independently managed 'sections' – a policy that has received little attention despite posing a *prima facie* contradiction to the goal of integrated water resources management. We demonstrate that, despite government officials' insistence that this policy is merely an 'artificial' administrative tool, river sectioning has significant material, discursive, and socio-political consequences for water governance. We highlight three emerging issues: (1) tensions over section boundaries, (2) the institutionalisation of a 'right to leave the river dry', and (3) ongoing struggles to establish formal vigilance committees in the lower sections. Far from functioning as a legal simplification, river sectioning is complicated and contentious and demands more attention in policy and research. We conclude by considering possible solutions aligned with efforts to move toward more coordinated and equitable water management in this crucial basin.

Keywords: Chile; Multiple water uses; River basins; Water governance; Water law

1. Introduction

In many regions of the world, mounting competition and conflict over increasingly scarce water resources pose critical water governance challenges. Understanding these challenges within the historical trajectory of river basin development and water management for a given watershed can shed light on pathways toward water user coordination and cooperation. By tracing the physical, social, and legal-institutional processes shaping river basin trajectories over time, research can elucidate opportunities for meaningful policy change in the future.

doi: 10.2166/wp.2017.250

© IWA Publishing 2018

Chilean water management is famous internationally as the textbook example of neoliberal market-led water policy, codified in the 1981 Water Code. The 1981 Water Code has been the subject of much debate, both in Chile and internationally. Since the 1990s, economists and international development experts have hailed Chile's market-led model of water management as a model for other countries to follow (Hearne & Easter, 1995; Briscoe *et al.*, 1998; Rogers & Hall, 2003). However, a growing body of empirical research points to escalating water conflicts in Chile that raise questions about the benefits of this approach and its international influence (cf. Bauer, 1998, 2015; Budds, 2004; Prieto & Bauer, 2012).

Much of the literature on the Chilean case has focused on the pros and cons of the market mechanisms introduced in the 1980s, while disregarding the legal underpinnings of the water code and management institutions. In fact, much of the underlying legal framework for water allocation, distribution, and management was carried over from past codes and historic practices (Bauer, 1998). These historical rules continue to shape Chilean water management and must be considered in relation to the challenges of water scarcity and conflict resolution. This article aims to move the conversation about Chilean water management beyond the debate about markets and toward a more nuanced evaluation of the legal rules underpinning current management challenges.

Recently in the realm of Chilean water policy, there has been growing concern about the issue of fragmented water management (World Bank, 2011; Instituto de Ingenieros, 2012; DGA, 2016). In response, there is renewed emphasis on the need for integrated water resources management (IWRM) and basin-wide coordination of water users. Yet, these policy discussions often remain disconnected from the issues on the ground. We explore one such disconnect in this article, through a case study of the Maipo River basin, where a little-known water law¹ has split the basin into multiple independently managed 'sections'. We examine how the legal-administrative policy of river sectioning – interpreted and implemented by government officials, water users, and user organisations – has shaped the river basin's trajectory. We demonstrate the differences between river sectioning in premise and in practice, as a policy intended as a legal simplification that is in fact quite complicated. We highlight a number of tensions emerging from this fragmented management and suggest the need for more research into the implications it holds for efforts to address water scarcity in Chile.

2. River Basin trajectories, basin closure, and the law

In this paper, we utilise Molle & Wester's (2009, p. 1) framework for 'river basin trajectories' to trace the 'institutional change and the shifting relationships of power that govern access to, and control over, water resources'. This approach calls for a dialectical understanding of human–environment relationships, analysis of political power and decision-making, and attention to the discourses of scarcity and development that shape water management. In short, the approach is historical political economy of water use.

Basin trajectories are shaped by shifting water management paradigms such as the hydraulic mission and IWRM (Molle & Wester, 2009). Molle and Wester identify a number of major processes evolving

¹ River sectioning is briefly mentioned in very broad terms in a report about IWRM in Chile by the Instituto de Ingenieros de Chile (Instituto de Ingenieros, 2012, pp. 16–17). However, in nearly a dozen water policy meetings attended in Santiago in 2015, river sectioning was never mentioned.

out of these paradigms that affect river basin trajectories, including overbuilding, overallocation, and overdraft of water resources, as well as a ‘double squeeze’ on subsistence farming between the expansion of large-scale industrial agriculture and demands for environmental protection (Molle & Wester, 2009). By tracing societal responses to these pressures, river basin trajectories also raise questions of *water governance* – the set of mechanisms by which actors engage in decision-making and conflict resolution related to water resources (Lemos & Agrawal, 2006; Bauer, 2015) – highlighting the deeply political nature of water management decisions (Molle, 2009).

Molle & Wester (2009) use the term ‘basin closure’ to characterise the trend toward unsustainable intervention in and depletion of rivers. They define basin closure as a process by which water resources are overallocated and overdrafted, and the infrastructure overbuilt, to the point that river flow no longer sustains human and ecosystem needs. Symptoms of basin closure include a lack of ‘slack’ in water allocation, increased competition and conflict among users, pressing quality and environmental issues, reduced access for vulnerable users, and dependence on inter-sectoral and inter-basin transfers (Molle & Wester, 2009). This hydro-social understanding of basin closure differs from administrative ‘closure’ of a basin, an action aimed at restricting diversions and development in an attempt to avoid the negative outcomes described above². We focus here on basin closure as defined by Molle & Wester (2009), understood as a point in a basin trajectory at which shortages frequently arise, externalities are accentuated, and conflicts become entrenched. In our study of the Maipo River basin trajectory, we build on the idea that basin closure can occur at different scales within a river basin, starting in a sub-basin and causing cascading impacts throughout the larger basin (Molle & Wester, 2009). We find that the legal jurisdictions (in this case ‘sections’) assigned to water user organisations shape the way the impacts of closure unfold across the basin.

Our analysis highlights the importance of examining the legal dimensions of river basin trajectories. In order to examine the role of the river sectioning policy in the Maipo River basin, we take a broadly defined ‘law and society’ approach (Trubek, 1990; Bauer & Catalán, 2017). This approach entails looking beyond written laws ‘on the books’ to include the ways they play out in everyday life and the real world – that is, the ‘law in action’. In relation to water issues, this means recognising that the definition of water rights and management boundaries is a political act that is subject to contestation and redefinition (Blomquist & Schlager, 2005; Molle, 2009). The legal pluralism literature helps us to further explore the tensions between state law and local water institutions (Bruns & Meinzen-Dick, 2000; Spiertz, 2000; Roth *et al.*, 2015). From the emergent literature on legal geography (Braverman *et al.*, 2014), we are particularly interested in Blomley’s (2008) discussion of property rights and administrative boundaries as legal simplifications that become complicated when imposed upon the shifting nature of rivers.

3. Methods

This article explores one thread within a broader study on water governance in the Maipo River basin based on three months of in-depth fieldwork in 2015. We used NVivo software to conduct

² We would like to thank the anonymous reviewer who pointed out the need to acknowledge the different meanings associated with the term ‘basin closure’. While we are primarily engaging with Molle & Wester’s (2009) conceptualisation of basin closure, administrative closure also exists in Chile and is being used to try to avoid further overallocation and degradation.

narrative analysis (Hoggart *et al.*, 2002) of 53 semi-structured interviews that the lead author conducted with a range of actors in the basin, including government agency officials and water user organisation board members. Interview questions were informed by a thorough review of the existing literature about the Maipo basin, including government documents, academic publications, and news articles. Participant observation of forums and planning meetings related to water policy, drought response, and climate change adaptation added contextual understanding of regional and national water management goals. Particular attention was paid to incongruences between stated water policy goals in meetings and documents and actual user practices and experiences on the ground.

The focus on river sectioning emerged, at first quite unexpectedly, from interviews in which questions about ‘basin-wide’ dynamics and institutions were often met with multi-part responses with different answers for each section of the river. Governance seemed to be segmented by river section, and yet the boundaries of the sections were highly contested. While government maps showed three clearly marked legal sections, interviews revealed a long-time feud between the lower section users and the DGA about a fourth section. The assertion by DGA officials that sectioning was purely administrative and ‘artificial’ was difficult to reconcile with the prominent role that sectioning seemed to have in the way that most stakeholders understood the basin.

This article presents our efforts to trace the source of these curiosities and contradictions. It does not pretend to offer a comprehensive review of river sectioning, but rather to open a conversation about this legal rule in relation to the broader issue of fragmented management. Interestingly, it was very difficult to find clear information about basic things like the number of canals and water users in each section, how and when water rights were assigned, if or to what extent minimum flow requirements are met, and how decisions are made within water user organisations³. We try to reconcile contradictory reports and find the most reliable data, while also noting these challenges as symptomatic of the broader issue of institutional fragmentation in the water sector.

4. History of Chilean water law and river sectioning

Introduced by the military regime as part of a broad project of neoliberal economic restructuring, the 1981 Water Code established a system of private rights to water use that are freely transferrable on the market, with very little government regulation (Bauer, 1998). The national water agency, known as the General Water Directorate (DGA for its Spanish abbreviation), allots water rights, but relies on water user organisations to oversee water distribution and, in theory, to also coordinate among different types of users and resolve conflicts. The basic structure of water user organisations established under the 1951 Water Code was maintained in the new model, while the regulatory role of the government was greatly reduced.

³ In a recent DGA report (DGA, 2015) all of the data were categorised by upper, middle, and lower sub-basins, which had different boundaries from those of the first, second, and third sections, effectively combining the irrigated parts of the first and second section in the ‘middle’ and separating the upper basin hydropower area as ‘upper’. Other DGA reports organise data by legal section, but many extend the sections of the Maipo across the entire basin (including its major tributaries such as the Mapocho and Angostura, which have their own sections and organisations). The public water rights registries kept by the DGA are categorised by administrative province, without any specification of to which legal section they correspond.

Formal water user organisations in Chile date back to at least the early 1800s, but were codified into law in 1908 (Law 2139) and then integrated into Chile's first Water Code in 1951 and maintained in the 1981 reform. Water rights that were granted or recognised by various laws during the 1800s and early 1900s were similarly incorporated into the regime established by the 1951 and 1981 Water Codes (Bauer, 1998). The water codes distinguish three types of water user organisations: (1) water communities [*comunidades de agua*] of as few as two people sharing a common source of water (i.e. a branch of a canal); (2) canal associations made up of all of the users and water communities sharing a canal; and (3) vigilance committees [*juntas de vigilancia*] that function as federations of all the lower level canal associations and water community user organisations, overseeing distribution of surface water to each diversion point along a river or river section.

According to the Water Code (first in 1951 and then maintained in the 1981 version), vigilance committees are made up of 'users that in any way utilise waters from the same watershed or hydrographic basin'. This follows a basic principle of water law based on the concept of 'unity of flow', recognising the interconnectedness of water resources in a given basin (Vergara Blanco, 1998). In theory, this means that there should be one vigilance committee overseeing all of the points of diversion from the main stem of a river, thus functioning as a sort of overarching river basin organisation. However, in practice, this is not always the case, as there are often three to five vigilance committees along the length of a single river. This is due to an exception in the Code that holds that separate vigilance committees can be formed in each section of a natural flow that is considered 'a distinct flow for the purpose of its distribution', in which case the water is 'distributed independently of the neighbouring sections of the same flow'⁴. These distinct flows or 'sections' of a river generally correspond to points at which the river is used up or naturally seeps into the aquifer and then re-emerges or regains flow downstream due to groundwater springs, tributaries, and return flow from agricultural run-off.

In practice, this means that a basin can be split into multiple independently managed legal-administrative 'sections', each of which can be overseen by a separate vigilance committee. One river thus becomes managed as if it were three separate rivers, each supposedly with 'distinct' flow, such that users have no obligation to let water flow past the downstream boundary of their section. Legally, users can leave the riverbed dry at the end of their section, under the assumption that the downstream sections have their own independent sources of water.

When it comes to allocating water in times of scarcity, river sectioning has a major impact on distribution of resources across the basin. Chile's water codes have always held that water scarcity is to be apportioned proportionally to water users' shares in the total available flow. 'Permanent' water rights receive their full allocation before 'eventual' rights holders receive any water. In times of scarcity, 'eventual' water rights are not fulfilled while allocations to 'permanent' rights holders are all reduced proportionally. In the case of rivers that are split into multiple sections, this rule is applied to each section *separately* such that the permanent *and* eventual water rights of the first section may be fulfilled regardless of whether even the permanent rights holders of the second section receive any water. This is, once again, based on the concept that the second section would have its own independent sources of flow.

It is important to note that river sectioning was not an invention of the 1951 Water Code but rather a codification of already existing water use practices and de facto jurisdictions exercised by water user organisations, some of which had already been functioning for more than a century. While there is some debate as to whether distinct river sections existed 'naturally' prior to human interventions, the general observation is that most

⁴ Articles 263 and 264 of the 1981 Water Code; Article 159 of the 1951 version.

rivers in northern and central Chile have long been split into sections by dry swaths. Indeed, in 1948, one critic of the codification of river sectioning in the water code legislation lamented that in central and northern Chile, 'river sectioning is the rule and unity of flow the exception' (Aldunate Errázuriz, 1948).

Chilean legal scholar Alejandro Vergara posits that river sectioning was intended only to delineate the jurisdictions of vigilance committees but that it has been interpreted by the DGA to also influence the way they measure water availability and allot water rights (Vergara Blanco, 1998). He argues, 'our legal and administrative practice has tended to create an excessively broad legal concept of sectioning ... that is separated from reality' (Vergara Blanco, 1998, p. 256). The DGA has indeed used the river sections as the parameters for hydrological assessments that determine how much surface water is available and how many water rights can be allocated in each part of the river (DGA, 2015). In the Maipo basin, however, the DGA no longer allots new surface water rights in any of the three sections of the Maipo River, which are considered fully allocated – or 'closed' in an administrative sense (DGA, 2015).

When asked about the river sectioning issue, DGA officials were somewhat defensive and tried to distance their administrative practices from the conflicts resulting from the policy: 'The only motivation we have for sectioning a river – really in an artificial, mental, on-paper way – is to allot water use rights... It may be useful, ok, but it is always artificial' (Interview, July 2, 2015).

Regardless of the real or artificial nature of these boundaries, the river and water users to which they apply are constantly changing. Over time the number of irrigators in each section has greatly increased (Peña Torrealba, 2000), and irrigation technology has been improved such that less irrigation water ends up infiltrating into the groundwater and/or making its way back into streambeds (Scott *et al.*, 2014). These changes hold serious implications when linked to a rigid legal rule like river sectioning, leaving less 'slack' in the system to be reutilised downstream (Molle & Wester, 2009).

We did not find evidence of water markets being used to address the particular issues related to river sectioning, probably in part because it is a relatively unknown issue that has garnered little attention among water market scholars or policy-makers. Analysis of water rights transactions in the Maipo Basin since the 1990s mirrors the general pattern throughout the country: routine but infrequent water rights sales that amount to a small percentage of total water allocation (Hearne & Donoso, 2014)⁵. Across Chile, there are many factors that constrain water rights trading, including canal infrastructure that is rigid or inadequate for changing water distribution, legal titles that are incomplete or contradictory, price signals that vary widely in quality, and Chilean cultural values of farming and rural landownership (Bauer, 1998)⁶. In order for markets to address the issue of river sectioning, along with these other issues, there would need to be substantive changes to the capacity and function of the DGA, a proposal that has advanced little amidst ongoing debate about Water Code reform.

⁵ Analysis of data from the Maipo Basin for the period 1993–1999 suggests a total of 793 trades, representing 1–2% of irrigation rights annually (Donoso *et al.*, 2001). Later data for 2005–2008 suggest a higher level of activity but with major fluctuations in number of transfers and value of rights, making generalisations difficult (Hearne and Donoso, 2014).

⁶ These factors are common throughout Chile, with local variations, and have been discussed in depth elsewhere. For detailed discussion and references, see Bauer (1998, 2004). For a recent summary by two water economists, see Hearne and Donoso (2014). The Limarí River Basin in northern Chile is the exception that proves the rule: the country's only example of an active local water market is thanks to a set of unusual conditions that are not replicated elsewhere in Chile. Those conditions include adequate reservoir storage, built by the government many decades ago; high-value export crops; and well-organised private canal associations. The Limarí water market is confined to the agricultural sector (Bauer, 2004, pp. 87–89).

5. Trajectory of the Maipo River Basin: history and first section

As in many semi-arid river basins, water management in Chile's Maipo River basin has been shaped by the challenges of urban growth and periodic drought since the mid-16th century. The Maipo River has sustained Chile's growing capital city (Santiago), booming agricultural production, and the expansion of hydroelectric generation from the river's swift descent from the Andes. Now, with the population of Santiago exceeding 5 million, an extended 'mega-drought' racking central Chile, and climate change projections predicting more variable precipitation, the stakes of water management in this critical river basin are higher than ever.

Located in semi-arid central Chile, the Maipo River flows 250 kilometres from the Andes cordillera to the Pacific Ocean through a basin of approximately 15,000 square kilometres (DGA, 2003). The Maipo basin roughly matches the administrative territory of the Metropolitan Region, with the exception of the western-most stretch of the river as it flows out to the Pacific Ocean through the Valparaíso Region. The Metropolitan Region is home to more than 6 million people, approximately 40% of Chile's population, the large majority of whom live in the capital city of Santiago.

The Maipo River supplies 90% of the water for urban and residential use and 70% of total irrigation water in the region, in addition to sustaining mining and hydropower production (DGA, 2015). The 136,000 hectares of irrigated agriculture in the basin constitute the main consumptive use of water, amounting to about 75% of the total demand (Meza *et al.*, 2014). There are 12 run-of-the-river hydroelectric plants in the Maipo River basin with a total generating capacity of 324 MW, primarily produced on the mountain tributaries of the Maipo (DGA, 2015). In that same area, the private water company Aguas Andinas manages the 220 million m³ Yeso Reservoir, as well as the Laguna Negra and Lo Encantado lakes, for the city water supply.

As shown in Figure 1, the Maipo River is split into three independently managed 'sections' under Chilean water law, with a fourth shown in parenthesis where third section users argue there is yet another separation. These sections are defined in reference to points of diversion along the main stem of the river, such that the urban supply for Santiago falls within the first section due to its point of diversion despite the fact that it appears to fall within the second section. The second and third sections almost entirely comprise agricultural users, while the first section includes the urban water utility and hydropower companies in addition to irrigators.

5.1. Early water development and multiple user conflicts

Santiago was founded in 1541 near the banks of the Mapocho River, a main tributary of the Maipo that often failed to meet water demands during dry periods. As early as 1709 there were proposals to build a canal to bring water from the Maipo River to the Mapocho River for use in the city and its surrounding agricultural fields (Escobar, 2008). After a century of technical and financial difficulties, the San Carlos canal was completed in 1825. In 1827, the Sociedad Canal de Maipo, Chile's first water user organisation given status as a legal entity, was formed to manage the canal and distribute its water to shareholders (Escobar, 2008). The Sociedad was the model for a 1908 law (No. 2139) giving all canal user associations legal status to oversee the distribution of water and the resolution of conflicts along their canal (Obando Camino, 2009). A 1910 law then created the figure of the *junta de vigilancia* (vigilance committee) to unite the canal user associations under one umbrella organisation (Escobar, 2008).

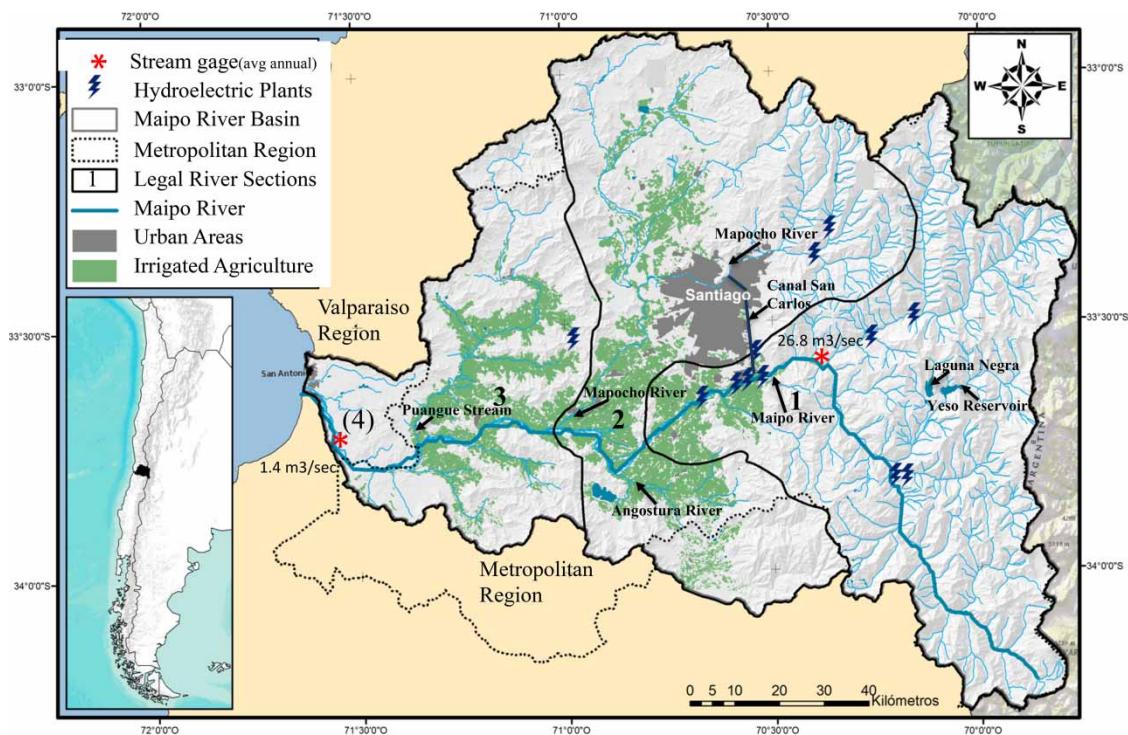


Fig. 1. Map of the Maipo River basin. Source: adapted from map by MA PA⁷, courtesy of Sebastián Vicuña; stream gauge data from DGA (2008, p. 28).

By the start of the 20th century, the regional agricultural economy was flourishing, but irrigators were having to come to terms with the growing demand for Maipo River water for energy generation and urban supply (Escobar, 2008). In 1909, the Sociedad Canal de Maipo began leasing Maipo water from the canal to power the La Florida hydropower plant (which it would come to own in 1983, along with several other hydropower plants). This non-consumptive use, managed on their terms, provided more benefits than costs. Urban supply, on the other hand, was seen as a major threat, and the irrigators were unsuccessful in suing the government when it awarded water to the city and approved construction of the Yeso storage reservoir (Escobar, 2008). From 1932 to 1952 the population of Santiago and its urban area both doubled (Escobar, 2008). By 1989, the irrigated area overseen by the Sociedad Canal de Maipo decreased by 78% (from 90,000 to 20,000 hectares) due to continued urban expansion (Escobar, 2008).

5.2. From conflict to cooperation in the first section of the Maipo River

In the last 30 years, the historically conflictive relationships between irrigators, hydroelectric companies, and urban water companies have shifted in interesting ways, motivated by water scarcity and

⁷ <http://www.maipoadaptacion.cl/descripcion-2/contexto-antecedentes/la-cuenca-del-rio-maipo/>.

mediated by their gradual integration into the overarching vigilance committee organisation. Board members of the vigilance committee cite improvement in their relationship with the water utility since it was integrated into the vigilance committee in 1999 as the owner of the water rights to the Yeso reservoir.

During the last seven years of drought, as the Yeso reservoir became severely depleted, the committee came up with a method of helping the Aguas Andinas buffer against scarcity using a 'running account' of water loans. Board members of the vigilance committee pointed out that it is through these voluntary agreements that they are able to achieve integrated management, which they understand as the ability to coordinate users to ensure that water resources are fully utilised:

'The truth is that the Water Code is quite rigid and it doesn't permit us to do many things. Like, for example, if the irrigators didn't say to the vigilance committee 'leave our water in the reservoir' this water would probably get wasted in the sea' (Interview, July 22, 2015).

The other notable shift in the trajectory of conflict and cooperation among diverse water users in the Maipo basin is the relationship between the hydropower companies and the irrigators. The American-owned electric power company, AES Gener, initially refused to form part of the vigilance committee, but in 2006 a Santiago Appeals Court judge ruled in favour of the vigilance committee arguing that AES Gener was inherently part of the vigilance committee the minute they acquired water rights to the first section of the Maipo. Since AES Gener paid its overdue membership fees, elected a board member, and finally began actively participating in the vigilance committee in 2007, their ability to negotiate was improved, as one board member explains (his emphasis): 'It is *essential* that our user organisations have boards where members see each other's faces – friends and enemies – and are *obligated* to resolve their issues, because if they don't, the association doesn't function' (Interview, July 23, 2015).

It is worth noting that, in accordance with the design of the neoliberal model of water governance, coordination between these major actors is achieved through private bargaining and negotiation that may or may not represent the interests of all the water users represented by the vigilance committee. And certainly, while irrigator, hydroelectric company, and water utility representatives do have a voice at the bargaining table, non-extractive, in-stream water users (such as for recreation or conservation) do not.

The water management challenges and achievements in the first section of the Maipo River have been the object of much scholarly and policy attention due to the prominent role of its vigilance committee. The first section vigilance committee is often referenced as an example of IWRM because of the coordination between different water use sectors that it has achieved. One official in the Water User Organisation Unit of the DGA described this committee as 'almost the ideal of what the Water Code wants to see reflected in the user organisations', adding, 'they have the best of the basin, which is the upper part, and this means that their work has a lot of value' (Interview, June 16, 2015).

The first section users hold a privileged position in the basin in terms of having first access to the full flow of the river. There is no need for them to follow what happens in the lower sections because they have no legal obligation to leave water for them or coordinate with them in any way. A prominent Chilean water lawyer pointed out that first section users are unlikely to support any changes to the policy since they are benefitted by this rule and tend to be 'either vineyards, big companies, or large land-holders who have all the power to impede the advance of court cases or a change of rules' (Interview, July 22, 2015).

6. Beyond the first section: the divided river

While the first section is the stage upon which the historical trajectory of the Maipo was largely defined, it does not represent the current situation in the rest of the basin (see Table 1). One DGA official noted this discrepancy between the sections:

'As one follows the river from the cordillera toward the ocean you find a different reality. In the first part, you have intakes and hydraulic works that are very developed with sensors and all kinds of instruments that allow optimisation in diverting and distributing water. Great. But, as we go down-river we find rustic and temporary works that don't permit that idealised management. And that reality should not be lost from our focus' (Interview, June 16, 2015).

In this next part of the paper, we examine the characteristics of water management in the lower sections of the Maipo River, reflecting on the implications of river sectioning as it plays out in practice. In particular we highlight three emerging issues: (1) tensions over section boundaries, (2) the institutionalisation of a 'right to leave the river dry', and (3) ongoing struggles to establish formal vigilance committees in the lower sections.

6.1. The second section

The second section starts at the Paine-Talagante railroad bridge⁸ southwest of Santiago, is met by the Angostura River about midway through the section, and then ends at the confluence of the Maipo and Mapocho Rivers (DGA, 2015). The seven canals of the second section have no overarching vigilance committee, despite a number of efforts on the part of the National Irrigation Commission to form one⁹. This difficulty stems from bureaucratic complexity, as well as an ongoing dispute with the third section users, which is described in more detail below. Meanwhile, however, the lack of formal representation has been interpreted by members of the first section vigilance committee as evidence that there is no water scarcity in the second section: 'In the second section, they have more water than they need. There is no scarcity. And there has not been scarcity all these years, so they haven't formed their vigilance committee' (Interview, July 23, 2015).

This impression stands in stark contrast with the dry riverbed that marks the beginning of the second section (Figure 2). The legal logic of river sectioning holds that the second section can only be a separate section if it has its own source of water. And it does – the Angostura River¹⁰ – but not until further

⁸ It is unclear why the boundary between the first section and second sections was drawn at the railroad bridge.

⁹ The National Irrigation Commission was created in 1975 with the mission to expand and improve irrigation. In 1985, it incorporated the functions laid out in the irrigation expansion law (no. 18.450) of 1985, subsidising private infrastructure construction and maintenance, including among small farmers. As part of that mission, CNR has supported the creation and strengthening of water users organisations. The National Irrigation Commission financed a project aimed at finalising the constitution of more than a dozen water communities and an overarching vigilance committee in the second section of the Maipo River according to the official boundaries defined by the DGA (CNR, 2009). Until these organisations are formally recognised, it is difficult for the irrigators to secure funding for infrastructure projects, which contributes to the stark contrast between the state of irrigation technology in the first and second sections.

¹⁰ The one legal user organisation for the Angostura has the right to dry up the river after its final canal, canal Hospital, but the river regains flow from Estero Paine before its confluence with the Maipo (DGA, 2003, p. 9).

Table 1. Comparison of the Maipo River's three sections.

| Section | Primary water rights holders | Average annual stream flow of Maipo (DGA, 2008, p. 28) | Vigilance committee? | Conflicts/issues |
|---------|---------------------------------------|---|--------------------------------------|--|
| First | Irrigators, hydropower, water utility | 26.8 m ³ /s at El Manzano <i>prior to irrigation intakes</i> | Yes (since 1910) | Multiple user conflicts – most recently regarding hydropower |
| Second | Irrigators | No stream gauge, but riverbed appears nearly dry until met by Angostura River | No (failed) | Dry section dependent on return flows |
| Third | Irrigators | 1.4 m ³ /s at El Cabimba after <i>Metropolitan Region diversions</i> | De facto (excludes 'fourth section') | Conflict over section boundaries |



Fig. 2. Left, seen from the railroad bridge marking the end of the first section, the Maipo River trickles into the second section. Right, the Maipo near the Natalhua bridge after its confluence with the Angostura River. *Source:* photographs by David Vonnegut Chambers.

downstream. For the first four canal intakes of the second section that are upstream of the Angostura, the only source is the excess and return flows from the first section. This seems to contradict the underlying purpose of the river sections, making water supply for the users in the upper part of the second section precarious and contingent on the upstream users.

The keeper (*celador*)¹¹ of the last canal of the first section was fully aware of the dependency of the second section irrigators on the leftovers from the first. He has lived and worked on the border between the first and second sections of the Maipo River for 25 years and explained his relation to the second section users:

'In this moment, they are only receiving water when we have excess water from the first section. That is the truth. We pass them water. We let it pass because if we don't there would be no water for them'

¹¹ A *celador* is much like a 'ditch rider' – the person in charge of overseeing water distribution through a particular canal system. According to Article 279 of the Water Code, canal keepers are responsible for overseeing and enforcing 'the just and correct distribution of water, as arranged by the established water rights and adopted agreements'.

... so in general we try to make sure there is always a little water for them ... out of good will (Interview, August 6, 2015).

The canal keeper noted that his ability to take care of the downstream neighbours depends completely on 'what they do up above', referring to the upstream water users and the decisions of the vigilance committee. Seeing the effects of the recent drought, he worries that there will likely be really dry years in the future in which there won't be any excess water to pass on. Also, a different canal keeper might not look out for his downstream neighbours if they do not have the same 'affection' he has for them (Interview, August 6, 2015).

Beyond the water supply implications, the dry riverbed also raises questions about the ecological impacts of river sectioning and the ambiguous nature of Chile's minimum flow requirements. Since the 1990s, Chile has made several efforts, including the current proposed reforms to the Water Code, to graft environmental flow requirements onto the water rights regime, handicapped by a widespread presumption that the requirements cannot be retroactively imposed on existing rights (Bauer, 2015). Some environmental flows have been required as part of approving environmental impact statements for new dam projects. However, an example of how little environmental flows have been incorporated into the Chilean water rights system is the fact that the fees for non-use that were introduced with the 2005 reforms of the Water Code were not designed to encourage them (Bauer, 2015).

One prominent water scholar raised the issue of the lack of enforcement of minimum stream flows in relation to river sectioning and noted that these issues are 'hidden' and absent from water policy debates:

'Behind all of this there is an explicit definition that you can legally dry up a river. That is, to severely affect an aquatic ecosystem. So we have serious problems of biological alteration in the middle and lower sectors of the Maipo. From the perspective of quantity, there are populations that are increasingly vulnerable to what is essentially a situation of water scarcity ... And then there is the impact on quality, which is a serious problem, always getting worse downstream' (Interview June 9, 2015).

The DGA notes that, despite the healthy flow at the end of the second section, no additional water rights can be allotted in that section because the flow is already claimed by downstream users in the third section (DGA, 2003, p. 38). This further complicated the disparities between the legal section boundaries and the jurisdictional boundaries practised by the water user organisations along the river, a conflict best illustrated by the third section.

6.2. The third (and some say fourth) section(s)

Officially, the third section stretches from the confluence of the Maipo and the Mapocho rivers to the mouth of the Maipo River at the Pacific Ocean on the southern coastline of the Valparaiso Region (DGA, 2015). However, a vigilance committee operates in practice within a different set of boundaries that place their section as the third of *four* river sections (CNR, 2009; Tapia Sobarzo, 2012). This de facto vigilance committee for the third section of the Maipo has been operating since the late 1800s, according to the president of the organisation. However, it has never been formalised or legally registered because its boundaries conflict with those of the DGA. The de facto committee defines its jurisdiction as extending from the Naltahua Bridge to the end of the Metropolitan Region, essentially

extending its upstream border to include the lower (flowing) part of the second section and excluding the final part of the basin as the Maipo flows into the Valparaíso and to the coast.

The de facto committee cites the Water Code definition of river sections to justify their alternative boundaries for the third section. About their upstream border, the president of the de facto vigilance committee for the third section argues that the beginning of their section is marked not by the Maipo-Mapocho confluence but by the Naltahua Bridge, 'even though it might seem nice to have a section start at the confluence of two rivers' (Interview, August 6, 2015). This extra 10 km upstream officially falls within the second half of the second section, but the de facto third section committee argues that it should be theirs to claim because it is where the river 'naturally' regains its flow downstream of the second section's canals.

As for excluding the final stretch of the river as a separate fourth section, the president of the vigilance committee appeals to physical, administrative, and historical arguments. The physical argument is based on the fact that the riverbed is nearly dry after the final canal of the de facto third section (Canal Codegua). Since the Puangue reintroduces flow to the main stem downstream of them (Tapia Sobarzo, 2012), the committee argues that the downstream users thus have an independent source and should be considered legally separate. The administrative factor provides further justification for separation, since the fourth section is part of the Valparaíso Region and overseen by a separate regional office of the DGA (Tapia Sobarzo, 2012). And finally, the historical argument is that irrigation is relatively new to the fourth section, where modern pump systems made it possible to get water up onto the steep hills to grow wine grapes, citrus, and avocado (Figure 3). The president of the third section committee estimated that irrigation in the final section has increased tenfold in the last ten years.

The de facto third section committee claims to have 'systematically used up the river' every year for the last six years. They point to the fact that the fourth section keeps irrigating as proof that it is its own section, fed by the Puangue: 'What water are they irrigating with if it [the fourth section] is not its own section? The fourth section *has* its own sources [*recursos propios*]!' (Interview, August 6, 2015, his emphasis).

Ultimately, the dispute with the fourth section users has not been about sufficient water supply, but rather about the formal boundaries of the section. Similarly, there is no particular conflict in terms of water supply between the second and the third sections, but there is an issue of overlapping boundaries for the proposed vigilance committees. While the principle of separating sections with independent sources of flow does not pose any particular problem of water supply, by implicating the jurisdiction of water user organisations, river section boundaries are imbued with issues of representation, decision-making, and bargaining power.

The de facto third section committee has tried repeatedly to formalise the organisation and get the DGA to recognise its boundaries, but with no success. Their attempt to register the organisation through the courts in March 1999¹² was impeded when the DGA submitted its technical report in 2002 stating that the third section extended to the Pacific Ocean and should be managed in a 'united manner' including the downstream users¹³ (CNR, 2009, p. 100). The regional director of the DGA explained the agency's position on the matter, again dismissing sectioning as 'artificial':

¹² Segundo Juzgado de Letras de Talagante, Rol N° 1155-99.

¹³ DGA Technical Report N° 42 of 2002, in response to the record NJ-1304-003 of 1999.



Fig. 3. Vineyard expansion into the coastal hills in the southwestern edge of the Maipo basin. *Source:* photograph by David Vonnegut Chambers.

'There were some that asked for four and some that asked for three [sections]. Our position was ... we don't choose whether there are four or three. We said 'for our order, we use three, regardless of the fact that the characteristics of the users and the morphology of the river would lead one to believe that there are four – whatever you would like to use, follow that.' ... But if they are interested in finalising the administrative rule, it should be that there are three. [But] there is no rule because the sectioning is an artificial division' (Interview, July 2, 2015).

On two occasions, the National Irrigation Commission has failed to form an overarching vigilance committee for the third section according to the official DGA boundaries, met with strong opposition from the de facto committee. The president of the de facto committee expressed his frustration with the process:

'I think there is a need for policy that is more coherent and aligned with the users themselves. They said to us, 'look, we (the CNR and the DGA) are interested in having strong user organisations,' but then they just ran right over us. So, we said, 'Excuse me! You want strong organisations? Then that's what we'll give you!'" (Interview, August 6, 2015).

The de facto committee has continued to fight for recognition of its boundaries. However, a second attempt by the de facto committee to formalise the organisation by judicial means was recently rejected by the civil court in Talagante¹⁴. The proposed upstream border of the de facto third section conflicts with the official borders of the second section, simultaneously in the process of being formalised by the CNR. A lawyer working on the CNR project said that he sees this as 'a never-ending argument' that will continue being conflictive even after a judge decides one way or the other (Interview, July 28, 2015).

¹⁴ Primer Juzgado de Letras en lo Civil de Talagante', V-7-2014.

7. Vigilance committees, boundaries, and basin-wide coordination

Recently, there has been a new wave of efforts to strengthen and legally formalise the user organisations in the lower sections. This could provide a basis for more coordination to take place between the sections, even if the separate sections remain. However, as long as the DGA holds fast to the official boundaries of its three sections, the process of formalising vigilance committees in the lower sections will continue to be slow and contentious.

One potential means of fostering more coordination between the sections could be to shift all of the section boundaries to match the actual points of distinct flow (from tributaries) along the length of the river. The first section could incorporate the dry swath of the second section and extend to the confluence with the Angostura, formalising the water sharing currently practiced informally by the local canal keeper. The second section could comprise the stretch from the Angostura to the Mapocho, the third from the Mapocho to canal Codegua, and the fourth fed by the Puange stream and ending in the Pacific Ocean. These boundaries might facilitate the formation of independent user organisations in each of the sections, and perhaps open more possibilities for coordination. However, it would further reinforce the right to leave the river dry, leaving the related ecological impacts unaddressed.

Yet another possibility would be to form one overarching vigilance committee for the entire river using the same judicial process used by the second and third section users. However, one water lawyer described his failure to accomplish this very task in the Aconcagua River. His clients in the lower section backed out of the plan because they felt threatened by the upstream users ‘who say ‘look, if you start the court case, we will leave you with even less water’’ (Interview, July 22, 2015). This follows a nationwide trend of proposals of basin-wide organisations being stalled by resistance from existing organisations (Bauer, 1998).

When asked about the potential for coordination between the users of the different sections of the Maipo River, the first section vigilance committee at first brushed it off as far-fetched. However, upon being informed that the second and third sections were already in the process of formalising their vigilance committees, one board member became more serious and stated:

‘Those of us who administer water in this section have always had a very broad vision of the issue. So, I think that if tomorrow there were other sections and we needed to converse with them, I don’t think there would be any major problem’ (Interview, July 22, 2015).

Though members of both the first and de facto third section vigilance committees defend the idea of the hydrological independence and ‘distinct flow’ of their sections, they also alluded to more complex relations in passing. The president of the first section committee conceded, ‘it is clear that the second section depends on what infiltrates from the first section, but there is little written about this’ (Interview, July 22, 2015). The president of the de facto third section committee mentioned that the actions of the upstream users didn’t matter before, but they are starting to now due to the drought that ‘is here to stay this time’ (Interview, August 6, 2015). While these comments seem to contradict the very logic of river sectioning, they also signal a growing awareness about the interconnections throughout the basin.

8. River sections: a legal simplification, complicated

Despite some General Water Directorate officials’ insistence that the policy of river sectioning is artificial, apolitical, and meant only to simplify, this legal simplification has become quite complicated in

practice (Blomley, 2008). Beyond the explicit conflicts and coordination issues acknowledged by DGA officials themselves, river sectioning also has serious material effects on river flow and consequences for water user representation and water access in the lower sections of the river. River sectioning, as a legal rule and as a practice, has shaped the Maipo River basin trajectory. At the same time, the basin trajectory, and particularly the early history of water development in the first section, has shaped the way that this law has played out upon the river and its users, complicating its even implementation across the basin.

The Maipo River is being moulded to the grid of the administrative sections, but not so neatly as to fulfil the original utilitarian purpose. The situation is reminiscent of Scott's (1998, p. 24) observation about commercial forestry when he writes, 'state fictions transformed the reality they presumed to observe, although never so thoroughly as to precisely fit the grid'. Water users' legal right to collectively leave the river dry at the end of each section has become an institution in itself, leaving the boundaries of the administrative sections etched into the very flow of the river. And yet, the river does not always re-emerge or regain flow neatly at the beginning of each section, as we see in the dry swath at the beginning of the second. In the Maipo, the river sections and the people using them are interdependent, despite being considered legally and administratively separate. In the case of the second section, especially, the lack of truly 'independent flow' leaves water supply fragile, socially contingent, and highly vulnerable to drought and future changes in climate.

The legal simplification of river sectioning is further complicated by the discrepancy between the state's official section boundaries and the boundaries actually practised and enforced by the water users of the lower sections. On one hand, we see movements for the fortification and formalisation of alternative boundaries, such as that of a third section independent of the fourth. On the other hand, interview responses by the presidents of the first section and de facto third section vigilance committees reveal a growing awareness of the undeniable interconnections between the sections. These comments, and their apparent contradiction with these actors' main discourses, reflect the dissonance between the rigid legal grid outlined in the Water Code and the real-world changes observed by water users.

9. Conclusions

The trajectory of the Maipo River basin holds important lessons for Chile and beyond, as a basin that exemplifies promising new approaches in water management as well as entrenched water conflicts and coordination issues. The first section vigilance committee is often cited as a model of how coordination among irrigators, hydropower companies, and urban water utilities can help overcome conflict and confront situations of scarcity. However, this accomplishment is limited to the owners of surface water rights in the first section. There is no coordination with the users in the lower sections of the basin, where vigilance committees have not been formed or formalised and where water supply is increasingly precarious.

To understand and address the basin's fragmentation, we must look beyond the debates about water markets and the 1981 Water Code. We have examined the underlying principles of Chilean water law and the historical processes that defined the river basin trajectory of the Maipo, with particular emphasis on the policy of river sectioning. The case study revealed three key findings.

First, the very concept of river sectioning seems to stand as a *prima facie* contradiction to IWRM. And yet, even as policy-makers, scholars, and water users all over Chile are calling for IWRM (Vergara Blanco, 1998; World Bank, 2011; Instituto de Ingenieros, 2012; DGA, 2016), river sectioning is

rarely mentioned and remains poorly understood. We have highlighted several ways in which the underlying principles of river sectioning, though meant to simplify water distribution, are quite complicated in practice. River sections are defined as having an independent source of flow, and yet the upper part of the second section of the Maipo is entirely dependent on the return flows from the first. River sections are meant to provide clear jurisdictional boundaries for the vigilance committee in charge of each section, and yet only the first section of the Maipo has a formalised user organisation of this type. Disagreement about how to apply the legal definition of sections to the reality of the river has resulted in a constant clash between the lower section users and the DGA, complicating efforts to improve coordination between user organisations across the basin.

Second, it is critical to examine basin closure at sub-basin scales in addition to the basin scale in order to capture the ways that legal-administrative boundaries can produce new sites of closure. In the Maipo we have observed how the policy of river sectioning has shifted basin closure to the scale of the river section, occurring to different degrees in each of the basin's three independently managed sections. River sectioning has been interpreted as a right to leave the river dry, a perception that is increasingly institutionalised, taken for granted in management decisions by users, and even used to justify further legal fragmentation of the basin. Swaths of dry riverbed attest to the ecological impacts associated with this practice and provide a visual indicator of basin closure at the scale of the river section. And yet, from an administrative perspective looking at the basin scale, the healthy river flow reaching the Pacific Ocean eclipses the points of scarcity along the way. Basin-scale policy assessment and action has largely disregarded river sectioning and has overlooked some key challenges and barriers to coordinated management.

Finally, the case of river sectioning provides an example of the historical inertia of water rights regimes despite changing circumstances. In the Maipo basin, the oldest water rights were granted in the first section, where the entire available stream flow was distributed among the members of the first section vigilance committee. At that time, however, irrigation water use was inefficient and provided significant return flows for downstream use. Today, with the effects of drought and the use of technology to increase irrigation efficiency, the 'slack' that has allowed this fragmented system of water allocation to function is quickly disappearing. The legal system fails to account for the complexity of the hydrological connections across the river basin and poses barriers to efforts to improve coordination.

In Chile, although the saga of sectioning has remained a hidden undercurrent for decades, the ramifications of this policy are finally surfacing. The river basin trajectory of the Maipo stands at a critical juncture, as water users confront growing water scarcity and user organisations are forced to reconcile their overlapping boundaries. We have highlighted a number of emerging issues, but there is much more work to be done. Further research is needed to model the hydrological connections between the river sections, investigate the shifting relationship between surface and groundwater uses in the basin, examine climate change adaptation options, and search for new mechanisms for increased cooperation and coordination among water user organisations. In all of this work, it is critical that we keep in mind the historical trajectory of this basin. Water law has played a critical role in the trajectory of this divided river basin and will require careful attention in the growing debates about how to achieve IWRM.

Acknowledgements

The first author would like to thank Drs Carl Bauer, Elizabeth Oglesby, and Christopher Scott for their invaluable mentorship and support. Heartfelt thanks also go to the many *Chilenos* who generously

shared their time and experiences as part of this research. The authors would like to thank François Molle for his feedback on early drafts of the manuscript, Sebastian Vicuña and the MAPA team for use of the map, David Vonnegut Chambers for the use of his photographs, and two anonymous reviewers for their helpful comments. This work would not have been possible without the generous support of the Inter-American Institute for Global Change Research project CRN3056, which is supported by U.S. National Science Foundation (Grant GEO-1128040) and IAI SGP-CRA #005 (Grant GEO-1138881). Additional funding was provided by the Tinker Foundation, the Latin America (LASG) and Cultural and Political Ecology (CAPE) specialty groups of the American Association of Geographers (AAG), the Conference of Latin Americanist Geographers (CLAG), and the Social and Behavioral Sciences Research Institute at the University of Arizona.

References

Aldunate Errázuriz, C. (1948). *De las Juntas de Vigilancia*. El Mercurio, Santiago, 4 June, 1948.

Bauer, C. J. (1998). *Against the Current: Privatisation, Water Markets, and the State in Chile*. Kluwer Academic Publishers, Boston, MA.

Bauer, C. J. (2004). *Siren Song: Chilean Water Law as a Model for International Reform*. Resources for the Future, Washington, DC.

Bauer, C. J. (2015). Water conflicts and entrenched governance problems in Chile's market model. *Water Alternatives* 8(2), 147–172.

Bauer, C. J. & Catalán, L. (2017). Water, law, and development in Chile/California cooperation, 1960s–1970s. *World Development* 90, 184–198.

Blomley, N. (2008). Simplification is complicated: property, nature, and the rivers of law. *Environment and Planning A* 40(8), 1825–1842.

Blomquist, W. & Schlager, E. (2005). Political pitfalls of integrated water management. *Society and Natural Resources* 18, 101–117.

Braverman, I., Blomley, N. K., Delaney, D. & Kedar, A. (2014). *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford Law Books, Stanford, California.

Briscoe, J., Anguita Salas, P. & Peña, H. T. (1998). *Managing Water as an Economic Resource: Reflections on the Chilean Experience*. World Bank Environment Department Paper No. 62.

Bruns, B. R. & Meinzen-Dick, R. S. (eds) (2000). *Negotiating Water Rights*. ITDG Publishing, London.

Budds, J. (2004). Power, nature and neoliberalism: the political ecology of water in Chile. *Singapore Journal of Tropical Geography* 25(3), 322–342.

CNR (Comisión Nacional de Riego) (2009). *Programa de Fortalecimiento de la Gestión de las Organizaciones de Usuarios de Aguas de la Tercera Sección del Río Maipo, Región Metropolitana. Informe Final*. September 23, 2009. Available from http://documentos.dga.cl/ADM5212_1.pdf (accessed 2 April 2016).

DGA (2008). *Plan Director Para la Gestión de los Recursos Hídricos Cuenca del Río Maipo. Fase II Actualización del Modelo de Operación del Sistema y Formulación del Plan. Volumen 1 y 2 y resumen ejecutivo*.

DGA (2015). *Diagnóstico Plan Maestro De Recursos Hídricos Región Metropolitana De Santiago: Informe Final Vol 1&2*. Ministerio de Obras Públicas, Chile [Consultant Arrau Ingeniería]. November 2015.

DGA (2016). *Altas del Agua: Chile 2016*. Dirección General de Aguas. Available from www.dga.cl/atlasdelagua/Paginas/default.aspx (accessed 2 April 2016).

DGA (Dirección General de Aguas) (2003). *Evaluación de los recursos hídricos superficiales en la cuenca del río Maipo*. Available from <http://documentos.dga.cl/ADM2976texto.pdf> (accessed 10 October 2015).

Donoso, G., Montero, J. P. & Vicuna, S. (2001). Análisis de los mercados de derechos de aguas de aprovechamiento de agua en las cuencas del Maipo y el sistema Paloma en Chile: Efectos de la variabilidad en la oferta hidrica y de los costos de transacción, paper presented at XI Jornadas de Derecho de Aguas, U. de Zaragoza, Zaragoza, Spain.

Escobar, S. C. (2008). *180 Años: Sociedad Canal de Maipo (1827–2007)*. Asociación de Canalistas Sociedad del Canal de Maipo.

Hearne, R. R. & Donoso, G. (2014). Water markets in Chile: are they meeting needs? In: *Water Markets for the 21st Century: What Have We Learned?* (Easter, K. & Huang, Q., eds). Springer, Dordrecht, pp. 103–126.

Hearne, R. R. & Easter, W. K. (1995). *Water Allocation and Water Markets: an Analysis of Gains-From-Trade in Chile*. World Bank Technical Paper No. 315.

Hoggart, K., Lees, L. & Davies, A. (2002). *Researching Human Geography*. Arnold, London.

Instituto de Ingenieros (2012). *Hacia una gestión integrada de recursos hidricos: Una propuesta*. Instituto de Ingenieros de Chile, Santiago, Chile.

Lemos, M. C. & Agrawal, A. (2006). Environmental governance. *Annual Review of Environmental Resources* 31, 297–325.

Meza, F., Vicuna, S., Jelinek, M., Bustos, E. & Bonelli, S. (2014). Assessing water demands and coverage sensitivity to climate change in the urban and rural sectors in central Chile. *Journal of Water and Climate Change* 5(2), 192–203.

Molle, F. (2009). Water, politics and river basin governance: repoliticizing approaches to river basin management. *Water International* 34(1), 62–70.

Molle, F. & Wester, P. (2009). *River Basin Trajectories: Societies, Environments and Development*. No. 8. IWMI.

Obando Camino, I. M. (2009). Estructura y jurisdicción de las organizaciones de usuarios de aguas en Chile durante el siglo XIX. *Revista de Derecho de la Pontificia Universidad Católica de Valparaíso XXXII*, 107–132.

Peña Torrealba, H. (2000). *Desafíos de las organizaciones de usuarios de agua en el siglo XXI. III Jornada de derecho de agua*. Santiago, Chile, pp. 1–12.

Prieto, M. & Bauer, C. J. (2012). Hydroelectric power generation in Chile: an institutional critique of the neutrality of market mechanisms. *Water International* 37(2), 131–146.

Rogers, P. & Hall, A. W. (2003). *Effective Water Governance*, Vol. 7. Global Water Partnership, Stockholm.

Roth, D., Boelens, R. & Zwarteveen, M. (2015). Property, legal pluralism, and water rights: the critical analysis of water governance and the politics of recognizing 'local' rights. *The Journal of Legal Pluralism and Unofficial Law* 47(3), 456–475.

Scott, J. C. (1998). *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press, New Haven and London.

Scott, C. A., Vicuna, S., Blanco-Gutierrez, I., Meza, F. & Varela-Ortega, C. (2014). Irrigation efficiency and water-policy implications for river basin resilience. *Hydrology and Earth System Sciences* 18(4), 1339–1348.

Spiertz, H. L. J. (2000). Water rights and legal pluralism: some basics of a legal anthropological approach. In: *Negotiating Water Rights* (B. R. Bruns & R. S. Meinzen-Dick, eds). ITDG Publishing, London.

Tapia Sobarzo, C. A. (2012). *Adaptación al cambio climático de la gestión hídrica para el sector riego en la tercera sección del río Maipo*. Universidad de Chile, Santiago.

Trubek, D. (1990). Back to the future: the short, happy life of the law and society movement. *Florida State University Law Review* 18, 4–55.

Vergara Blanco, A. (1998). El principio de la libre transferibilidad de los derechos de aguas. *Derecho de Aguas: Tomo I*. Editorial Jurídica de Chile.

World Bank (2011). *Chile: Diagnóstico de la gestión de los recursos hídricos*. World Bank, Washington, DC.

Received 21 August 2017; accepted in revised form 12 November 2017. Available online 8 December 2017