



Legal disputes as a proxy for regional conflicts over water rights in Chile



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SUMMARY

Water demand and climate variability increases competition and tension between water users –agricultural, industrial, mining, hydropower– and local communities. Since 1981, the Water Code has regulated water allocation through private individual property rights, fostering markets as the distribution mechanism among users. When legal conflicts occur between parties, it is the responsibility of the courts to settle the conflict. The aim of this research is twofold: first, to apply a geographical approach by mapping water conflicts using legal disputes reaching the higher courts as a proxy for conflict intensity and second, to explain the diversity of water disputes and how they vary regionally. We built a representative database with a sample of 1000 legal records corresponding to decisions issued by the Supreme Court and 17 courts of appeal throughout the country from 1981 to 2014. For geo-tagging, all records were transformed to plain text and analyzed to find words matching the entries of a geographical thesaurus, allowing records to be linked to geographical locations. The geo-tagging algorithm is capable of automatically populating a searchable database. Several maps were constructed using a color scale to visualize conflict intensity. Legal disputes represent different types of conflicts among water users, such as competition between agriculture and hydropower. Processed data allowed the identification of the regional variation of conflicts. The spatial pattern for the intensity of conflicts related to specific sections of the Water Code is explained in terms of the main geographical, climatic and productive characteristics of Chile. Geo-tagging legal records shows a strong potential to understand and define regional variation of water conflicts. However, data availability would become a barrier if measures to improve data management were not taken. Regarding the institutional framework, the same regulations for water management rules are applied throughout the highly diverse ecosystems of the country, impeding the resolution of conflicts that are strongly related to the local geographical context. This leads to a collision of interests and visions around water resources of both a public and private, extractive and non-extractive uses, national, and international nature of individuals, aboriginal communities, and corporations, especially mining industries.

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1. Introduction

Chile's 1980 Constitution was drafted to give primacy to the protection of economic rights, including ample protection for private property rights, to promote markets as allocation mechanisms, to incorporate environmental externalities through pricing, and generally moving from the traditional concept of common pool resources (Bauer, 2004). Within this framework, the 1981 Water Code establishes the basic characteristics of water

rights, water markets, and water management and applies to the whole country the same unitarian legal system, regardless of the local ecosystem and abundance of natural resources. Water rights are the cornerstone of water management as markets resolve allocation of resources by allowing water rights to be traded with little state involvement (Hearne and Donoso, 2014). Nevertheless, there is a first instance where the state intervenes. Since 1981, the Chilean Water Authority (*Dirección General de Aguas*, hereafter DGA) has granted water rights for free to any petitioner, wherever applicable from a legal standpoint and if there exists available surface water or groundwater. There is no priority given to water use of particular industries and the water use does not need to be

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justified (Retamal et al., 2012; Hearne and Donoso, 2014). Despite water being a national resource for public use, water rights are tradable and their price fixed in a self-regulated water market (Melo and Retamal, 2012; Bauer, 2005; Tecklin et al., 2011). Thus, as noted by several authors, there is a *de facto* ownership over water resources, with no attachment to land or use, which is a common cause of conflicts (Bauer, 2009; Prieto and Bauer, 2012; Budds, 2009).

The rationale behind the nature of water rights in Chile is that optimal allocation is achieved through market transactions of water rights among owners and new users, allowing reallocation of water to high-valued uses. Even though the framework for the water market shows economic benefits regarding the allocation process (Donoso, 2006), with the exception of few localized markets, trading has been traditionally limited in Chile (Hearne and Donoso, 2014).

Water rights management at the watershed scale is managed by water users organizations (WOU), which are legal entities incorporated when two or more people have the right to use water from the same channel, aquifer, or reservoir (Melo and Retamal, 2012). All WOU are decentralized, private organizations that are not under government administration.

Under the Chilean legal framework, WOU are responsible for the settlement of disputes among their members regarding the use of water rights (Melo and Retamal, 2012; Hearne and Donoso, 2014). The main conflicts within WOU are related to internal issues involving water rights holders, whether or not they share the same water source (Hearne and Donoso, 2014; Vergara, 2012; World Bank, 2013). In such circumstances water users can appeal to the ordinary courts or private arbitrators. In the case of private arbitrators, the resolution of the conflict remains secretive if no further appeal occurs. In a survey of 75 WOU in a Central Valley basin with agricultural, hydropower and mining uses, the most frequent and significant conflicts were related to water distribution (changes in diversions, water overuse in relation to water shares) and delays in payments for the maintenance of infrastructure. Thus, it is plausible to state that water conflicts are mainly a matter of reallocation of water rights under increasing conditions of water scarcity for increasing demand. Regarding disputes and conflicts related to the ownership of water rights, previous studies have focused on quantifying the fraction of current water rights fulfilling the requirements for an administrative procedure known as *regularization* (Section 2 Transitory of the Water Code) in order to populate and update databases. Based on studies by the DGA, on average, 15% of current water rights should be undergoing the DGA regularization process. Other types of conflicts arise when water right holders appeal an administrative decision –from DGA or other government agencies– before a court of justice.

Any unsettled conflict could reach ordinary courts, courts of appeals and, if it proceeds, the Supreme Court. Additionally, writs of protection are first presented before courts of appeals to protect individual rights such as property rights. Considering the variety of causes and outcomes of water conflicts related to water rights, legal disputes reaching courts appear to be an objective proxy for conflicts and their plausible causes. It is expected that in regions with strong competition for water resources among users, particularly between productive activities and society, are likely to experience more formal disputes.

As conflicts are related to territory, institutions and people (Stamm and Aliste, 2014), we include hydrological, geographical and political analyses in order to explain what emerges from the generated maps (resembling critical analyses from legal geography or political ecology; Delaney, 2015). Prior work on water and environmental conflicts have focused on smaller data sets following the course of specific conflicts (<http://www.derechoalagua.cl/mapa-de-conflictos/>) (Larraín and Poo, 2010), a map of socio-

environmental conflicts (INDH, 2013), and a compilation of case studies on water and native communities (Yáñez and Molina, 2011). However, several socio-environmental conflicts related to water scarcity are not under any *formal* procedure for resolution, but they have media coverage and communication actions (INDH, 2013). Despite the discussions regarding environmental justice, indigenous peoples and social politicization in Chile being important topics to approach, they are beyond the scope of this paper.

The spatial distribution and intensity of water conflicts related to water rights remains unknown at the country level. Therefore, the aim of this research is to answer the following question: Is there a geospatial pattern for water rights-related conflicts reaching courts of appeals and the Supreme Court? A spatial analysis of conflicts related to water rights conflicts reaching the courts would provide opportunities to tailor specific policies to the territory by revealing the main features of conflicts and local communities. On the other hand, judgments issued by courts are explicit in terms of administrative units, but they do not provide accurate descriptions of locations. The first legal action usually takes place in the administrative unit where the conflict is occurring, but as the dispute moves from ordinary to higher courts, the information passed from one court level to another is not consistent or complete. To overcome this issue, we developed and used an automatic extraction of information and geo-tagging algorithm tool that does not make any prior assumption regarding the underlying patterns of water conflicts.

The article is organized as follows. First, the methods section describes the legal records database, how the database was analyzed and the sections of the Water Code linked to water rights conflicts. The results are presented in as a set of maps showing the spatial distribution of legal disputes linked to sections of the Water Code showing the diversity of legal water disputes and how legal disputes vary regionally. We then discuss political, geographical, and institutional issues that explain the spatial distribution of legal disputes, as well as the barriers and possibilities for using legal disputes to understand the regional variation of water conflicts.

2. Data and methods

2.1. Dataset and their geographical context

Under the assumption of a homogeneous distribution of population, natural resources and energy sources, it is plausible to expect that the geographical distribution of conflicts would also be homogeneous. To test this assumption, we defined a set of search terms based on key sections of the Water Code, pointing to specific issues already explored in several government studies (e.g. Donoso, 2006; World Bank, 2011).

The set of court decisions is a sample from actual judgments reaching the courts of appeals and the Supreme Court, providing an objective proxy for conflicts. The data set contains legal disputes that were not settled in first instance by institutions such as WOU, the DGA, and ordinary courts. This method allows us to gauge intensity and link disputes with their geographical setting. This approach is similar to the one applied by Torre et al. (2014) to gauge conflict intensity using media information.

As a geographical and functional unit for analyzing legal disputes, we used provinces because (1) the official inventory of basins is structured in terms of regions, but a high number of sub-basin boundaries overlap one or two provinces, and (2) they are correlated to the jurisdiction of the courts of appeal (usually a group of provinces or even a region). Thus, the number of legal disputes within each province corresponds to the aggregate value for each sub-basin. Fig. 1 shows the administrative regions in Chile.

2.2. Methodology

To understand the geographical distribution of legal disputes among water users, 1000 public legal records were used to build a searchable database. All records are court sentences issued by the Supreme Court –located in Santiago, the capital city– and seventeen courts of appeals. All judgments are publicly available at the judiciary system web site, but there is no automatic method available for filtering or retrieving them in a batch basis. Therefore, an information company provided us with processed records after filtering out decisions from 1981 –the commencement of the Constitution– until 2013. The database is not exhaustive as it contains different types of disputes, but it is a representative selection of the corpus. All records were transformed to plain text to automatically populate a database and facilitate its processing using a natural language process. The records were analyzed to find words matching the entries of a geographical thesaurus, allowing records to be linked to geographical locations (geo-tagging) (Costumero et al., 2015; Torre et al., 2014). The database was manually examined to check its representativeness.

The geo-tagging algorithm (Costumero et al., 2015) is capable of populating different fields –complainant, defendant, location of the court, date of judgment, and the type of legal action– delivering a fully searchable database. We defined this set of information as the minimum set for analysis. Additionally, the database provides a summary of the judgment (*doctrina*) and keywords (*voces*).

As noted earlier, disputes are first processed in the province in which the dispute has occurred, but they could be linked to different provinces (for example, two low-population provinces are part of the jurisdiction of a single court of appeals). Therefore, if words matching the entries are associated with more than a single province, we retained all appearing locations. For example, legal disputes reaching the Supreme Court are *ipso facto* associated with the Province of Santiago, plus the territorial unit in which the conflict actually occurred or the legal dispute started. Due to the structure of Chilean judicial systems, double-tagging introduces a

strong bias in records linked to Santiago, where the Supreme Court is located, as before the dispute reaches the Supreme Court, it is processed by a court of appeals. Indeed, double-tagging allows us to quantitatively explore this boundary condition.

To complement the spatial and temporal analyses, Gross Domestic Product data was downloaded from the World Bank data catalog and the sorting of contribution of productive sectors was downloaded from the Central Bank of Chile data time series. Copper mining, production, and price data was obtained from the National Copper Commission (*Comisión Chilena del Cobre*).

Using different search terms and filters –by field, location, year– we performed a screening process. This approach diminishes bias as compared with manual database analysis by trained readers that extract required information. However, although automatic extraction and geo-tagging follows a set of fixed rules, it loses details and contextual information. Thus, the density –number of legal disputes– within a given territorial unit is used to gauge the conflicts that were not settled within WOUs or by the DGA. As an analog, the number of divorces is a proxy for conflicts that ended as legal disputes with a third party endorsing the resolution.

The presence or absence of legal disputes related to specific sections of the Water Code can be interpreted in different ways. A low density of disputes could lead to the conclusion that the institutional framework is effective or ineffective due to low access to or trust in dispute resolution mechanisms, so we added political and regulatory analysis to overcome disambiguation.

2.2.1. Structuring key sections of the 1981 Water Code

As most legal disputes are related to the use, trade, and granting of water rights (Hearne and Donoso, 2014; Melo and Retamal, 2012), we chose the name of specific sections of the Water Code to define search terms. Table 1 summarizes the key sections of the code that were used in this research, as they provide information regarding different types of conflicts over water rights.

An in-house web-platform automatically delivers occurrence frequency tables for search terms. We drew all maps using

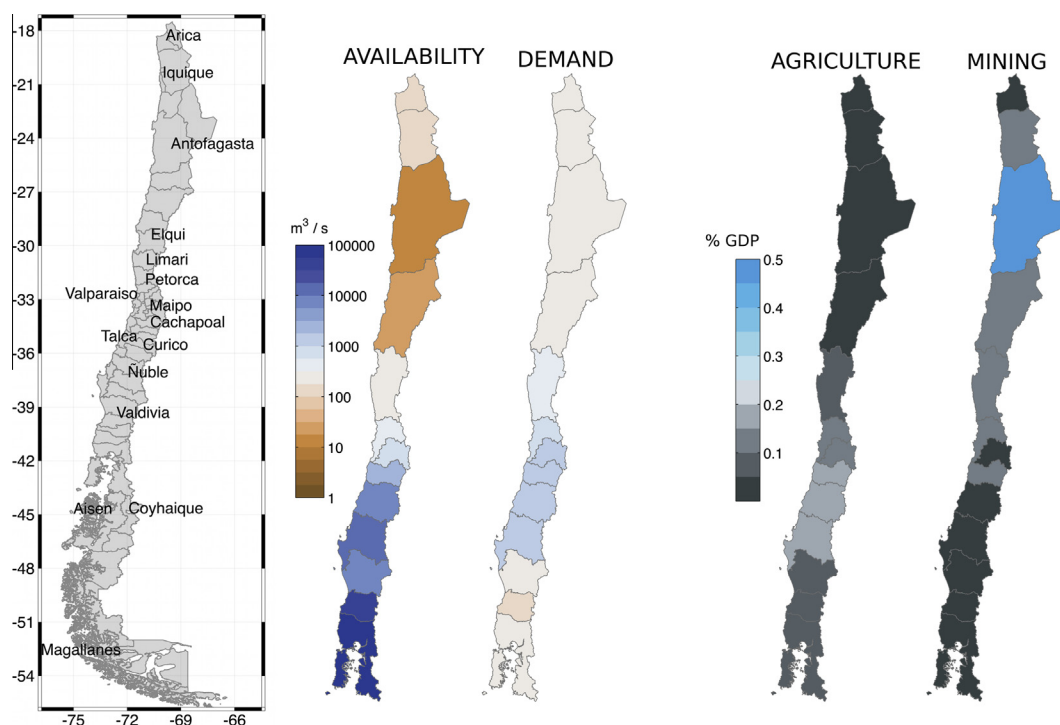


Fig. 1. Administrative organization of Chile and water availability, water demand, and GDP for each region. Source: Ministry of Environment and Valdés-Pineda et al., 2014. Chile is divided into 15 regions. Each region is further divided into provinces, which are groups of counties (*comunas*) sharing territorial and productive features.

Table 1

Description of key sections of the Water Code.

Claim, procedure or definition	Section
The Water Code applies only to inland waters (surface water and groundwater)	1
Definition of water rights: a real good and protected property right, granted for free and with no time limit, that entitles the ownership of the right to use water from inland waters. Water rights are tradable in the water market	6, 20
Water rights are divided into consumptive and non-consumptive uses	12
Owners of consumptive water rights are entitled to totally consume the granted volume of water	13
Owners of non-consumptive water rights are entitled to use a given volume of water and are obligated to restore the same volume to streams	14
Application for water rights	22 and 141
Regularization of granted water rights: provision of all mandatory information such as coordinates for diversions, volume of extraction, and changes in ownership	1 and 2 Transitory
Restrictions to grant water rights: The DGA is entitled to limit, restrict or prohibit the granting of new water rights if a specific aquifer or watershed has reached the limit of sustainable use. Under extreme scarcity conditions, the DGA is entitled to distribute water, overriding the powers of WOUs	62, 63, 64, 65, 314
Provision of environmental flows as the minimum stream flow to maintain the ecological functioning of the streams, but not affecting current water rights	129 bis 1
Taxation to unused water rights (consumptive and non-consumptive)	124 bis 4, 129 bis 5
Complaints regarding taxation of unused water rights. If the decision does not satisfy the water right owner, he or she has the right to file a claim in a court of appeals	129 bis 10
All complaints regarding the decisions of the DGA must be filed in the corresponding court of appeals	137
Any conflicts among water users not included in the water code should be settled by ordinary courts	177
Private arbitrators may be hired to settle private conflicts. Parties can appeal the decisions	185, 245
<i>Amparo de aguas</i> is a legal action filed at ordinary courts when a water right owner claims that third parties are using or affecting his/her water rights	181

MATLAB's Map Toolbox to visualize conflict intensity by a color bar. The list of search terms is as follows:

1. *Amparo de aguas* (Water action of protection). Section 181 of the Water Code allows complainants to present a writ of protection, restricted to the holder of a water right, if there has been an impediment to the full usufruct of the property over water granted by an administrative authority or authorized by law. It is worth noting that if the judge requires a visit to specific locations, the cost must be provided by the complainant. This situation poses an entrance barrier to small farmers with insufficient economic resources to use this legal instrument (Galaz, 2004; Godoy-Faúndez et al., 2012). By mapping this term, we assessed the intensity in using this legal mechanism.
2. We searched for *Artículo 2 transitorio* (Section 2 transitory), as the last modification of the Water Code in 2005 allows a set of administrative mechanisms to organize and modify existing water rights. To balance this instrument, section 132 allows third parties to oppose granting new rights. Changes in ownership must be recorded at the Real Estate Registry (*Conservadores de Bienes Raíces*) and the DGA under the jurisdiction of the Ministry of Public Works. However, the process is slow, costly, and inefficient for all users and there exists an asymmetry in access to information (Hearne and Donoso, 2014; Retamal et al., 2012). Only registered rights can be bought, sold, and mortgaged, and thus, the fact that most rights remain unregistered impedes the transfer of water.
3. The term *Artículo 129 bis 1* (Section 129 bis 1) was used to gauge the intensity of conflicts regarding the stream flow requirements to support the ecological functioning of the streams (*caudal mínimo ecológico*). This restriction applies only to water right applications after 2005, so the potential positive effect appears to be negligible. However, civil organizations have raised concerns regarding the need for conservation of riparian ecosystems.
4. One of the most discussed changes introduced in 2005 was the fine for non-use of the water right (*patente por no uso*). This policy was introduced to incentivize water rights holders to build infrastructure or sell water rights in the water market. Thus, we searched for *Artículo 129 bis 4* (Section 129 bis 4), which is the corresponding section of the Water Code.

5. The 1981 Water Code regulates inland waters and divides water rights into consumptive uses, where water rights holders are allowed to consume all water, and non-consumptive uses, where holders are allowed to use water but not consume it. Non-consumptive users are obligated to restore the water to streams while not affecting third parties in terms of quality and quantity. The division of water rights into consumptive and non-consumptive uses is seen by several authors as an incentive for hydropower infrastructure (Tecklin et al., 2011). As the demand for energy has been increasing during the last decade, we searched for the terms *hidroelectricidad* (hydropower) and *no consuntivo* (non-consumptive) as queries into the database. Consumptive and non-consumptive uses are two distinct legal entities and there is no clear rule to settle conflicts when, for instance, a holder of consumptive water rights affects third parties owning non-consumptive water rights.
6. The Water Code gives the power to administrate water resources to the DGA (Valdés-Pineda et al., 2014). Thus, we searched all conflicts where the DGA appeared as a party by applying a filter. Disputes reaching higher courts are indicative of the efficacy of administrative mechanisms to settle disputes. For temporal analysis, four periods were defined: the neoliberal period under dictatorship (1980–1988), the neoliberal period under democracy (1989–1996), the discussion period for the proposed changes to the Water Code (1997–2004), and the current period, starting with the commencement of the Water Code reform in 2005 (2005–2013). A strong bias is expected, as any complaint against the DGA's central administration must be filed in Santiago due to an extremely centralized system.

3. Results: mapping water conflict intensity at the province level

Even though the Water Code allows us to present special legal actions to resolve conflicts (*amparo y juicio de agua*), Fig. 2 shows that for a period of 34 years (1980–2014) only 24 disputes out of 1000 reached higher courts, with a slight prevalence in Santiago, Valparaíso, Pétorca, and Elqui. A plausible explanation for the small number of actions is the slow processing within the lower courts and the high cost of litigating in Santiago – when a dispute reaches

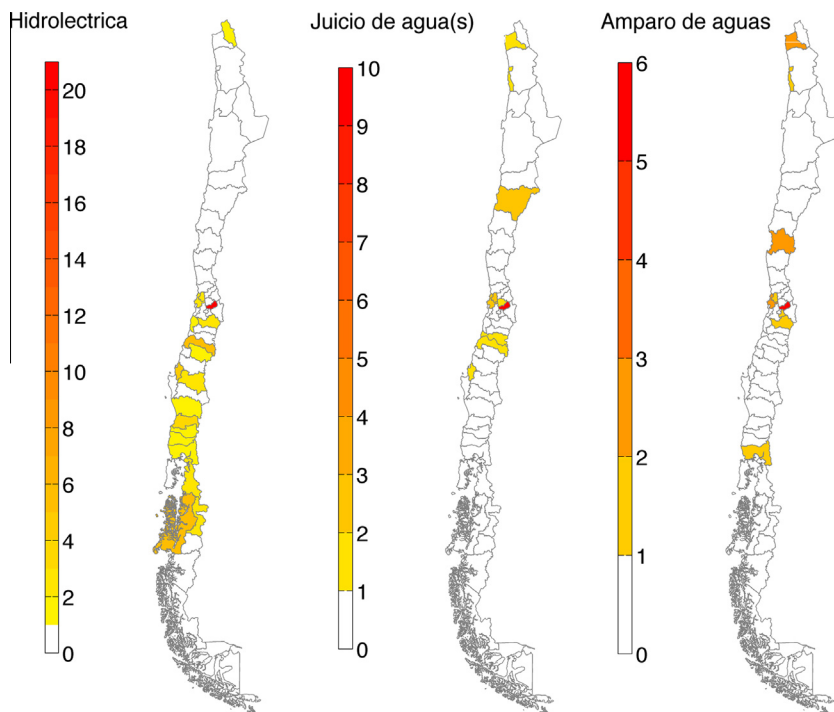


Fig. 2. Conflict intensity for, from left to right: hydropower, water writ of protection following Section 181 of the Water Code, and legal procedures following writs of protection following Section 181 of the Water Code.

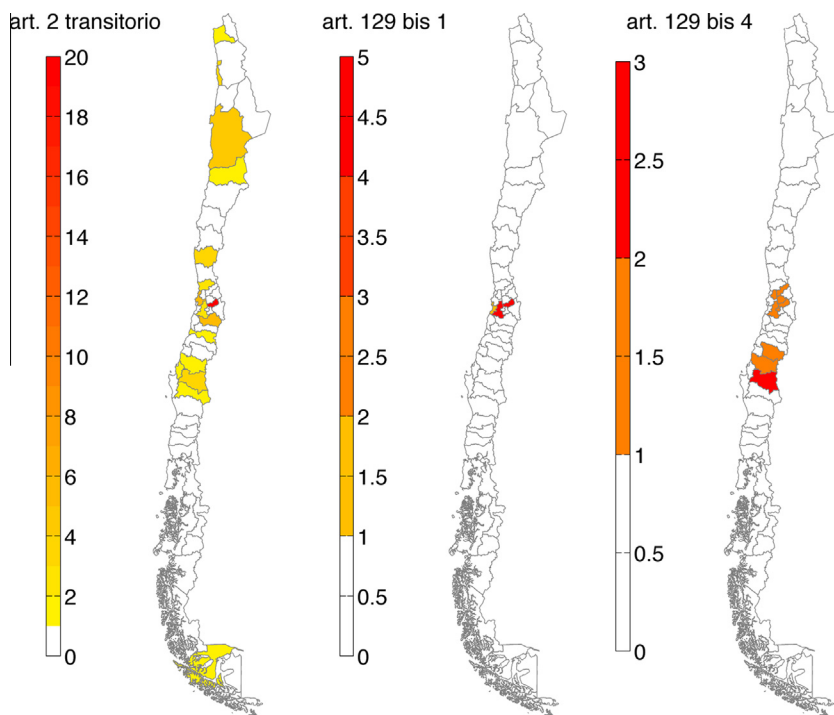


Fig. 3. Conflict intensity for terms, from left to right: section 2 transitorio, section 129 bis 1, section 129 bis 4. Data from 2005 to 2014. In 2005 the transitory section was appended to the Water Code.

the Supreme Court. Thus, this legal instrument for solving conflicts is rarely applied in practice, as the willingness to pursue the disputes would depend upon the economic power of the parties.

Fig. 3 shows the spatial distribution of legal disputes related to water rights regularization based on Section 2 transitorio that reached courts of appeals and the Supreme Court. There is a spatial pattern based on water uses. Conflicts in the northern regions are

related to water rights used for agriculture that could be transferred to mining operations through trade in the water rights market. In the Central Valley, conflicts are related to the ownership of water rights between agricultural users and the Water Authority – administrative complaints – and between irrigation use and drinking water supply. The latter is important since current regulations do not acknowledge drinking water as a priority use, so companies

must trade water rights if they are available on the market, which is an incentive for speculation (Bauer, 2009; Budds, 2009). In the South, conflicts are between water rights for irrigation and hydropower, which comprise a type of dispute between consumptive and non-consumptive uses. It is worth noting that from the IX to the XII region, there are no conflicts reaching high courts, as availability exceeds water demand. In line with Hearne and Donoso (2014), the regularization procedures have generated a significant proportion of the current water use conflicts that must be settled by the DGA and courts.

As seen in Fig. 3, only few conflicts related to environmental flow have reached high courts, showing the low impact of such sections of the Water Code on river conservation and creating no spatial pattern. The concept of environmental flows has attracted attention from social organizations and communities, as a perceived administrative tool to mitigate overuse of rivers during dry seasons (Budds, 2012). The requirement for environmental flow is not applicable to water rights granted before the year 2005, unless changes on water intake's location, so minor effects on the health of rivers are expected. Most disputes are related to administrative issues –third party complaints to preserve stream-flow or complaints from applicants for new water rights– and are solved by the DGA's central administration in Santiago, making the difference between the actual location of the conflict and the location where the legal dispute takes place more pronounced.

Legal disputes related to non-consumptive uses such as hydropower are concentrated in the southern regions as in these territories the hydropower potential of mountain rivers is high and surface water is more abundant. The explanation of the increase in disputes after 2005 is twofold. First, energy companies must go to the courts when non-consumptive water rights are not being used and they must pay a non-use tariff. Second, current water right holders are being challenged to release water rights or put them onto the market. Hearne and Donoso (2014) point out that the non-use tax has actually operated as an incentive for the increased offering of water rights in the water market, even though a large portion of disputes are related to the applicability of the tax. It is interesting to note that before 2005, conflict intensity is low

compared to the period after 2005. For comparison, Fig. 4 shows the occurrence of the term *hidroelectricidad*. However, this result is not indicative of the absence of conflicts. The first mechanism to challenge DGA's decisions related to non-use tariff is the DGA itself and public information shows that there is a large number of complaints under review (Hearne and Donoso, 2014).

The DGA has the power to solve administrative conflicts regarding water rights. We identified 207 conflicts where the DGA is one of the parties. However, one interesting finding is that the DGA was the plaintiff only twice. This fact could be explained by the fact that administrative actions led by the DGA are reactive instead of proactive. Fig. 5 shows that during the period 1980–2004, the number of legal actions contained in the database reaching higher courts is minimal and concentrated in the central region, this is in contrast to the period of 2005–2013 in the central and northern regions. A first glance suggests that the main driver for conflicts is the commencement of the Water Code reform in 2004, as most of the conflicts are related to third parties opposing new water rights, the regularization of water rights, and appealing non-use tariff debts (Hearne and Donoso, 2014; Donoso, 2006; Retamal et al., 2012). Results from Fig. 5 show the need to perform temporal and spatial analyses, as disputes are strongly linked to political processes.

Water conflict intensity varies regionally as there exists a strong relationship among intensity of conflicts, regional economic activities and relative abundance of water resources. As different sections of the Water Code are related to specific water rights conflicts, maps are a valuable tool to assess drivers and causes for conflicts. By aggregating maps for different sections of the Water Code, five regions are hotspots for water conflicts. In the Northern region (18–33°S), Antofagasta province accounts for ca. 10% of total water rights conflicts. This province experiences arid and semiarid conditions, and even though both water demand and water availability are low, demand surplus leads to scarcity conditions of up to 40% deficit (Núñez et al., 2013). The main productive activities are mining operations that require large amounts of water for their processes. Fresh water is sourced from surface water, groundwater and desalinated water. Even though mining

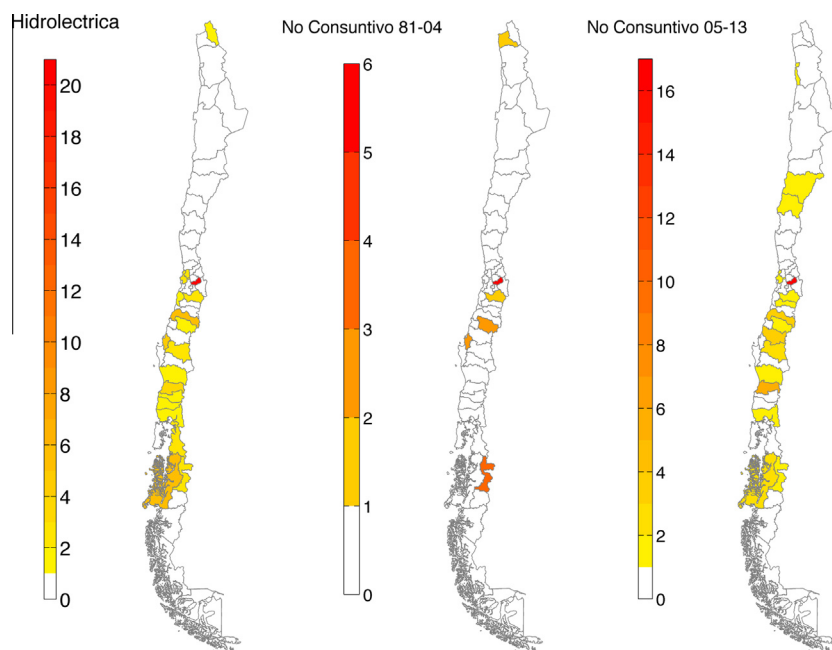


Fig. 4. Conflict intensity for terms, from left to right: hydropower, non-consumptive use for the period 1981–2004, non-consumptive use for the period 2005–2013.

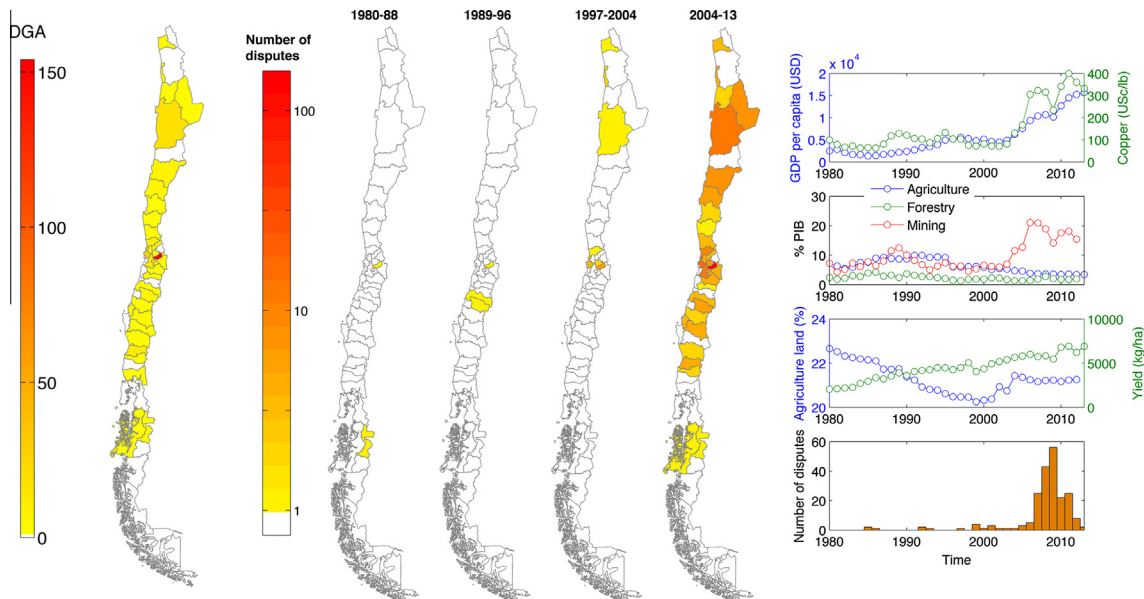


Fig. 5. Conflict intensity for considering the DGA as one of the parties and divided into four periods.

recycles close to 80% of water and uses ca. 7% of total available water, the expansion of mining operations requires new sources (production is expected to increase from 3.7 million tons of Copper to 6.8 million tons in 2021). This large capacity for ore processing is impacting the environment, examples include the release of large solid waste deposits, sterile piles, and lixiviation piles, as well as large energy and water consumption (Oyarzún and Oyarzún, 2011). Conflicts are mainly related to changes in the ownership of water rights, i.e. transfers from agricultural uses to mining, as well as administrative decisions from the DGA for banning new groundwater rights. The second hotspot is the cluster of provinces of Valparaíso-Petorca-Melipilla located in Central Chile. Even though in this region available water exceeds demand on an annual-basis, the availability/demand ratio changes throughout the year.

During summer in the provinces of Valparaíso-Petorca-Melipilla, rainfall is less than 10% of the annual mean and stream-flow is provided by groundwater systems as baseflow. During the last 10 years, the territory has experienced a strong expansion of high value crops such as avocados, but annual precipitation was below mean values. A scenario where demand increases and supply is lowered by climate change and variability has led to conflicts among water rights holders –small farmers and large agricultural companies– for exercising their right to use water (Budds, 2012). The third –Concepción and Ñuble– and fourth –Valdivia– hotspots are located in the central-south region (35–40°S). Conflicts are mainly related to hydropower projects and environmental flows, as there exists a high density of natural streams. However, hydropower generation –a non-consumptive use– is under strong competition for water from agriculture and forestry –consumptive use (Tecklin et al., 2011; Bauer, 2015). The fifth hotspot is the Santiago province, but unlike other hotspots that are related to the actual location of the conflicts, Santiago is the *administrative hotspot*. The 1980 Constitution established an institutional design with a hierarchical and centralized structure of the judiciary systems. Indeed, Chile's judiciary has been compared with military organizations: an internal culture of discipline, fear of innovation, and a risk-averse attitude by the judges (Hilbink, 2007). Therefore, the system itself poses a geographical bias to Santiago.

Legal disputes can be classified depending on the nature of the parties into two groups with similar weight: (1) conflicts among

private individuals, and (2) conflicts between individuals and the State. In the case on private parties, most of the conflicts are related to the use and trade of water rights, due to (not recorded) changes of ownership, use of water above the granted water rights affecting downstream users, and conflicts between consumptive and non-consumptive uses. For the second group, the State is represented by the DGA. Main conflicts are related to appeals against DGA's administrative decisions regarding the non-use tariff, oppositions to grant new water rights and potential downstream effects of hydropower operations. This results are consistent and give support to findings from Hearne and Donoso (2014) and Melo and Retamal, 2012) who explored conflicts in WOUs using *ad hoc* surveys. Thus, lower conflict intensity is not indicative of the absence of water conflicts. Indeed, previous research shows the importance of WOUs as the first instance institution for conflict resolution (e.g. Hearne and Donoso, 2014; Melo and Retamal, 2012; Vergara, 2012).

As the intensity of conflicts related to specific sections of the Water Code matches the main geographical, climatic and productive characteristics of Chile, mapping legal disputes allows the identification of different types of water conflicts.

4. Discussion: political and geographical factors explaining legal disputes

Water rights conflicts are related to multiple drivers and causes. Therefore, to explain the spatial distribution of legal disputes it is necessary to include the nature of Chile's judiciary system, water rights and regional variation of climate. In terms of the courts, all complaints against the central administration of the DGA –located in Santiago– should be presented in Santiago, regardless of the location of water rights (Vergara, 2012). Thus, Vergara (2012) points out that the court of appeal located in Santiago province, happens to be the *de facto* single water court in Chile. This situation generates strong bias regarding the litigating power of parties, but it also breaks down the conflicts into administrative and actual hotspots (cf. Larrain and Poo, 2010). The joint effect of climate and hydrogeological setting strongly shapes the nature of conflicts. Chile's economic model considers water as a commodity and raw material for productive uses by the energy sector, land use, agriculture, and forestry activities. In the northern regions, the abundance

of minerals led to intensive mining operations under natural conditions of water scarcity. The central region, where climate is benign for agriculture, has experienced a strong expansion on water demand, while available water shows strong interannual and decadal variability. The *status quo* regarding the granting process for new water rights as well as the nature of private property over water, impedes the applications of integrated water resources frameworks as the State is obligated to grant water rights where water is available (Hearne and Donoso, 2014). Thus, unless under extreme drought conditions (Núñez et al., 2013), the role of the State is reactive instead of preventing water conflicts.

The current situation is prone to conflicts due to the interaction and feedback of increasing water demand for agricultural, industrial, mining and hydropower activities, high climate variability affecting water availability, disparate distribution of natural resources along the country, and a legal framework that forces water users into a private water resource management system. Moreover, Chile is facing a process of politicization, where social movements are active in incorporating social issues into the political discussion under the assumption that politics and policy actions will solve scarcity and water supply. In this regard, social movements protest and express their disagreements with how politicians approach their claims. However, this social process is ongoing, and showing contradictions and heterogeneities (UNEP, 2015). The main legal instruments for conflict resolution in the Water Code –*amparo de aguas* or *juicio de agua*– are not being used due to high legal costs that are not affordable for small communities or even medium-sized companies. Thus, social movements have considerable importance since they bring attention to latent conflicts that have not yet been brought to the courts.

Thus, legal disputes reflect the hydrogeological and climate setting of the country. In turn, the geographical setting defines the productive activities. Differences in conflicts also arise as a result of the features of the relationship between companies and communities. In the north, large mining companies litigate against medium-sized and small farmers, while in the Central Valley conflicts are related to large agricultural companies against, again, medium-sized and small farmers, but also among same sized companies. Inequitable access to information and legal advising is seen as a barrier to small farmers with insufficient economic resources to solve conflicts (Galaz, 2004).

As the Water Code allows the hiring of private arbitrators, we hypothesize that an increasing number of conflicts are solved by this means, as it provides faster responses and does not require that any evidence or document –even the decision itself– be made public, unless one of the parties does not agree and decides to appeal before the corresponding court of appeals.

During the period 1981–2004, energy companies applied indiscriminately for water rights as regulations gave them high legal security (Prieto and Bauer, 2012; Bauer, 2009), and an increase in water-related conflicts that have become closely linked to competing water uses for energy (hydroelectricity) and the environment (Bauer, 2015). One aspect for analysis in the conflicts between hydropower and agriculture is the generation of energy by hydropeaking. Even though the users must restore the water in the same quality and quantity, the regulation does not make explicit that the flow rate of intake should be the same as the flow rate at the discharge. Thus, energy companies store water upstream of turbines for use during the night, when electricity demand and price is higher, lowering streamflow. Farmers, however, tend to use water during the day. The Supreme Court in 2012 ruled that the hydropeaking operation violated the rights of downstream users (Prieto and Bauer, 2012). Currently, the company is part of a River Board (*Junta de Vigilancia del Río Tinguiririca*), showing that integration and cooperation is a feasible target for conflict resolution. In this regard, the 2005 reform of the Water Code appears as a

new empowerment opportunity for communities and water user organizations, as it not only in some degree makes non-consumptive rights less secure, but also decreases power asymmetries. It is also worth noting that for the period 1981–1990, most non-consumptive water rights were granted to the then state-owned energy company that was later privatized. Thus, private companies, in addition to infrastructure, also acquired the ownership of water rights.

Fig. 5 shows the need to add political and regulatory context to give plausible explanations to the outbreak of disputes after 2005 (Muñoz et al., 2012; Rehner et al., 2014). Agriculture and forestry GDP has shown no trend over the last 35 years, contributing between 5% and 10% to GDP. From 2005, the contribution of mining to the GDP went from levels similar to those of agricultural activities to an average of 17%. The trigger for this accelerated contribution to GDP was the rise in the international price of copper. However, under the neoliberal economic system that prevails in Chile, the higher the price, the stronger the incentive to extract raw materials instead of manufacturing. This situation has led to an intensive use and demand for water (e.g. in some cases, the trading price for 1 L/s has reached 250,000 USD). Agriculture shows an increase in cropped area and water efficiency, as Chilean agriculture entered the global market for fruits and fresh vegetables. However, the increase of agriculture's contribution to the GDP is modest compared to that of mining, even though there is still room for increasing water and irrigation efficiency. However, efficiency in irrigation at the plot scale remains quite low (Bauer, 2012), and the basin-scale effect on changing cropping patterns remains unclear (Muñoz et al., 2013).

The DGA, as the first mechanism for resolving disputes, has a large role in water conflicts (Fig. 5), but in most cases the initial action was taken by individuals who are not in agreement with the administrative decisions of the DGA. An institutional authority such as the DGA could increase the efficiency of dispute resolution, especially with greater definitions of such rights as non-consumptive rights and exactly what they entail. Improving the access and efficacy of conflict resolution at administrative level –DGA faculties– and at court level, would improve the water market and reduce power asymmetries. Thus, as noted by the World Bank (2013) and Bauer (2012, 2015), there is an urgent need to change the institutional landscape by improving coordination among institutions, increasing inspection by law enforcement and improving the data system. Evidence suggests a low coordination among water-related institutions, leading to slow and bureaucratic processes to settle disputes among water users (World Bank, 2011; Hearne and Donoso, 2014; Retamal et al., 2012), with asymmetries in access to formal processes (Galaz, 2004).

Since WOUs are *de facto* institutions for water management, it is necessary to strengthen local organizations (World Bank, 2011; Hearne and Donoso, 2014), as a large percentage of WUAs have not updated their capacity to meet new challenges and have not been effective in resolving inter-sectoral conflicts (Bauer, 2004). The power and ability to cope with conflicts within a WOU largely depends on the level of organization, such as budget, staff, and members' schooling (Valdés-Pineda et al., 2014; Jara et al., 2009). For instance, the presence of technical-professional staff directly affects the development and growth of WUAs (Jara et al., 2009), supporting the need for training programs (Hearne and Donoso, 2014).

The Chilean state has recently been implementing new information platforms for WOUs and water rights. However, there also exists an urgent need to modify data management practices in the judicial system in order to account for private arbitration, and to include more accurate and reliable information related to the location of the conflicts. For example, in most cases, first instance rulings and writs of protection contain a complete description of the

location of the conflicts, while upper courts refer to geographical information in other judgments.

Geo-tagging legal records shows a strong potential to understand and define regional variation of water conflicts. This approach used legal disputes reaching higher courts; so expanding the database to first-instance courts should improve the understanding of the legal path followed by parties, as well as the proportion of disputes that are settled at each level of the judiciary system. However, from a technical point of view, it is necessary to develop and implement new techniques for data analysis before performing deeper analyses such as tracking specific water rights, courts or law firms. Data availability would become a barrier if measures to improve data management were not taken. According to Boettiger (2012), Chile presents a lack of reliable information regarding water stocks, water rights and current physical infrastructure. Currently, the *Catastro Público de Aguas* –CPA– is the official database for registered water rights aimed at providing updated information to relevant stakeholders. The Water Code (section 122) establishes the obligation for government agencies, real state registries and water rights holders to inform changes in ownership of water rights to the CPA. However, the legal obligation to inform has not been sufficient to foster the water market as the CPA remains incomplete and out of date (Boettiger, 2012), suggesting a barrier to use legal disputes as information is out-of-date or incomplete. Mapping key sections of the Water Code provides valuable information regarding spatial patterns, but spatial analyses should include information regarding the physical infrastructure, the institutional landscape and updated information of water rights (Budds, 2009, 2012).

5. Conclusions

We used legal disputes as a proxy for water-related conflicts and mapped the occurrence of specific types of disputes. The context of water conflicts is the diversity of the water market, water rights, water users organizations, water users, regulation, and regions. We focused on water rights because they are the cornerstones of water allocation through water markets. Thus, hydrological conditions (available water), the concentration of resources and extractive activities (water demand), the institutional framework, and communities (social dimension) shape water conflicts.

Most legal disputes are related to conflicts among water users and their access to water rights due to the increasing competition among productive activities. However, the current legal structure requires changes to cope with conflicts (World Bank, 2011, 2013; Hearne and Donoso, 2014; Retamal et al., 2012). The predominant water uses in different regions of the country have spatial patterns. In the North, mining, agriculture and local communities are the main actors in a region with limited water resources. In the central region, conflicts are among agricultural, mining, and hydropower uses, in addition to significant competition between consumptive and non-consumptive uses. Southern Chile presents fewer disputes as water resources are abundant and demand is low, even though there is growing concern from social movements over the environmental impacts of future large hydropower operations (latent conflicts). However, the legal disputes reaching courts are fewer than the actual conflicts due to inequitable access to legal system. Also, changes made in 2005 to the Water Code increased legal disputes related to the regularization of existing water rights, complaints regarding fines for non-use of water rights and conflicts among users.

Water resources are less available due to natural climate variability and decreasing trends in precipitation due to climate change, and demand is increasing (for instance, the DGA has closed new water rights for aquifers in northern Chile as the rate of

extraction is close to recharge). Therefore, scarcity and competition for water is growing. In northern Chile, water demand from mining operations is closely linked to higher copper prices. Demand from agriculture is also growing as Chile is reaching competitive positions in global markets. Other players are hydropower companies, as more energy is needed to fuel industrial expansion, increasing the pressure over water resources and natural ecosystems all over the country. Thus, there are territories where there exists scarcity of water despite low demand (II Region) or high availability (V Region).

Although Chile has a high diversity of ecosystems, the same regulations are applied to the whole country, leading to a failure to settle conflicts that are strongly linked to geographical context and variables such as resources, industry, and local communities. In the north of Chile, small farmers and local communities litigate against large mining companies while in the southern regions farmers litigate against hydropower companies. Both cases show an unequal access to environmental justice (Larraín and Poo, 2010).

Thus, current regulations are not only failing to resolve conflicts, but are also failing to provide the best regulatory and policy framework to operate water markets. Therefore, the conflicts are related to the relationship between availability and demand, instead of the absolute magnitude of water availability or runoff. Communities and social movements are also key actors in increasing awareness of environmental justice. Exploring this issue was out of the scope of this study, but incorporating fields such as political ecology or legal geography need further research.

As the Chilean economy and the system of water allocation do not provide conflict resolution mechanisms apart from court disputes, Chile would benefit from increasing access to the legal system. The intensity of the conflicts is related to institutional drivers inherited by the 1980 Constitution and economic drivers from a neoliberal economic model based on natural resources as raw materials.

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