HYDROSOCIO-TERRITORIAL STRUGGLES

Shifting of water rights frameworks in Bolivia

Rígel Rocha-López

Propositions

1. In the Andean region's river basins, diverse actor coalitions strategically deploy diverse and divergent water rights legitimation languages to reinforce their water claims and materialize their wished-for hydrosocial territories.
   (this thesis)

2. Irrigation development, beyond institute-based prescriptive projects, needs to be understood as a multi-actor negotiated process involving continuous contestation and redesign.
   (this thesis)

3. Technological instruments can be evaluated *"not only for their contributions of efficiency and productivity, … but also for the ways in which they can embody specific forms of power and authority"* (Winner, L. 1980. Do artifacts have politics? Daedalus 109 (1): 121-136. Page 121).

4. *"History is the fiction we invent to persuade ourselves that events are knowable and that life has order and direction"* (Watterson, B. 1994. Homicidal psycho jungle cat: a Calvin and Hobbes collection. Andrews McMeel Publishing: Kansas City. Page 148).

5. It is easier to write about irrigation in the Bolivian Andes than to irrigate in this highlands region.

6. Natural resource management is conflict management.

Propositions belonging to the thesis, entitled
Hydrosocio-territorial struggles: Shifting of water rights frameworks in Bolivia

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Rígel Rocha-López

Thesis committee

Promotor
Prof. Dr R.A. Boelens
Personal chair, Water Resources Management Group
Wageningen University & Research

Co-promotors
Dr J.M.C. Vos
Associate Professor, Water Resources Management Group
Wageningen University & Research

Dr E. Rap
Visiting researcher
IHE Delft Institute for Water Education

Other members
Prof. Dr J.W.M. van Dijk, Wageningen University & Research
Prof. Dr T.A. Perreault, Syracuse University, USA
Prof. Dr J.D. Van der Ploeg, Wageningen University & Research
Dr F. de Castro, CEDLA, University of Amsterdam

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Shifting of water rights frameworks in Bolivia

Rígel Rocha-López

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CHAPTER 1 GENERAL INTRODUCTION

Water rights in practice: Leaders of irrigation groups in Tiraque verify the opening of gates in the Totora Khocha irrigation system (October 8th 2009).

Source: Centro AGUA, 2009

1.1 Introduction

Historical and contemporary development of people's economies, cultures and political structures is deeply coloured by and highly dependent on the availability of particular natural resources; water being one of the most decisive ones (Molle 2003). This fact is even more evident in semi-arid climate regions, which suffer from water scarcity conditions[1], such as Bolivia. In this country, the population's food security and rural livelihoods in particular, heavily depend on access to irrigation water. This sector is, by far, the main user of water in the country's basins (FAO 2015). Therefore, over the past 50 years, successive governments have considered the strategic role of irrigation for national development and allocated increasing amounts of economic resources to expand irrigation water provision. These public investments led to the construction of several new irrigation systems and the modification of traditionally existing irrigation systems (Callejo-Veracc 2019; Perreault 2008; Saldías et al. 2012).

However, most Bolivian irrigation systems have been built by local smallholder communities and respond to local demands, sometimes supported by government or development partners (Goodwin 2019; Gutiérrez 2005; Hoogendam 2019). Developing and sustaining irrigation systems goes not without conflict. Especially in the case of outside interventions into locally managed water use systems or river basins, strong clashes of interest tend to arise. Therefore, projects often face conflicting situations when groups of local actors oppose the implementation of a system that is conceived and designed by outsiders. The latter may often also put at risk the sustainability and continuity of existing systems, that in many cases have been functioning relatively well since decades or even centuries. Questions concerning technical design (Gutiérrez 2005; Saldías et al. 2012), defence of land and territory (Gelles 2000; Hommes et al. 2016) and demands for water rights (Gerbrandy and Hoogendam 2002; Vos et al. 2020), are the principal claims of these groups. These claims turn projects into conflictive settings for water struggles. As a result, the question arises how to design irrigation systems more sustainably and improve their engagement with local water management and use rationalities (Callejo-Veracc 2019; Gutiérrez 2005; Kooij 2016; Veldwisch et al. 2009; Vos 2002).

It is from these questions that this PhD study originates. Despite the various success stories and failures of intervention in irrigation projects in Bolivia, and the Andean region in general (Boelens 2015a, 2015b; Paerregaard et al. 2016; Perreault 2008; Seemann 2016a; van der Ploeg 2006, 2008; van Koppen et al. 2012), it seems that the same mistakes of the past continue to be repeated. This study invites rethinking irrigation development policies and strategies from a multiscale perspective on water development in an Andean river basin. This becomes even more urgent given the rapid political and economic changes in Bolivia, just as in neighbouring countries.

1.2 Research problem: Irrigation development as an arena of disputes

Considering the strategic role of irrigation to ensure national food security and poverty reduction worldwide, the last 60 years many national governments in the Global South

[1] More than 40% of the world's population lives in water-scarce river basins (Molden 2007).

have invested large capital flows in the expansion of their irrigated area. According to Faures et al. (2007), between 1960 and 2002 the area under irrigation worldwide almost doubled, increasing from 139 to 277 million hectares (ha). This has even tripled water extraction. It is expected that by 2050, the agricultural area under irrigation will reach a total of 322 million hectares (ha) (Alexandratos and Bruinsma 2012). Much of the area under irrigation corresponds to developing countries (75% in 2002), and specifically to Asian countries (56% in 2002) (Faures et al. 2007). In Latin America, the expansion of the irrigated surface was less, increasing from 13.8 to 18.6 million ha between 1980 and 2002 respectively (35% increase in 22 years). Unlike Asia, where the area under irrigation covers 35-42% of the total arable area, in Latin America it barely reaches 12.6%.

According to the *Comprehensive Assessment of Water Management in Agriculture* (Molden 2007) the conditions that led to an accelerated increase in public irrigation investment have changed radically. Current circumstances require substantial changes in irrigation development strategies. Increased water scarcity, climate change, urbanization (product of rural-urban migration) and emerging environmental problems, are among the main challenges for irrigation. They have led to the need to reinvent irrigation (de Fraiture et al. 2010; Faures et al. 2007). Because of such changes in the irrigation context, the growth rate of the irrigated surface area has reduced in recent years. Two periods may be distinguished in the development of irrigation. Abundant water and land resources availability (or 'making them available') characterized the first period (1960-1980). Irrigation development focused on the realization of massive investments to increase irrigation water provision, reaching to an annual growth rate of the area under irrigation of 2.2% in decade 1971-1980 (Faures et al. 2007). Increased water scarcity characterized the second period (1981-2020), in which irrigation development focused on improving water management and use, resulting in the decrease in annual growth rate of irrigated area to 1.2%, in the decade 1991-2000 (Faures et al. 2007). This growth is expected to reduce to 0.1% between 2005-2050 (Alexandratos and Bruinsma 2012). Irrigation expansion will become increasingly difficult and complex in the future, as water scarcity and competition for water by the large cities and industry continue to reduce the allocation of water available for agriculture. In particular smallholder families and communities tend to lose their irrigated areas, either to national and transnational agribusiness companies or to non-agricultural water use sectors (Baud et al. 2019b; Mehta et al. 2012; Vos and Boelens 2014, 2015; Vos and Marshall 2017).

While investments in irrigation development have generally resulted in significant improvements in food security and poverty reduction (Molden 2007), many interventions have failed and others have generated high social and environmental costs, such as inequity in water allocation and unwanted environmental impacts (de Castro et al. 2015; de Fraiture et al. 2010; Rap 2004). Considering the politically contested nature of water, these irrigation projects generate conflictive settings, full of resistance and water battles (Perreault et al. 2018a, 2018b). These have led to questioning the form and guidelines that spur irrigation development today. While in policy circles the body of literature on irrigation development at the global and regional levels is considerable, relatively little attention has been paid to the study of how irrigation development impacts on diversified access to water at the local level and, in

particular, how collectively managed irrigation systems are confronted with irrigation amplification and development processes. They prominently bring the question to the fore of 'who wins and who loses' in these processes.

Currently, smallholder families and communities aiming for the expansion of their irrigation areas to make a decent living, face a difficult and complex situation, considering that much of the primary water sources are already being harnessed or are under the control of some group of users (Wester et al. 2005). This situation is especially evident in semi-arid climate regions, such as the Bolivian Andes. As was mentioned, here, overall irrigation development has been headed most of all by peasant communities (Callejo-Veracc 2019). The latter have historically led the creation of irrigation systems, from the construction of hydraulic infrastructure to take advantage of available water flows, to establishing ownership rights (or 'hydraulic property') over the water captured and the infrastructure built (Boelens and Vos 2014; Coward 1983; Gerbrandy and Hoogendam 2002). As part of these processes, in Bolivia, peasant communities developed their own regulatory frameworks to control and manage the water. This is manifested in the ways they defend and claim recognition of their rights over water and their territories. In the current context of growing demand and decreasing availability, there is little room to undertake new irrigation projects without affecting water rights or socioterritorial control over the water sources of any group of users (Callejo-Veracc 2019; Hoogesteger et al. 2016; Perreault 2014).

As irrigation projects propose changes in access to and allocation of scarce and politically contested resources, various conflicts tend to arise in response to these attempts to re-order irrigation systems. Moreover, this often happens according to conceptions and interests largely external to the understanding and acceptance of local actors. As a result, in many irrigation projects promoted by the Bolivian state, various actors are competing, on the one hand, to defend and legitimize their rights over their waters and territories, and on the other, to control the extra water generated by intervention projects (Gerbrandy and Hoogendam 2002; Perreault 2008; Seemann 2016a; van Koppen et al. 2012). Most of the struggles around irrigation projects have their origins in the changing and divergent conceptions of water rights of the different actors involved, but Bolivian policymakers (and other governments in the region) display a strong lack of attention to this fundamental issue (Andersen 2019; Andolina 2012; Boelens 2015b; Guevara-Gil et al. 2010; Hommes et al. 2019a; Hommes et al. 2019b; Hoogesteger 2013; Lynch 2012; Paerregaard et al. 2016; Stensrud 2019).

Therefore, the research problem focuses on the lack of knowledge about the interaction between irrigation development and the changing and divergent approaches to water rights applied by the diverse actors involved. The lack of understanding and simplification of intervention processes in irrigation systems, by planners and designers of irrigation development, results in the implementation of prescriptive, top-down irrigation projects. Commonly, their proposals for re-ordering the irrigation systems are fiercely resisted by groups of actors who are involved in or excluded from these processes (Funder et al. 2012; Gandarillas et al. 1994; Gerbrandy and Hoogendam 2002).

Irrigation development in the *Pucara River Basin* is a case in point. This case study was purposefully sampled to produce more fine-grained empirical and analytical

understanding of irrigation development. This allows comprehending irrigation development as a politically contested process, generating water conflicts, in which peasant communities and their collectively managed irrigation systems play a major role. The case in particular allows apprehending how new hydrosocial networks, territories, and water rights are being negotiated and materialized (or not) at multiple scales in a river basin. This leads to infrastructural adjustments to increase water supply at the system, river basin and interbasin scales; and their socio-material and political contestation. The units of analysis of this case study - a complex hydrosocial network - vary with these three scales at which this water network is investigated: (1) the system, (2) the river basin and (3) the interbasin scale of water transfers. The Pucara river basin is a suitable and fruitful case for such analysis, since water users and indigenous peasant communities have taken an active role in demanding, defending and materializing their water rights at all scales, from the very local to the national. It was not by chance that these water user communities also played a prominent role in supporting the 'water war' against privatization of water rights in the city of Cochabamba (Assies 2003; Perreault 2005, 2008). This became an iconic struggle that drew international attention and created a national popular movement, in which (indigenous) water rights figured prominently, and which supported the political campaign of Evo Morales to become president. As will be detailed later on in this thesis, Cochabamba is further the region with the largest irrigated surface, the largest irrigation potential and the specific region which Morales' government targeted for the largest expansion of irrigated surface. This illustrates the interplay of technical, territorial and political (f)actors in irrigation development and water control.

This research, therefore, aims at providing an empirical and theoretical understanding of irrigation development processes at the irrigation system, river basin and interbasin scales. It does so by studying the political arena that has developed around changes in irrigation technology and water control processes in Cochabamba Valley's Pucara river basin.

Accordingly, the main research question guiding this study is:

> *How have changing approaches to water rights shaped irrigation development and control over water for different stakeholders in the Pucara river basin?*

1.3 Central themes

Each of the chapters of this thesis elaborates a complementary part of the conceptual framework. These chapters were all published as peer-reviewed journal articles (except for chapter 2 which is published as a peer-reviewed book chapter, and the conclusion chapter). In this section, I introduce three main themes of the research: irrigation development, water rights' dynamics, and hydrosocial territories. These themes will be further elaborated conceptually in the subsequent chapters of the thesis.

1.3.1 Irrigation development

Generally speaking, irrigation development is related to the construction of hydraulic infrastructure to regulate, store, control and transport water from its source to farmers'

land (Turral et al. 2010). The main aim is controlling unpredictable water flows and ensuring timely water provision for food production and the reproduction of rural livelihoods. In this regard, Coward (1980) indicates that irrigation development focuses not only on the design and implementation of hydraulic infrastructure and agricultural systems, but also on the establishment of patterns of interaction and organization of water users for the management of the irrigation system in its entirety. This process includes, on the one hand, investments by farmer communities and national governments to construct new irrigation systems, and the rehabilitation and modernization of traditional irrigation systems; and on the other hand, the implementation of normative arrangements and institutional structures for irrigation management and water governance.

The term 'irrigation development' is mostly associated with state intervention projects for agricultural intensification and irrigation modernization in public and/or private sectors. But in much of the world, as is the case in the Andean region of Bolivia, the development of irrigation has a long history closely related to local societal and cultural development. As Boelens and Gelles (2005) argue, the development of smallholder irrigation in the Andean region arises in particular from hybrid combinations of local and state actions and rules. To sustain their livelihoods, inhabitants from the Andean region have ordered the resources available to them in their lived spaces, in hugely diverse cultural and context-specific ways. Irrigation systems, as dynamic hydrosocial networks in space and time, join people, water sources, hydraulic infrastructure, land, knowledge, rules and rights, and diverse other material and non-material elements, around the control and use of irrigation water (Andolina 2012; Paerregaard 2018; Paerregaard and Andersen 2019; Perreault 2014; Rasmussen 2015).

To understand irrigation in local Bolivian contexts, it is crucial to leave aside the traditional analytical dualism that divides nature and society. Water flows, irrigation systems and territories are not simply regarded as natural elements governed by natural laws, nor are they merely social phenomena configured by social relations. Rather, they are 'hybrid' constructions (Haraway 1991; Latour 1993), social and natural at the same time (Baletti 2012; Linton and Budds 2014; Swyngedouw 2004b). A hydrosocial approach is required, conceptualizing irrigation systems as hydrosocial networks constituted through particular forms or "*modes of ordering"* (Wester 2008): subject to struggles, negotiations and agreements on water control and use (Swyngedouw and Boelens 2018). Modes of ordering, thereby, are understood as conscious, reflective strategies to configurate sociomaterial networks (Law 1994). In this sense, the development of irrigation through state and/or farmer communities' initiatives can be understood as a series of attempts to (re)order hydrosocial relationships around the establishment of particular forms of water control and use (Andersen 2019; Andolina 2012; Boelens 2015a, 2015b). Swyngedouw (1999, 2015) states that these dynamic processes of (re-)construction of hydrosocial relationships produce 'waterscapes' that reflect the dominant power structures; and are expressed in disputed patterns of water access, hydraulic infrastructure, water flows, regulatory frameworks and water control discourses (cf. Rasmussen 2015; Roa-García 2014; van der Ploeg 2006). Therefore, the study of irrigation development processes requires the analysis of the hydrosocial networks in all their heterogeneity, exploring their dynamics in time and space, in order to understand how they came to be configured as we know them, and how planned

interventions may lead to important positive or problematic changes in these hydrosocial networks (Aubriot et al. 2018; Boelens et al. 2016; Hommes et al. 2019b; Hoogendam 2019).

1.3.2 Water rights' dynamics

The capture of a particular source or flow of water, following the construction of hydraulic infrastructure, commonly coincides with how water use rights are (re)arranged in favour of a group of beneficiary users. This simultaneously determines the exclusion and/or decrease in water supply available for other uses and users. In this context, as irrigation projects deal with the allocation and access to an increasingly scarce and disputed water resource, they tend to constitute arenas for the defence of water rights and/or struggle for water control in the territorial areas where they are developed.

In this thesis, water rights are defined as *"authorised demands to use (part of) a flow of water, including certain privileges, restrictions, obligations and sanctions accompanying this authorization"* (Beccar et al. 2002, 3). Therefore, a group of users can exercise their right of water only when it is authorized by an authority with legitimacy and power to enforce that right; and recognized by the other groups of water users and non-users. In this sense, the process of irrigation development in the Andean countries becomes complex, as it implies in addition to struggles for access to water, struggles to gain the legitimacy of their water rights (Boelens et al. 2014). The concept of legitimacy involves the various mechanisms of acceptance, formal and informal, through which water control structures and authorities are validated, respected and sanctioned by the user collectives (Gearey and Jeffrey 2006; Roa-García 2014; Romano 2017). Therefore, behind the struggles for water there is a fierce battle to establish accepted discourses (values, norms and languages) through which water rights are legitimized (cf. Long 2004; Rap 2004). As times goes by and contexts, policies and actor arenas change, the legitimacy of water rights is constantly subject to review, evaluation and re-evaluation: water rights are ever changing cornerstones within the dynamic network of hydrosocial relations. Therefore, in order to understand the processes of government interventions or community struggles for water, it is necessary to study the hydrosocial networks in which water rights are created, and legitimized or delegitimized.

In this thesis' emphasis, and more in general in Bolivian water governance practice, most water rights and governance forms are related to collective and community management, in other words, to the notions of the commons and common property resource management (Ostrom 1990, 1993, 2009)[2]. Vos et al. (2020) have characterized water management commons (or as they say, *"rooted water collectives"*), as *"instances of collective action, coordination and shared governance arrangements that either engage in communal management of water systems (and may have second or more tier federations) or form a social movement that advocates for local common property resources management"* (p.1). Beccar et al. (2002) and Suhardiman et al. (2017) suggest that collective action is based importantly on the need that arises in various

[2] For debates about common property and natural resource management commons, see e.g., Baud et al. (2019b); Baud et al. (2011); de Castro et al. (2015); Mosse (2006); Ostrom (1990, 1993, 2009); Paerregaard and Andersen (2019); Perreault (2008); Suhardiman et al. (2017).

relationships of 'interdependence' (economic, cultural, psychological, political, technological) among individuals and the users organization (see also Gerbrandy and Hoogendam 1998; Verzijl et al. 2017). As Callejo-Veracc (2019) shows, families could not survive alone, reproducing their agrarian production cycles without establishing cooperative ties with other families or under the umbrella of a collective management of water resources (see also Boelens 2015b; van der Ploeg 1990, 1998, 2008; Verzijl et al. 2017). Hereby, community management *"would cease to function without property relations that unite and motivate families to monitor and maintain their collective resources"* (Guillet 1992, 3). Interdependence is understood, then, as a mutual need to cooperate.

In the context of commonly managed systems, water rights can be individual or collective. While individual rights refer to the rights of users within irrigation systems, collective rights have an important function external to the irrigation system. The latter are conceived as *"the authorized claims on water use and control by a user organization vis-a-vis third parties (individual or collectives), whose interests may be in conflict with its own"* (Boelens 2015a, 1464). In line with the above observation, this study focuses mainly on collective rights. According to Beccar et al. (2002), collective water rights determine water use by a group of users (community, association, etc.) and the conditions for controlling water from certain sources. These rights are reflected in collective defence strategies and the autonomy of decision against other parties and regulatory systems (such as state legislation) or attempts at intervention. It should be noted that collective rights also include a number of 'lateral' rights related to water use and infrastructure, such as the right-of-way along hydraulic infrastructure. In the Andean region, water rights form the normative basis for collective action, which guarantees the sustainability of the irrigation system over time (Gerbrandy and Hoogendam 1998).

Given the plurality of socio-legal frameworks that interact in the Andean territories, it is evident that there are various mechanisms for obtaining water rights, which are established and recognized by different frameworks and authorities that regulate water governance (Boelens 2015a; Boelens and Doornbos 2001). Chapter 2 of this thesis contains a detailed description of the main mechanisms identified in the Andean region and in other regions' river basins. Dominance for acquiring collective water rights vis-a-vis other user groups is commonly based on profound negotiation or conflict processes among the different user groups involved. Important hereby are also the strong or weak influences of national regulatory frameworks and intervention projects (Beccar et al. 2002).

Water rights are dynamic, flexible and subject to frequent negotiations, because they are part of the social, political, and economic relations that structure society in multiple changing ways (Achi 2010; Meinzen-Dick and Pradhan 2002). In this sense, the definition and prevalence of a particular framework of water rights reflects the divergent economic, institutional and cultural objectives and power of the social groups involved (Suhardiman et al. 2017). Beccar et al. (2002) identify factors that may cause gradual and abrupt changes in irrigation water rights. Factors that cause gradual changes include: change in the number of users (population growth and migration), the reorientation of agricultural production, and changes in irrigation technology associated

with intervention projects (e.g., Achi 2010; Sanchis-Ibor et al. 2017; Stensrud 2019). Among the factors that often cause abrupt change are: land reform processes, encroachment by outside powerful stakeholders, and changes in national water laws and policies (e.g., Bebbington et al. 2010; Cleaver 2018; Hoogesteger and Verzijl 2015; Rap 2006).

As evidenced in this thesis, the creation, consolidation and transformation of collective water rights is highly dynamic. This refutes conventional notions that see water rights as static and fixed elements of water systems or prescriptive tools for water governance. Chapter 2 will present an elaborate framework regarding the different mechanisms of water rights acquisition and the modes in which these are implemented.

1.3.3 Hydrosocial territorialization

In the adverse bio-physical and cultural-political settings of the Andean region, where collective action forms the basis for the defence and reproduction of peasant livelihoods, water and territory are linked in the processes of materially creating collective hydraulic property systems (Boelens and Vos 2014; Guillet 1992; Hoogendam 2019; Verzijl et al. 2017). Thereby, collective processes of capture and use of irrigation water – from the construction, operation and maintenance of the infrastructure to multiple modes of water control – constitute processes of construction and reproduction of (contested) hydrosocial territories. These territories form the basis of the socio-productive, political and cultural management of water and related resources by the peasant community. They constitute socio-natural networks in which people live and reproduce their livelihoods and identities (Guevara-Gil et al. 2010).

Thus, as Boelens et al. (2016) explain, irrigation systems and basin configurations empirically appear and may be conceptually examined as hydrosocial territories. They are disputed, spatially bound socio-material constructs in which water is controlled by inter-related:

- physical elements (e.g., water sources and flows, hydraulic infrastructure to catch, conduct and distribute water, water provision places),
- normative elements (rules, rights and obligations regarding access to water and related resources),
- organizational elements (human organization to operate/sustain the system; capacities and knowledge of the art of irrigation) and,
- financial and agro-productive elements (soil, crops, technology, capital, labour force).

"These are embedded in cultural and political traditions and powers at different yet interrelated scales" (Hoogesteger et al. 2016, 93).

In this understanding, territory is built by society, and its conception and delimitation is dependent upon and constituted by social and power relations (Baletti 2012; Mancano 2009). Thus, hydrosocial territories are configured through complex processes of dispute and negotiation between the social actors involved in using water, who seek to guarantee their own interests and materialize their visions and projects (Hoogendam 2019; Seemann 2016a). Different groups imagine and realize their wished-for 'territory'

differently; they compete and struggle over the definition and composition of its boundaries, elements and meanings to shape their territorial projects (Hommes et al. 2019b). Interconnected by their water flows, hydraulic technologies and water governance, these territorial components and definitions are simultaneously social, technological and natural. Considering the heterogeneity of social groups and hydrosocial networks configured around water control, in a certain socionatural space - such as the Pucara river basin - multiple territories and territorialities are co-existing and overlap, often in competition with each other (Baletti 2012; Duarte-Abadia et al. 2015; Dupuits 2019).

Hoogesteger et al. (2016) elaborate how hydrosocial territories are structured, which can be understood by studying their:

- contents (water control, and the divergent meanings of its constituting elements),
- size and boundary arrangements (definitions of place, space and socio-natural boundaries) and,
- connecting relationships (among different actors, resources and natural environments, at different scales) (see also Hidalgo-Bastidas et al. 2018; Hommes et al. 2019b; Hulshof and Vos 2016).

As shown in this thesis, many of the conflicts and struggles around irrigation projects are processes of resistance and struggle against attempts to impose specific forms of water control, but also against attempts at "*de-territorialization and re-territorialization*" (Herner 2009; Hommes et al. 2016; Rodríguez-de-Francisco and Boelens 2016; van der Ploeg 2008).

Divergent views, interests and powers over how specific hydrosocial territories are or should be configured lead to the co-existence and overlapping of multiple territorial imaginaries and contested construction processes ("territorial pluralism", Hoogesteger et al. 2016). Thus, at the heart of the matter is how socionatural spaces and the resources they contain are organized and ordered, which respond to new forms of conceiving and valuing water and territory (cf. de Castro et al. 2015; Perreault et al. 2018a, 2018b; van der Ploeg 2006; Vos et al. 2006).

For controlling and defending Andean communities' hydrosocial territories, in addition to the right of access and material use of the water resources contained therein, the right to autonomously make decisions on these resources, therefore, is fundamentally important (Gerbrandy and Hoogendam 2002; Vos and Boelens 2014). These rights over water control are immersed in social, political and cultural inter-relations that determine the nature, function and value of water, and are closely linked to the identity of peasant communities (Benda-Beckmann et al. 1997; Perreault 2008; van der Ploeg 2008).

1.4 Context of the case study

This thesis on irrigation development in the Pucara river basin, Cochabamba, focuses on the in-depth historical development of the Totora Khocha irrigation system. The

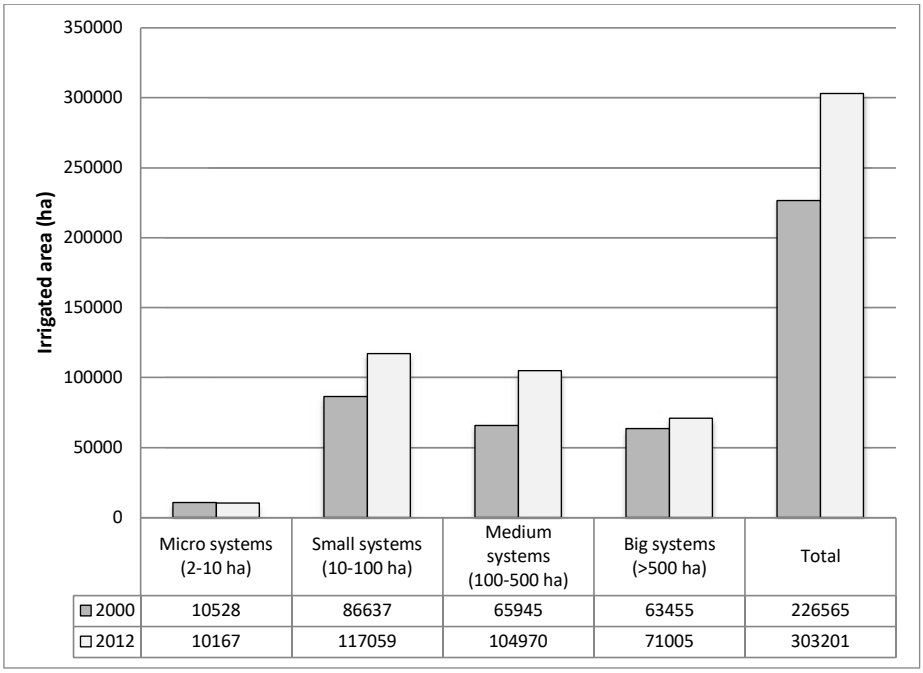
following sections contextualize the case study based on the description of irrigation development in Bolivia, and then present the main characteristics of the Pucara river basin and the Totora Khocha irrigation system.

1.4.1 Irrigation development in Bolivia

Bolivia is characterized by high climatic and topographic variability, distinguishing five main ecological zones: *Altiplano*, *Valles*, *Yungas*, *Llanos* and *Amazonia*. In much of the national territory, specifically in the Andean region (Altiplano and Valles), rainfall regimes are highly variable. The year consists of a long dry season and a short, but intense rainy season, with 6 to 9 months of water deficit per year for agricultural production. However, the production of the main food crops for Bolivian population, is concentrated mainly in the Andean region (Callejo-Veracc 2019). Agriculture in the Andean region is mainly in hands of peasant families. Peasant agriculture, covers more than 40 percent of the country's cultivated area and involves about 80 percent of the rural population (FAO 2015). In this sense, irrigation is essential for national food security and the sustainability of the livelihoods of rural population. Irrigation water is mainly for irrigation of tubers (27%), cereals (20%) and vegetables (19%) (MMAyA 2013). According to the National Irrigation Development Plan (Ministerio del Agua 2007) the Andean region have been defined as the priority zone for state intervention in irrigation.

Considering climate, soils and water resources, Bolivia is estimated to have around 2 million hectares with irrigation potential[3] (FAO 2000). According to data from the first inventory of irrigation systems (PRONAR 2000), Bolivia had a total of 4,724 irrigation systems in 2000, irrigating a total area of 226,565 ha. For the year 2012, when the second inventory of irrigation systems was carried out (MMAyA 2013), the number of irrigation systems had increased to 5,669, with a total irrigated area of 303,200 ha. The department of Cochabamba is the main region for irrigation in Bolivia. This department concentrates 24% (1,333 systems) of the total number of irrigation systems and the 32% (95,950 ha) of the total irrigated area of the country. Figure 1.1 outlines the change of the irrigated area in the period 2000-2012, considering four sizes of irrigation systems. According to this data, small (10-100 ha) and medium (100-500 ha) systems are the types of irrigation systems with the highest growth in this period. In terms of field application, surface irrigation (by gravity) is the most widely used irrigation method. However, in recent years, pressurized irrigation (sprinkler and drip irrigation) has been widely promoted, covering 3% of the total irrigated area (MMAyA 2013).

[3] Bolivia has an estimated arable area of 25.9 million ha; of which approximately 2 million ha (8%) is suitable for irrigation (FAO 2000).



	Micro systems (2-10 ha)	Small systems (10-100 ha)	Medium systems (100-500 ha)	Big systems (>500 ha)	Total
2000	10528	86637	65945	63455	226565
2012	10167	117059	104970	71005	303201

Figure 1.1 Change of the irrigated area in the period 2000-2012.
Source: Own elaboration based on PRONAR (2000) and MMAyA (2013)

In recent years, the Bolivian government has prioritized irrigation as one of the fundamental pillars of development. It has increased public investment in irrigation by more than 800% between 2006 and 2015. According to data from the Vice-Ministry of Water Resources and Irrigation (VRHyR), there was an increase of 112,174 ha under irrigation between 2012 and 2015. According to projections, in 2013 the Bolivian government set itself a target to reach 500,000 ha under irrigation until 2025 (VRHyR 2013), and then it expanded the target to one million hectares under irrigation in the frame of the so-called 'Irrigation Decade Act' enacted in 2015.

According to data from the second national inventory of irrigation systems (MMAyA 2013), 89% of the inventoried irrigation systems correspond to irrigation systems with less than 100 ha under irrigation. They are mostly relatively ancient community irrigation systems under collective management built by the users. The remaining 11% of the inventory of irrigation systems, corresponding to irrigation systems with areas greater than 100 ha, mostly are new community irrigation systems built by the state, or older systems with expansion of the area under irrigation. Historically, irrigation development in Bolivia has focused mostly on promoting projects to improve hydraulic infrastructure in small and medium-sized traditional community irrigation systems; and to a lesser extent the construction of new medium and large irrigation systems (as in the neighbouring countries of Ecuador and Peru).

Irrigation in Bolivia has its origins in periods even before Spanish colonization. Before the 1953 Bolivian Agrarian Reform, land and water in Bolivia were mainly controlled by hacienda-owners. Just after this national reform, the indigenous peasants, organized in rural communities, obtained the right to land and water. Since these times, peasant communities organized to construct collectively hydraulic infrastructure and ensure their livelihoods. In these community irrigation systems, water is managed collectively organized in associations, committees, or other organizational forms. It is in the context of these local organizations, that the rules and norms for the distribution and use of irrigation water are discussed and established, as well as the management of the irrigation system in general. An important feature of most of these systems is that the allocation of water rights is carried out according to the investment of resources (labour, money, etc.) in the construction of hydraulic infrastructure (hydraulic property). These water rights form the basis for structuring customary regulatory frameworks ('uses and customs'), which largely determines water governance in Bolivia (Gerbrandy and Hoogendam 1998).

In this context, around the 1970s, the Bolivian state oriented its actions mainly to the modernization of communal irrigation systems through their improvement and expansion. Improving the efficiency of water management was to increase the agricultural production. In 1994, through the Popular Participation Law, the state's role in irrigation development shifted from a top-down model to a more flexible demand-driven one. Through participatory planning, this law increased opportunities for peasant communities to participate in municipal decision-making, particularly in the irrigation sector (Kohl 2003). In 1997 the first Departmental Irrigation Federation (*Federación Departamental Cochabambina de Organizaciones de Regantes, FEDECOR*) was created (Fernández et al. 2006).

The neoliberal model, already implemented since 1985 in Bolivia, particularly influenced the "Drinking Water and Sewage" Law (*Ley 2029, de Agua Potable y Alcantarillado*), which fomented the privatization of drinking water services. This attempt of water privatization produced social mobilizations that pushed foreign private companies out of the country, with strong participation of FEDECOR (for instance, during the 2000 Cochabamba water war). These social mobilizations situated water as a central issue at national level, and resulted in the re-institutionalization of Bolivian water governance, and the promulgation in 2005 of the Law 2878 of "Promotion and Assistance to the Irrigation Sector for Agriculture and Forestry" (Perreault 2005, 2008). Through this law, Bolivian irrigators achieved, first, the legal protection of customary water uses through collective water rights and, second, the institutionalization of irrigators' control over the irrigation sector. This process was reinforced by Evo Morales' Government (since 2006), which institutionalized and consolidated local and regional water governance. The government empowered indigenous/peasant communities and gave them the right to make decisions about their territories and their resources (Morales 2011).

1.4.2 The Pucara River Basin

The Pucara River Basin, key research area of this thesis, has a long history of irrigation development and continues to be the focus of multiple state interventions. The Pucara River Basin (Figure 1. 2) is located in the Valle Alto of the Cochabamba department, in

the central region of Bolivia. It extends from the rugged Tiraque mountains (4650 meters (m) altitude), to the Punata Valley (2800 m altitude). The total catchment and discharge area comprise an area of 482 square kilometres (km^2). Administratively, the basin is divided into four provinces (Tiraque, Punata, Arani and Chapare) and six municipalities (Tiraque, Punata, Arani, Colomi, Sacaba and San Benito). The municipalities of Tiraque and Punata comprise 90% of the total area of the basin and concentrate more than 95% of the total population. The rural population is mostly organized in peasant communities and the urban population is concentrated in the two main towns: Punata and Tiraque.

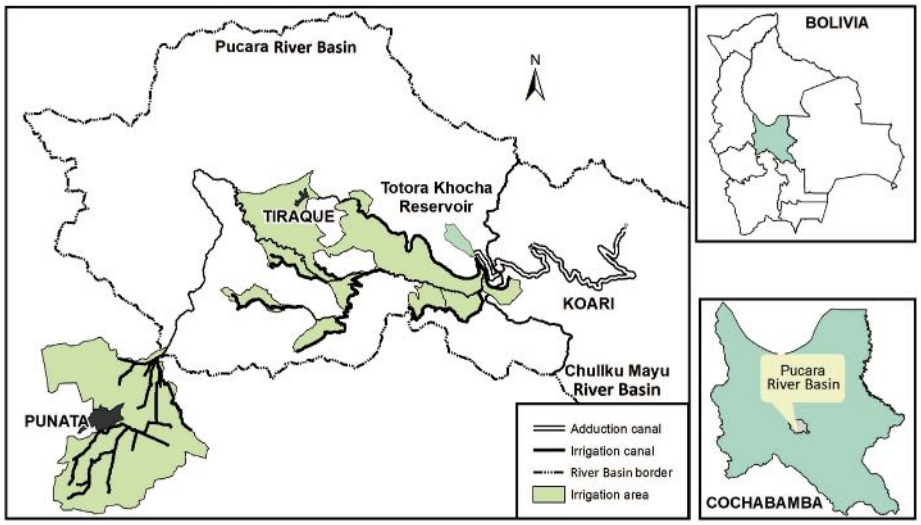


Figure 1.2 The Pucara River Basin.
Source: Own elaboration.

The livelihoods of most people in the basin are based on agriculture, and considering the shortage of rainwater, access to irrigation water is highly important for peasant communities. In this respect, the two municipalities differ notably. In the Tiraque municipality there is a relatively ample availability of water sources but lesser aptitude for agricultural production. This contrasts with the shortage of water sources but higher aptitude for irrigated agriculture in the Punata Valley. The Tiraque region is mostly mountainous and rugged, with thin, poor topsoil and a frigid (10.2–13.6 °C) and humid (rainfall of 500–800 mm/ year) climate. Agricultural production is limited to growing cold-hardy crops like potatoes, fava beans and grains. Historically more intensive production was restricted to the flatter areas of the alluvial fan near Tiraque village, whereas in the highland communities only small plots with food crops for self-consumption were grown. By contrast, the Punata region is a flat alluvial fan, with deep, fertile topsoil and a temperate (11.3–17.2 °C) and dry (rainfall of 300–400 mm/year) climate; enabling to grow a diversity of crops, such as corn, vegetables, peaches and others, under the condition of having access to irrigation water. Because of its own

limited water availability, Punata's agricultural production has historically been highly dependent on water sources from Tiraque.

In the Pucara river basin, irrigation is by far the most important water use sector, consuming around 80% of the available resources (16–20% domestic and 0–4% industrial use). Currently, the area under irrigation in the basin covers about 14,300 ha (30% of the basin), with 10,100 ha in Tiraque and 4,200 ha in Punata. A total of 21 communal irrigation systems were identified in Tiraque, with twelve systems that use water from reservoirs, seven from springs and two from rivers (Cáceres 2009). In Punata, a total of 74 communal irrigation systems have been identified, with 66 systems that use groundwater through wells, four from the river, three from reservoirs and one uses treated wastewater (Delgadillo and Lazarte 2007; Saldías et al. 2012). Most users have water rights in more than one irrigation system and can access water from more than one source. Despite the increasing exploitation of groundwater (in Punata), largescale reservoirs are the main source of water for irrigation and focus of state intervention, reaching 99% of the irrigated area in the basin. A total of fourteen reservoirs were built in the basin, which store around 18 million cubic meters (Mm^3) per year, with three reservoirs receiving water transferred from neighbouring river basins. The communities of Tiraque control a total of eleven reservoirs; Punata, two; and one is shared between the two regions. In consequence, at present, most of the available water is committed and managed by different groups of irrigators, with the result that during the dry period (April–October) all the water is utilized and the basin is 'closed' (Rocha et al. 2014).

Another important aspect that makes this basin an interesting case to study, is the highly political context where irrigation is developed. On the one side, the Pucara river basin is the result of historical conflict-ridden struggles and negotiations to control the basin's water, among Punata and Tiraque (e.g., Gandarillas et al. 1994; Gerbrandy and Hoogendam 2002; Rocha et al. 2015). On the other side, basin's irrigation associations played a highly important role in the transformation of water governance and the political changes in Bolivia, in the last years. The irrigators associations in Tiraque and Punata are strong supporters of the political party that till recently ruled Bolivia (Movement Toward Socialism – Instrument for Peoples' Sovereignty, MAS-IPSP). Unswerving participation by Punata and Tiraque irrigators in the movement that made Evo Morales President (the first indigenous president in Bolivia, from January 2006 to November 2019), positioned the irrigation sector in close relationship to the national and departmental governments.

1.4.3 The Totora Khocha irrigation system

The *Totora Khocha* irrigation system is the biggest and most important system in the Pucara river basin. It was developed as an attempt to 'reopen' the river basin through interbasin water transfer. It also has a long and rich history, considering that its origin dates to the beginning of the twentieth century. The Totora Khocha irrigation system extends along the Pucara River Basin: from the high and steep mountains of Tiraque, where water is collected and stored in the *Totora Khocha* dam (3700 m altitude); to the slopes and valleys of Tiraque (3000-3700 m altitude), and the Punata Valley (less than 2800 m altitude), where water is used for irrigation (Figure 1.3). Administratively, most of the system is located between the municipalities of Tiraque (upper part of the basin) and Punata (lower part of the basin).

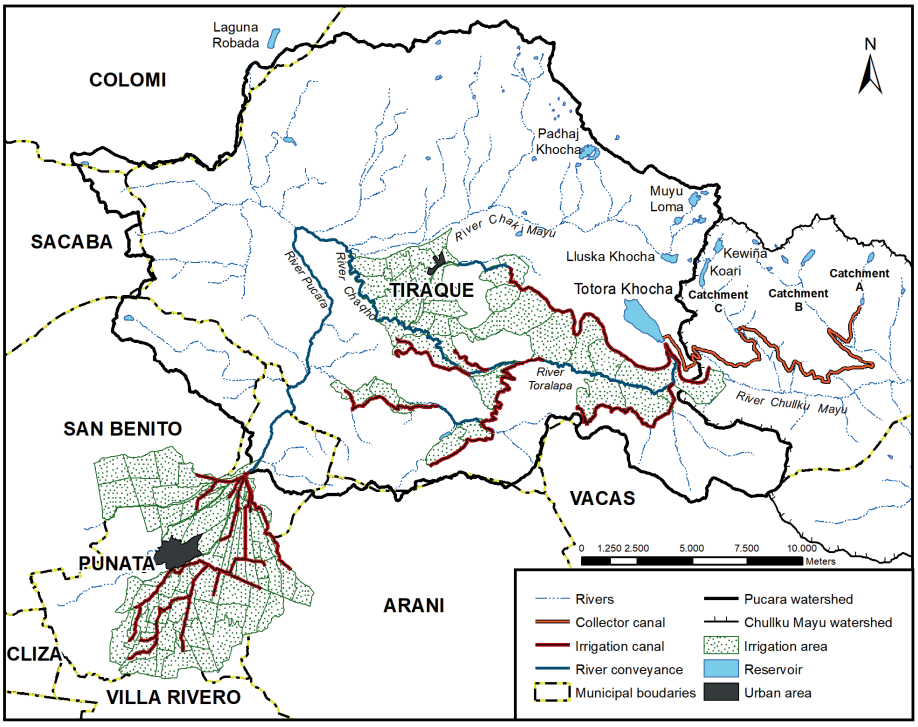


Figure 1.3 The Totora Khocha irrigation system in the Pucara river basin.
Source: Own elaboration based on PRIV (1992).

The Totora Khocha dam stores 40% of the annual water stored in the basin, and it irrigates 49% of the total irrigated area in the river basin. It has a storage capacity of 22 Mm^3. It stores water transferred from three neighbouring catchments, located in the *Chullku Mayu* river basin *(Kewiñal* or catchment A, *Condoraño* or catchment B, and *Lagunillas* or catchment C). It has a conveyance channel of 23 km in length. The stored water is led to the irrigation areas through canals and river beds, and is distributed to the fields by a network of canals within the irrigation areas. The irrigation area covers 7000 ha, distributed in two main irrigation areas:

- The mountains and valleys of Tiraque; with 34 peasant communities and an area of 2800 ha; and
- The Punata Valley; with 63 peasant communities and an area of 4200 ha.

The management of the Totora Khocha irrigation system is the product of a long historical process of constructing agreements and regulations around the management and use of water, expressed in the allocation and distribution of irrigation water. As a result of this historical process, a total of 4156 users (as of 2010 organized in three sub-

systems (*Tiraque Antiguos*, *Tiraque Nuevos* and *Punata*) share the right to use the water stored in the dam and the obligations regarding the operation and maintenance of the system. The water volume stored in the rainy season (December-April) is divided among the three sub-systems following the established agreements: *Tiraque Antiguos* receives a fixed volume of 0.8 Mm^3; and the remaining volume is distributed proportionally between *Punata* (60%) and *Tiraque Nuevos* (40%). Users are organized around the Punata Water Users' Association (ARSP for its abbreviation in Spanish); and the Tiraque Water Users' Association (ARST). The two associations assume the management of the irrigation system together.

The annual water allocation is made on the basis of the volumes stored in the reservoir during the rainy season, following the established agreements. Table 1.1 shows the characteristics and corresponding annual water allocation of the three sub-systems. It should be noted that, in practice, the number of users and shares ('*acciones*') may vary from year to year, since not all users make use of their water rights.

Table 1.1 Water allocation to the 3 sub-systems in the Totora Khocha irrigation system.

Sub-system	N° Communities	N° Users	N° Shares	Annual water allocation
Tiraque Antiguos	9	397	459	0.8 Mm^3
Tiraque Nuevos	34	1244	1880	40% of remaining water
Punata	63	2533	2883	60% of remaining water
Total	107	4156	5222	

Source: Data from the WUAs, year 2009 for Tiraque and year 2010 for Punata

The dam operates with discontinuous flow, or 'release'. Each sub-system independently defines how it will use the allocated annual volume, determining the 'release' periods according to the water need of its crops and the operation of the other irrigation systems with which it shares the infrastructure for water conveyance and distribution. The delivery of water to the sub-systems is done at the outlet gate of the dam, so once the water leaves the dam, the responsibility to convey and distribute the water among the users, rests with the irrigation sub-systems organized in committees. Within the sub-systems the allocation and distribution of water is carried out according to the number of shares of the users, grouped into communities and irrigation groups. Each sub-system has its own characteristics of operation and distribution of water according to the very conditions of the irrigation area.

1.5 Research questions

The main research question of this thesis research is: ***"How have changing approaches to water rights shaped irrigation development and control over water for different stakeholders in the Pucara river basin?"***.

The main question will be answered by addressing the following four sub-questions:

i. What heuristic conceptual framework on water rights can be formulated to analyse the diverse ways in which different actor groups legitimize their claims to water use in a river basin?

ii. How have different stakeholders, throughout history, strategically used diverse "legitimation languages" to claim water use rights in the Pucara river basin?

iii. How did the expansion of the Totora Khocha irrigation system lead to the negotiated construction of new water networks to control the Totora Khocha reservoir waters in the Pucara river basin?

iv. How did changing hydrosocial territorialization by different stakeholders, lead to the reiterated re-design of the planned interbasin expansion project of the Totora Khocha irrigation system?

1.6 Methodology

This study has collected, generated and scrutinized all available empirical data on the historical dynamics of irrigation development and collective water rights in the Pucara River Basin. As was mentioned in previous sections, the Pucara River Basin was selected as a case study because of its long history of struggles over irrigation water and the many modifications of the project designs that it underwent, in a highly complex setting of political struggle over the basin's water resources. The fact that this basin is 'closed', which means that most of the available water is already committed, makes this case particularly complex due to the conflictive arena of irrigation development. In this sense, the case shows a clear shift in the moral basis of the water right claims by different stakeholders. The case allows studying how new hydrosocial networks, territories, and water rights are being negotiated and materialized at multiple scales in a river basin. Finally, it is necessary to highlight, the political context of irrigation development in the Pucara river basin. Besides the historical conflict-ridden struggles and negotiations to control the basin's water, among the different stakeholders; they played an important role in the transformation of water governance and the political changes in Bolivia.

The theoretical knowledge, discussed in this study, is developed inductively from empirical data collected at three analytical scales: river basin, irrigation system and interbasin water transfer (Figure 1.4):

- ***At the river basin scale***, the study focused on historical analysis of the configuration of hydrosocial territorial networks in the Pucara basin, in relation to changes in the forms of water rights acquisition and defence. At this scale, the influence of the national socio-political context on hydrosocial dynamics and the changing power relations of water governance in the river basin is also studied.

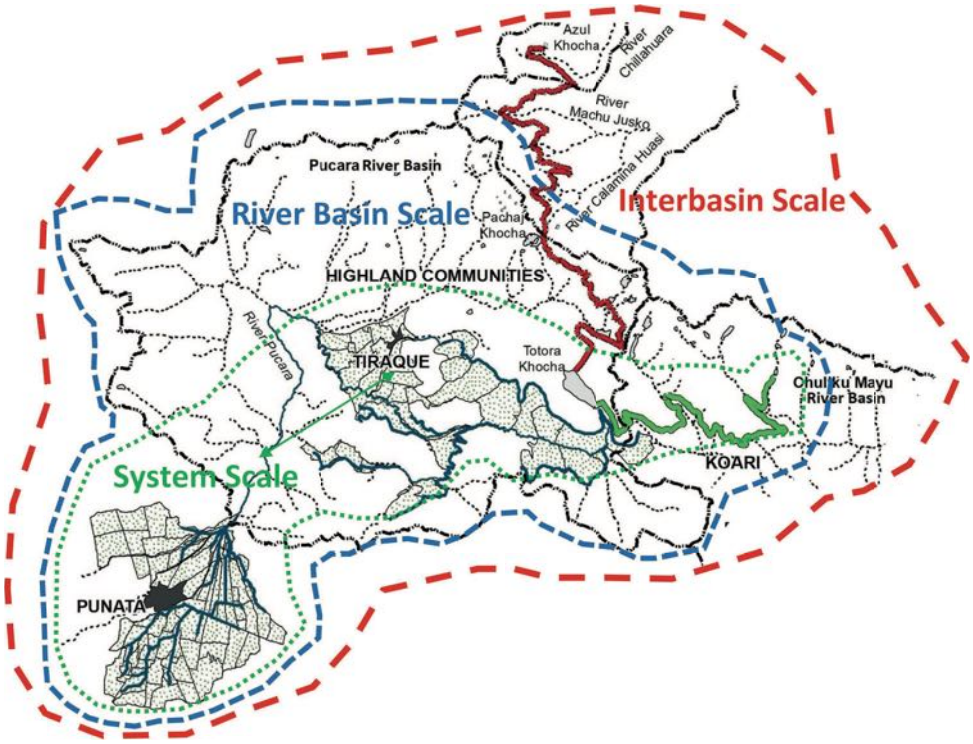


Figure 1.4 Diagram of analytical scales.
Source: Own elaboration.

- ***At the irrigation system scale,*** the study focused on the Totora Khocha irrigation system. Considering that this system constitutes the *'backbone'* of irrigation water management in the Pucara river basin, many of the problems related to the irrigation development process in the basin originate or come together in this system. The study focused on the analysis of the historical process of expansion of the Totora Khocha irrigation system (1950-1991), in the context of a river basin in the process of 'closure'.
- ***At the interbasin scale,*** the study focused on the negotiation process of the irrigation project "Trasvase Yungas de Vandiola" (1993-2012), aimed at a further expansion of the Totora Khocha irrigation system. This has given me the opportunity to witness and follow closely part of this process. This was done being member of the technical team of Centro AGUA-UMSS, which supported the communities of the river basin at different stages of the negotiation process.

It is important to note that the analytical scales considered in the study are not simply biophysical space characterizations with clearly delimited boundaries. The scales relate to the dynamic, socio-spatially evolving 'makings-of-place' within the hydrosocial territories studied.

Empirical data of both a qualitative and quantitative nature on irrigation development were collected through intensive field work carried out in 2009–2011, with follow-up visits during the years 2012–2018. Three qualitative methods of data collection were further applied: documentary and archival review, semi-structured interviews and participatory observation.

The ***literature and archival review*** included the study of scientific literature, official documents of the irrigation projects implemented (feasibility studies, project design and evaluations) and research reports generated by Centro AGUA-UMSS and other water governance and archival institutions. This enabled the re-construction of the irrigation development process in the basin, identifying the main milestones and irrigation development actions executed in the basin.

Considering that the study period spans from the 1950s, most of the documents produced are in physical format, and were generated in the 1970s to 1990s. In this sense, since these documents were dispersed, various sources had to be used: government institutions, files of irrigation associations and libraries. Several basic documents (like project documents and reports) were collected directly from some of the actors. Many of the official documents of the irrigation projects were incomplete (lack of maps and plans), in this sense I had to reconstruct some of design plans with the information of the documents.

In addition, based on the survey and study of the irrigation systems of the basin, a ***Geographic Information System*** (GIS) was established with information on: water sources, hydraulic infrastructure, agronomic and socio-geographical data, and irrigated area information. This GIS became a very useful tool in my introduction as a researcher in the study area. The irrigation associations in the study area showed interest in the GIS to be generated, so in addition to accepting my study, they helped me in getting to know the irrigation systems and helped in the collection of information about them. Doing this field work, enabled me to meet leaders and other users of the systems, who subsequently became the initial key informants of the study.

Three types of ***semi-structured interviews*** were conducted with key informants at the river basin scale and in the Totora Khocha irrigation system. The first type of semi-structured interview (8 interviews) was directed at leaders of the Punata (ASRP) and Tiraque (ASRT) irrigation user associations, inquiring about the historical process of intervention and control of water resources in the basin. The second type of semi-structured interview (28 interviews) was directed to leaders of specific irrigation systems (six irrigation systems including Totora Khocha), who were directly involved in intervention processes in their irrigation systems; inquiring about the specific historical process of the hydrosocial territorial configuration system and how users obtained, reproduced and defended their individual and collective water rights. The third type of semi-structured interview (4 interviews) was directed to government officials and consultants involved in irrigation system intervention processes in the basin; inquiring about the process of designing and building irrigation systems in the basin and the problems faced during the process. In the case of the follow-up to the project "Trasvase Yungas de Vandiola", the second and third types of interviews were expanded (resp. with 12 and 4 interviews), including topics on the negotiation processes that were

ongoing. In total, the 56 interviews that I have conducted, aim to cover most of the stakeholders involved in the irrigation development in the Pucara river basin.

The interviews (mainly with the leaders and water users) were conducted in several sessions, several of which included discussion of topics outside the research, but of great interest to the interviewee. Through these conversations, and my continuous presence over the years working with irrigator communities, bonds of trust were established. Participation in social spaces with irrigation users (such as sharing drinks in a '*chicherí*a'), were an integral part of this, strengthened bonds with local actors. More details about the interviews can be found in the different chapters of the thesis.

Participatory observation was applied to investigate positions, speeches and discussions about water resource control processes in the river basin. I have participated in periodic communal meetings and irrigation associations. I also participated in meetings held within the framework of the negotiation process of the Yungas de Vandiola interbasin project, such as meetings of associations, technical meetings and specific negotiating meetings with the participation of the different actors involved. Participatory observation also involved closely following and setting up records of the socio-material changes in the hydrosocial territories, in terms of constituting components, boundaries and discourses. Participatory observation of user meetings allowed to collect information on opinions and discussions around water resource control processes in the basin. Compared to the other irrigation development negotiations, in the case of the irrigation project debates around "Trasvase Yungas de Vandiola" it was more difficult to attend the meetings of the different opposing groups given their high sensitivity. I had to turn to informants who participated in the meetings. Likewise, at the suggestion and with the support of one of the leaders with whom I had friendly relations; I was able to participate 'incognito' in a couple of meetings. Due to the large number of participants, my presence was not noticed.

1.7 Structure of the thesis

The thesis is structured based on scientific articles presented as chapters. In general, each chapter maintains most of the structure and content of the original article. However, it is worth mentioning that slight modifications were included in the content of the chapters, with the main objective of more strongly presenting the thesis's main approaches and findings. Figure 1.5 outlines the general structure of the thesis, denoting the analytical scales applied in the study: river basin, irrigation system and interbasin. It begins with a synthetic review at a general level of various forms of legitimation of water rights (Chapter 2). Chapter 3 presents the analysis of irrigation development and the changing languages of water legitimation at the scale of the Pucara river basin. Subsequently, in order to analyse this interaction in greater detail, the analysis zooms in to the negotiated expansion of the Totora Khocha irrigation system (Chapter 4). Finally, in Chapter 5, the scale is enlarged again and focuses on interbasin scale, to analyse the reiterated re-design of the planned interbasin transfer project to expand again the Totora Khocha irrigation system.

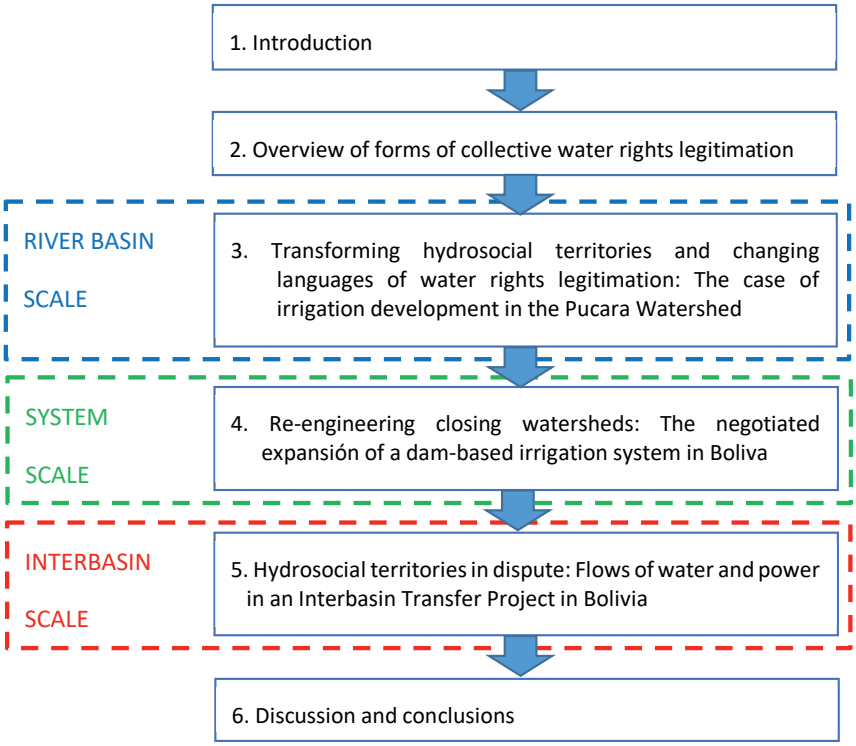


Figure 1.5 Structure of the thesis.
Source: Own elaboration.

The **second chapter**, *"Overview of forms of collective water rights legitimation"*, is based on a synthetic review of various mechanisms for the creation and legitimization of collective water rights. These are identified in five river basins around the world. The chapter presents the fundaments for the theoretical framework applied and further elaborated in the thesis, regarding the analysis of collective water rights.

The **third chapter**, *"Transforming hydrosocial territories and changing languages of water rights legitimation: Irrigation development in Bolivia's Pucara river basin"*, is based at the basin scale. It examines historical changes in the forms of legitimization of water rights, social acceptance of these claims and their realization in terms of hydraulic infrastructure and access to water. Applying the recent conceptual notion of *"hydrosocial territories",* this chapter shows how, over the three periods studied (1950-2017), the predominant language of legitimization of water rights in the Pucara river basin, changed from forms based on the creation of hydraulic property rights, to forms that emphasize socioterritorial rights. The territorialization of water claims is closely related to changes in national policies and regulations, such as the process of administrative decentralization (municipalization) and the empowerment of indigenous peasant communities. It is shown that, in order to improve the intervention processes in irrigation systems, it is necessary to understand (in addition to positions, interests and

power structures) also the multiple languages or forms of legitimization of water rights that underlie water control. This is crucial since these commonly result in situations of conflict or collaboration.

The **fourth chapter**, *"Re-engineering closing river basins: The negotiated expansion of a dam-based irrigation system in Bolivia",* analyses in depth the historical process of development of the Totora Khocha irrigation system (1950-1991). It shows how, when irrigation systems expand in space and across their boundaries, they include new territories, hydraulic infrastructure and water sources in the system, changing the networks' internal contents and compositions. Next, new demands from existing and emerging users get involved. This results in complex processes of design, dispute and negotiated redesign of irrigation projects, fundamentally altering the hydrosocial networks for water control.

The **fifth chapter**, *"Hydrosocial territories in dispute: Flows of water and power in an interbasin transfer project in Bolivia", analyses* the historical trajectory of the interbasin irrigation water transfer project Yungas de Vandiola. This project aims at expanding the Totora Khocha irrigation system. The chapter describes how different actors propose alternative configurations of hydrosocial territories regarding the use of the waters of the Yungas de Vandiola basins, at three key moments in the development of the project. During this process, communities that were not initially included in the project, changed their hydrosocial territorial imaginaries and forged multi-scale alliances in response to broader political and cultural developments. This altered the conception of the Yungas de Vandiola irrigation project, resulting in severe changes in the fate of the irrigation project.

In the **sixth and final chapter** I elaborate my conclusions, the discussion of the empirical and theoretical research findings, and I present the implications for irrigation development in Bolivia.

CHAPTER 2 FORMS OF COLLECTIVE WATER RIGHTS LEGITIMATION: A CONCEPTUAL OVERVIEW

Different waters, different forms of water rights: A leader of a peasant community takes note of the irrigation turns from different water sources in the Tiraque Water Users' Association - ARST (May 28th 2010).

Source: Centro AGUA, 2010

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2.1 Introduction

This chapter presents the theoretical framework through which I analyse how groups of water users defend and legitimize their collective water use rights vis-à-vis other groups of users and water governance actors. The theoretical framework focuses on the diversity of forms and mechanisms of legitimization of water rights, and their dynamic and hybrid nature in processes of struggle over water. To highlight and comprehend this diversity and dynamics, various modes or mechanisms of collective water rights creation and legitimization are presented. Through a synthetic revision, the mechanisms are identified in five river basins around the world. The systematization of cases considers two levels of analysis: first, the *main basis or principle* guiding acquisition and defence of water rights, which is recognized by authorities and users. Second, the *underlying arguments* that are applied by certain groups of users to legitimize their water rights claims, which shape the processes of fighting for water.

In general, in a specific territory, different groups of users have commonly developed, recognized and applied different modes for obtaining collective water use rights and they continue to do so. These mechanisms are cornerstones of the locally specific water regulatory and control systems, and reflect sociocultural norms and power relationships (Boelens et al. 2005). In this context, it is common to see how additional water norms and use rights are introduced or imposed by state intervention projects and/or through third parties aiming to gain access to local water sources from peasant irrigation systems (e.g. through irrigation projects, formalization of water rights, private sector intrusion, etc.) (Bebbington et al. 2010; Perreault et al. 2018b; Perreault et al. 2011; Seemann 2016b; Vos et al. 2020). These are often incompatible with local norms and regulations, and sprout from national policies and regulations, or are triggered by private sector interests (e.g., Budds 2010; Lynch 2012; Roa-García 2014; Seemann 2016a). Many studies have indicated how such interventions, when ignoring locally prevailing water rights frameworks and normative arrangements, tend to be fiercely resisted by groups of local actors (See Gerbrandy and Hoogendam 2002; Rocha et al. 2015).

The chapter is structured in three sections. Section 2.2 begins with a brief review of different perspectives of conceiving and understanding water rights, with special emphasis on collective water rights. The third section then discusses the forms or mechanisms for legitimizing water use rights. It establishes the framework to be applied for the analysis of collective water rights in basins in different parts of the world. Finally, the analysis of the five revised cases is presented in the fourth section. Particular emphasis is placed on divergent conceptions of legitimacy in existing mechanisms, regulated by various groups of users and authorities.

2.2 Conceptualization of water rights

In light of the so-called *"global water crisis"*, the issue of water rights has become particularly important, as a way to mitigate conflicts around the control of increasingly scarce water resources (Watkins 2006). Much of the international debate around water rights has been guided by principles of economic efficiency and water use efficiency (De Soto 2000; Hodgson 2006), while conceptualizing water rights as a fixed and

homogenous tool for state regulation to enable water management through market regulations. However, community irrigation systems reveal far greater diversity, complexity and coherence with regards to the functionality in locally particular environments. To understand this, it is crucial to study the principles and values underlying local conceptions of water rights, how they function in water governance practice and how they are created, consolidated and transformed (Boelens 2008; Pradhan and Meinzen-Dick 2003). In this sense, the discussion revolves around the conceptualization and clarification of the 'contents of water rights' - what does it mean to have a right of water? How are water rights defined and practiced? How do they constitute multiple, locally prevailing regulatory frameworks, and what are the principles and values underlying these rights formulation and implementation processes? (Pradhan and Meinzen-Dick 2003).

In the western legal tradition, water rights are generally conceived as the legal right "*to abstract or divert and use a specified amount of water from a natural source; to impound or store a specified quantity of water behind a dam or other hydraulic structure; or to use water in a natural source*" (Hodgson 2004, 14). Under this conception, water rights are focused on the right to extract and use water, and are mainly applied to contexts with perennial and abundant natural water sources such as those in Europe. In the case of the United States of America, characterized by marked climatic and hydrological differences, the literature on water rights mainly highlights two basic principles of water rights: the *"riparian doctrine"* in the relatively wet east, and the *"prior-appropriation doctrine"* in the relatively arid west of the USA (e.g., Hutchins 1971; Sax 1990). Whereas in the riparian doctrine, water use rights originate from the ownership of riparian lands, and include unrestricted water usufruct, provided that it does not affect the rights of other users; in the prior-appropriation doctrine, the right originates from first use, and allows the holder to physically extract a certain amount of water, provided that it is given a beneficial use (Burness and Quirk 1979).

However, beyond text book water governance, grounded field research has shown that water rights encompass a much wider and more diverse range of norms and rights. In addition to and beyond the simple right to extract and use water, these importantly include a diversity of water use and decision-making privileges, restrictions, obligations and penalties (Beccar et al. 2002; Benda-Beckmann 1995; Boelens 2008; Schlager and Ostrom 1992). For this, Schlager and Ostrom (1992) introduced the notion of "*bundle of water rights",* through which a water right is conceived of as a set or *"bundle"* of more specific forms of rights and obligations. In general, as Schlager and Ostrom (1992) and Boelens (2008, 2015a, 2015b) elaborate, these rights are grouped into two categories: *(a) Access and operational rights*, related to access to, and extraction of, a part of the water, and also the right use the infrastructure and the right to occupy positions in the organization; *(b) Decision-making rights*, related to rights to take part in decision making about system management, inclusion and exclusion of users, modification of infrastructure and transferring rights (Beccar et al. 2002; Schlager and Ostrom 1992). In this line of thought, Benda-Beckmann (1995) argued that a right of water is made up of a bundle of social relations between people in relation to water. Whether users have equal or different rights, will depend on each local set of regulations and practices.

In relation to the above ideas, water rights are linked to a number of particular actions and rules that give rise to the right and enable the exercise of that right. A related important idea is the notion of "*hydraulic property creation*" (Coward 1983), through which individual users and/or groups of water users create property rights over hydraulic infrastructure and captured water, based on the investment of resources (labor, monetary and others) in the construction or repair of hydraulic infrastructure. These rights are consolidated or re-created through the realization of new investments in the operation and maintenance of the created infrastructure. Boelens and Vos (2014) point out that actions for the creation and re-creation of hydraulic property establish relations between the individual irrigators, but also between water user collectives with others, both strengthening collective action, which is the basis of the sustainability of the irrigation system.

In many developing countries with a colonial history, the state introduced new logics in traditional irrigation system for the use of water and the granting of rights through the implementation of hydraulic infrastructure projects and national laws. In these contexts, various studies (e.g., Benda-Beckmann et al. 1997; Meinzen-Dick and Pradhan 2005; Spiertz 2000) revealed how water rights are conceived and constructed in situations of legal pluralism, *"in which in the same socio-political unit there is a plurality of normative ordering"* (Benda-Beckmann et al. 1997, 226). According to Meinzen-Dick and Pradhan (2005), these different legal systems (such as: state law, customary law, religious law and local law) are not isolated, but interact and influence each other. In this sense, it is common to find that traditional rules of creation and allocation of water rights in peasant irrigation systems are interspersed with external rules emanating from other sources of power and authority (state, government agencies, NGOs, etc.) (Gelles 2010; Joy et al. 2014; Mena-Vásconez et al. 2016). In this context, in order to understand the various notions of water rights in situations of legal pluralism, on the basis of the social and political organization of water rights, the following property regimes are distinguished: (a) *public,* where the state owns the rights of decision-making; (b) *private,* where individual or group owners own decision-making, access and operational rights; (c) *common property,* where groups of users and communities exercise control over the full range of access to water, operational and decision-making rights; and (d) *free access,* where there are no regulations for the use and control of water (Boelens 2008; Bromley et al. 1992; Ostrom 1990).

With increased water scarcity, and the consequent intensification of competition and water conflicts, the discussion in the 1980s and 1990s began to focus on the transfer and re-allocation of water rights, based on either the setting of use priorities or water rights markets (Dinar et al. 1997; Gould 1989; Rosegrant and Binswanger 1994). In this regard, Bruns and Meinzen-Dick (2005) identified three institutional arrangements for the (re)allocation of water: *"community based"*, where users collectively manage and allocate water rights, as water is commonly owned; *"state-led"*, where the state assumes the authority to allocate and manage water as public property, in accordance with national policies; or *"market-based"*, where individuals or organizations assume the authority to allocate and manage water as private property, according to the rules of the market. Although the transfer of water rights according to the market can theoretically lead to considerable improvements in the efficiency of water use (Rosegrant and Binswanger 1994), this has not been a successful solution in many

instances to resolve multisectoral water rights conflicts. This is mainly due to the diversity of institutional, legal and technological contexts, often incompatible with market logics. As, among others, Bakker (2010, 2013), Boelens (2008), Mehta et al. (2012) and Hendriks (1998) mention, this water policy encourages inequity and monopolization of water rights by dominant groups, and goes against collective action, by individualizing water rights.

In this same line of discussion, in recent years the study of groundwater use rights gained particular importance (Aarnoudse et al. 2012; Theesfeld 2010). In most developing countries, the right to use groundwater is treated as a right tied to private land ownership. This means that the landowner has the right to extract and use unlimited groundwater volumes within her or his property without restriction. However, in the wake of the growing water scarcity problem, several countries declared groundwater as public domain resources, resulting in the state to exercise ownership of the resource, and users who must apply to the state for groundwater extraction and use rights (Theesfeld 2010).

The discussion on the priority of water uses led to the debate on water valuation (Castro 2013; Martinez-Alier 2002; Preciado et al. 2015), the related valuation languages (Martinez-Alier 2009a; Martinez-Alier et al. 2010) and more recently, "*nature's right to water*" (Rawson and Mansfield 2018). Based on the recognition of the multiple dimensions and ontologies of water, these studies agreed that it is not possible to reduce the value of water to a simple economic resource (market value). Rather, the value of water should reflect the existence of various alternative rationalities from which water frequently acquires immeasurable values (Castro 2013). Thus, these values cannot be commensurate. Consequently, considering that water is conceived of differently by different cultures and valued through several languages, makes that the prioritization of water use by imposing one particular valuation language is a matter of political power (Martinez-Alier et al. 2010).

2.3 Mechanisms for the acquisition and legitimization of water rights

As water becomes scarcer, competition and conflicts over access and control of water are growing, and disputes over water use rights are becoming more intense. This situation is most evident in processes of intervention and development of water resources, where as a result of the intervention, multiple actors and claims for water rights emerge. In this conflictive setting, the various actors struggle, not only to access and take advantage of water resources as such, but also to legitimize and defend their specific ways or mechanisms to obtain their water use rights.

Considering the multiple conceptions of water rights and the plurality of the sociolegal water right frameworks, discussed in the previous section, different mechanisms for obtaining water rights are evident in different contexts. The study of the diversity of water rights regimes around the world led to the identification of six basic principles for legitimizing water rights (Boelens 2015a; Boelens and Doornbos 2001):

i. ***Granting of water rights:*** Water rights are granted by the state to individual or collective users, who obtain the right to use and manage a certain flow or

volume of water, for a certain period. The state maintains formal ownership over the resource and generally charges fees to the user for the grant.

ii. ***Historical water rights***: Water rights are based on the principle of *"prior appropriation"*, based on which the first people to use water in the past legitimize their right vis-to-vis others (*"first come"* claims). Likewise, this argument is often used to defend the rights of water acquired by groups of users in the past, regardless of the purchasing mechanism, which is legitimized from the continuous exercise of the right.

iii. ***Socioterritorial rights***: Rights to use water based on the location of a water source in, or flowing through, a particular territory or political-geographical place. These claims include so-called *"riparian rights"*, based on the possession of land with a water source, or located along a stream.

iv. ***Transfer of water rights:*** Water rights originating from the transfer of water rights from one owner to another, through: sale, rent, barter, donation, exchange, marriage or inheritance. Each type of transfer is subject to the particular rules of each system, mainly related to obligations and restrictions.

v. ***Acquisition of rights by force:*** Water rights arising from the forced expropriation of rights by powerful groups. For example, through colonization.

vi. ***User investment:*** Water rights (hydraulic property) originated from the investment of resources (labour, capital, knowledge, etc.) in the construction or rehabilitation of hydraulic infrastructure.

In a river basin or even in the same irrigation system, it is common to find several of these mechanisms simultaneously in action, in interaction or opposition. According to Boelens and Doornbos (2001), the dominant application of a particular mechanism, whether for the creation or defence of water use rights, depends on whether the actors involved recognize the power and legitimacy of the authority that regulates the mechanism. In this sense, as described in the next section, it is possible that in a specific situation, different actors may have divergent positions regarding the legitimacy of the mechanisms applied. The actors can also change their positions over time, and adapt their claims according to the (legal) contexts where they are discussed. In this regard, Benda-Beckmann et al. (1997), Beccar et al. (2002), Boelens (2009) and Roth et al. (2015) show how the implementation of a particular mechanism will depend on the ability of actors to defend and position their focus on water rights against other actors.

2.4 Analysing collective rights at the basin scale

In order to illustrate the diversity and understand the dynamics of mechanisms of water rights acquisition and legitimization, this section presents a synthetic review of water rights legitimization modes in five river basins around the world. The collection of information was carried out on the basis of literature review, identifying the main forms of acquisition and legitimization of water rights at two levels:

(i) ***The main basis for water rights acquisition in the basin***: These are the mechanisms of water rights acquisition certified by local and national

authorities and generally accepted and recognized as legitimate by other user groups.

(ii) ***The underlying arguments for the legitimization of water rights:*** These represent the diverse mechanisms (or arguments) deployed by particular user groups to claim and defend the legitimacy of their water rights, vis-à-vis the water rights claims of other groups of users, institutions, national normative frameworks, etc.

2.4.1 Case studies

Information was collected from five basins around the world (Table 2.1): three basins located in South America (Bolivia, Ecuador and Chile), one in Africa (Tanzania) and one in Asia (Nepal). The basins studied were selected, mainly because they have a long history of struggling for and confrontation over water rights, and these arenas of conflict and struggle have been documented in literature. Although the basins analysed are characterized by having more than one water-use sector, the overview study focuses on the irrigation sector.

Table 2.1 Study river basins

River basins	Country	Area (Km²)	Main uses of water
Pucara	Bolivia	482	Irrigation, domestic consumption
Chambo	Ecuador	3,580	Irrigation, domestic consumption
Copiapo	Chile	18,704	Irrigation, domestic consumption and mining
Great Ruaha	Tanzania	68,000	Irrigation, household consumption and hydro-power
East Rapti	Nepal	3,222	Irrigation, household consumption and hydro-power

2.4.2 Ways of acquiring and legitimizing water rights in river basins

Five different arguments of acquisition and legitimization of water rights were identified: (a) water rights concession, (b) transfer of water rights, (c) historical rights, (d) user investment, and (d) socioterritorial rights. As illustrated in Table 2.2, the two levels of analysis show the diversity and dynamics of the mechanisms for acquiring and legitimizing water rights.

Table 2.2 Overview of water use rights in five river basins.

River Basin	Official property regime	Main ground for water use rights at basin scale		Underlying arguments for water rights legitimization				
				Water rights concession	Transfer of water rights: Sell/Purchase	Historic rights	Users' investment	Socioterritorial rights
Pucara (Bolivia)	Common property	Users' investment	Communities in the lower basin claim water use rights based on **investments made in the construction** of reservoirs and canals in the upper part of the basin			X	X	X
		Socioterritorial rights	Communities in the upper basin claim water use rights based on their **socioterritorial rights** over water sources	Historical rights in the form of '*uses and customs*' originated from user investments in the construction of hydraulic infrastructure in the framework of irrigation projects; versus socioterritorial rights based on the prevalence of water sources and infrastructure located in their communal/municipal territories				
Chambo (Ecuador)	Public property	Water rights concession	Formally, the state **grants** water-use rights **concessions** to communities and users organized in Water Users' Associations	X		X	X	X
				Traditional irrigation systems claim rights to use water historically originated from investments in the construction of hydraulic infrastructure and the control of water sources in their territory. Through the formalization process, the state grants water-use rights to water users' associations				
Copiapo (Chile)	Private property	Transfer of water rights	Water use rights originating from **transfers** (purchase/sale) to private users, following **market rules**	X	X			
				Water use rights originating from the granting of water use concessions by the state to individuals and companies interested in using a particular water resource; subsequently these rights, considered private property, were transferred (purchase/sale) to private users, following market rules.				
Great Ruaha (Tanzania)	Public property	Water rights concession	Formally, the state **grants** water-use rights **concessions** (permits) to water users' associations or user committees	X		X	X	
				Traditional irrigation systems claim rights to use water historically based on investment in the construction of hydraulic infrastructure. Through the formalization process the state grants water-use rights (permissions) to water users' associations or committees. Communities refuse to pay the required annual fee.				
East Rapti (Nepal)	Public property	Water rights concession	Formally the state **grants** water-use rights **concessions** to legally registered Water User Associations (WUAs)	X		X	X	
				Traditional irrigation systems claim water use rights based on investments in the construction of hydraulic infrastructure and historical rights of use (prior use); in accordance with the formalization process, the state grants water-use rights concessions to legally registered water users' associations.				

The following section describes the situation of collective water rights regimes and legitimation in the five basins studied:

a) ***Pucara basin, Bolivia*** *(Gandarillas et al. 1994; Rocha et al. 2015)**:*** In Bolivia, although according to current regulations the state maintains ownership of water resources, water is managed almost autonomously by users. They are commonly organized in communities and irrigation associations, under a common ownership regime. In the Pucara basin, two main forms of water rights acquisition were identified: ***socioterritorial rights*** and ***user investment rights***, leading to conflicting claims on water resources for irrigation. While both mechanisms can be found in the basin, there is a clear difference in positions regarding the legitimacy of the mechanisms. While the communities in the lower part of the basin claim the legitimacy of their rights from investments they have made in the construction of hydraulic infrastructure in the upper part of the basin (building reservoirs and canals); communities in the upper part of the basin claim water use rights based on their socioterritorial rights over water sources located in their territory. Both mechanisms are also legitimized under the figure of the so-called '*uses and customs*' (***historical rights***), recognized by national legislation.

b) ***Chambo basin, Ecuador*** *(Boelens 2015b; Peralta 2010)**:*** In Ecuador, the state maintains ownership of water resources, under a public ownership regime. Thus, in the Chambo basin, the state grants water-use right **concessions** to communities and water users' associations, this being the main form of acquisition of water rights. However, at the level of water rights formalization processes, communities in traditional irrigation systems resist this process and claim water rights based on their ***historical investments*** in the construction of hydraulic infrastructure and ***socioterritorial*** rights over disputed water sources.

c) ***Copiapó basin, Chile*** *(Bitran et al. 2014; Meza and Sturla 2015)*: In Chile, water is managed under a private property regime, where the right holder acquires all rights to use and manage water and may transfer them to third parties. According to current regulations, the Chilean state originally allocates resources and the market has the role of reallocating them in an efficient way. In this sense, in the Copiapó basin, the main form of rights acquisition is ***transfer*** (purchase/sale). Originally, individual users and companies received ***water use concessions*** from the Chilean state. Subsequently these rights were transferred to third parties, through the purchase/sale, following the rules of the market. As a result, the Chilean state lost ownership of water to companies and individual users.

d) ***Great Ruaha Basin, Tanzania*** *(Lankford and Mwaruvanda 2007; Maganga 2003)**:*** In Tanzania, a public property regime governs, where the state maintains ownership of water resources, and grants water-use rights to water users' associations or committees through the granting of water use concessions (permissions). Thus, in the Great Ruaha basin, granting ***water-use rights concessions*** is the main form of water rights acquisition. However, several traditional irrigation systems are reluctant to formalize their water rights and resist paying the annual fee established by the state; on the grounds that they

previously acquired ***historic*** water use rights from ***investments*** in the construction of hydraulic infrastructure to capture the water in question.

e) ***East Rapti Basin, Nepal*** *(Adhikari 2001; Kayastha and Pant 2003)**:*** In Nepal, a public property regime applies, where the state maintains ownership of water resources. Thus, in the East Rapti basin, the Nepalese state grants water use rights to legally constituted water users' associations through water ***use concessions.*** Faced with this formalization process, traditional irrigation systems refuse to request water use concessions, claiming their historical water use rights, originating from the realization of investments in the construction of hydraulic infrastructure and ***historical rights*** of use (prior use).

The cases analysed show that it is common to find in one particular geographical context, such as a river basin, a variety of forms of legitimization of water rights. These are simultaneously brought into action are recognized and contested. In all cases, divergent positions on the legitimacy of forms of water rights acquisition were identified, which respond to different conceptions of water rights within the different water ownership regimes in force. As evidenced in the following chapters of this thesis, understanding these divergent conceptions and positions is paramount to understanding water struggles over irrigation development processes, and supporting more user-oriented water governance.

2.4.3 Dynamics of the forms of acquisition and legitimation of water rights

Like water rights' definitions and contents, the forms of acquisition and legitimization of water rights in a specific space are dynamic over time. These dynamics respond to processes (or attempts) to redefine or recreate the contents of water rights, for instance as the product of technological, legal, social or political changes in irrigation systems. Figure 2.1 outlines the dynamics of water rights claims in the process of developing the Totora Khocha irrigation system in the Pucara basin in Bolivia. This case will be fully analyzed in Chapter 4 of this thesis. The three different types of lines represent the three groups of users who disputed water rights in the four stages of dam development.

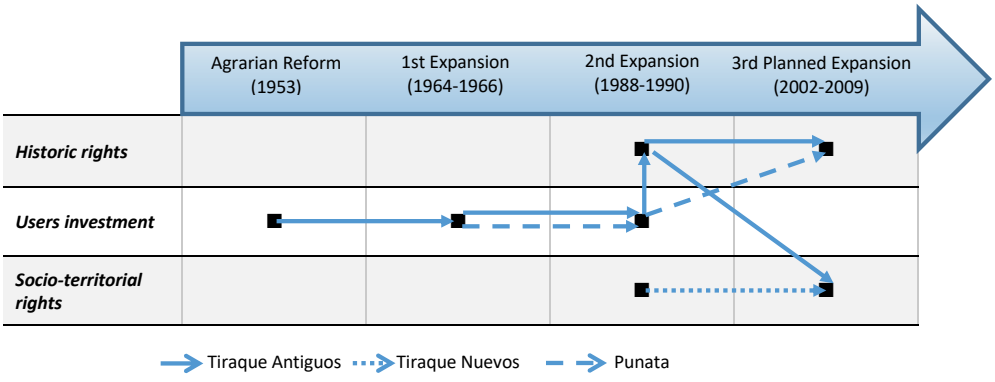

Figure 2.1 Dynamics of water rights claims at the stages of development of the Totora Khocha dam (Bolivia).
Source: Own elaboration.

The origin of the Totora Khocha dam dates to the early twentieth century, when the landowner of the estate commanded his laborers (who inhabited and cultivated their lands) to construct a rustic dam. Over the course of the four stages of development of the Totora Khocha dam, water rights claims changed, as described below:

i. ***Agrarian Reform (1953):*** At the time of the agricultural reform (1953), the land of the estate (in the lower part of the basin) as well as the water rights of the dam, were distributed among the laborers of the estate. At this stage, the communities in the upper basin claimed the water use rights of the dam by referring to the 'hydraulic property rights' created with the dam construction, having invested (forced) labour in its construction during the pre-Agrarian Reform era.
ii. ***1st Expansion of the dam (1964-1966):*** The 1st expansion of the dam (0.8 Mm^3) required more labour that could not be covered by the first users, so it was chosen to include new users to mobilize new labour and monetary investments. At this stage, the lower basin users (Punata) tried to gain water rights by participating in the construction work, but were ultimately not accepted into the system.
iii. ***2nd Expansion of the dam (1988-1990):*** The 2nd expansion of the dam (22 Mm^3) involved major changes in water rights, due to the increase in the amount of water available and the expansion of the irrigation area. At this stage, three types of water rights claims were confronted. The original users claimed their historical rights originated from the investment in the construction of the original dam. Two new user groups emerged: new users from the upper basin (Tiraque Nuevos) who wanted to be included in the project by claiming socioterritorial rights over the dam and its catchment area, and new users from the lower basin (Punata) who received water rights from the project, in addition to claiming old rights for labour investment in the 1st expansion of the dam. In order to ensure the execution of the project, the inclusion of new users was negotiated, validating the claims of each group of users.
iv. ***3rd Planned Expansion (2002-2009):*** the 3rd planned expansion is the discussion around the Yungas de Vandiola project (never implemented) expanding the catchment area of the Totora Khocha dam. At this stage, water rights claims are again polarized. Users of the lower basin (Punata) claim historical rights arising from their contributions in the two previous stages of the dam construction. Users of the upper basin (original and new users from Tiraque) claim socioterritorial rights over the dam, demanding the exclusion of Punata users. The irreconcilable divergence of the two types of claims, and the predominance of discourses around socioterritorial rights, led to the project's failure.

As described, different forms of water rights claims converge in the four stages of dam (and corresponding territorial) development, from which the creation and allocation of water rights were negotiated. Each group defended the legitimacy of its claim, trying to position it against the other user groups and the project. Another important element is the fact that user groups vary their positions over time, applying different forms according to the situations and contexts wherein water rights are negotiated. These negotiation processes around the legitimacy of water rights claims usually generate

discussions and often result in conflicting situations among the actors involved, where power relations tip the balance on one side or the other.

2.5 Conclusion

Based on the studied cases, two central aspects were identified for the analysis of forms of acquisition and legitimization in struggles over water rights. In specific socio-spatial contexts: (i) Various groups of actors strategically apply various forms or mechanisms to claim and legitimize their water rights. These express divergent positions on and conceptions of water rights. (ii) These forms or mechanisms are dynamic over time in relation to processes to redefine or recreate the contents of water rights. The latter is commonly the product of technological, legal, social or political changes in irrigation systems.

In short, instead of top-down regulation by means of the prescriptive application of a specific mechanism for the acquisition and legitimization of water rights in a given territory, this study will investigate how water rights' definitions, contents, acquisition mechanisms and their relation to territory-building, can be understood and brought in tune with users' conceptions and normative frameworks. Therefore, the following chapters set out to first study and understand the different ways in which local stakeholders legitimize their water claims, and then examine how policy choices can be based on stronger inclusiveness and equity.

CHAPTER 3 TRANSFORMING HYDROSOCIAL TERRITORIES AND CHANGING LANGUAGES OF WATER RIGHTS LEGITIMATION: IRRIGATION DEVELOPMENT IN BOLIVIA'S PUCARA RIVER BASIN

The organization and collective action to defend the legitimacy of claims over water rights: A view of a meeting of the Punata Water Users' Association - ARSP (December 22th 2008).

Source: Centro AGUA, 2008

This chapter is based on: Rocha López, R., P. Hoogendam, J. Vos, and R. Boelens. 2019. Transforming hydrosocial territories and changing languages of water rights legitimation: Irrigation development in Bolivia's Pucara watershed. *Geoforum* 102: 202-213.

3.1 Introduction

Irrigation plays a fundamental role in development policies in Bolivia. It is one of the main supports that rural families request from the government (VRHyR 2013). Through the implementation of irrigation projects, the state intends to provide, increase and control water supply for food production, to increase the productivity and economic benefits of agricultural activity for rural families, contributing in this way to the national policy of sovereign food security (Ministerio del Agua 2007). The implementation of irrigation projects seeks, on the one hand, to capture new water sources and expand irrigated land and, on the other, to improve and reorder traditional peasant irrigation systems to establish 'more efficient, productive' irrigation water use and management. Most government-financed irrigation projects include building dams, inter-basin water transfers, improving and expanding hydraulic infrastructure and irrigation areas, favouring zones with greater agricultural potential (Ministerio del Agua 2007; VRHyR 2013).

Throughout history, peasant communities in Andean countries have ordered and mutually connected their available resources (natural, material, human, etc.) in highly diverse ways, shaping culturally-specific forms of irrigation water management to reproduce their livelihoods (e.g., Gelles 2000; Lynch 2012; Orlove and Caton 2010; Paerregaard 2013; Rasmussen 2015). By constructing specific relationships with their hydrosocial context, peasant communities have developed culturally embedded rules, hybrid norms and organizational entities to access and control water resources. This becomes manifest in the ways they struggle to defend and demand recognition of their water rights vis-à-vis other user groups and society at large (Boelens 2015b). Despite their complexity, diversity and grounding in particular histories, cultures and power relationships, conventional academia and dominant policy making have analysed water rights mostly in narrowly defined technical, economic and legalist ways. Influential are formal water law perspectives, technocratic engineering schools and neo-liberal and new institutional economic theories. Rather than trying to scrutinize how water rights actually work in practice – as developed and deployed dynamically by hugely diverse water cultures, these modernist and rationalist water rights schools have commonly aimed to prescribe how water rights should look like. Their frames provide, at once, the analytical tools to formulate and identify water rights and the measuring sticks for evaluating, judging and correcting presumably 'inappropriate' rights and water governance behaviour (e.g., Roth et al. 2005, 2015).

In this thesis, I deploy the recent concept of hydrosocial territories (Boelens et al. 2016) to shed new theoretical light on this dynamic arena of water rights claims. I show how different groups conceptualize and imagine their territory in different ways, and based on this conceptualization, they strategically use particular water rights legitimation languages to strengthen their water claims and materialize their desired hydrosocial territory. As I outline further in the next section, this analytical notion views the physical, social, political and symbolic domains of water management, entwined in particular territorial, multi-scalar configurations (Hommes and Boelens 2017, 2018; Hommes et al. 2016; Marks 2019; Seemann 2016a); whereby different actors imagine, design, strategize, and intend to construct and defend this territory in particular ways (Hoogendam 2019; Hulshof and Vos 2016). Socially imagined, strategically planned, and symbolically and physically materialized territory informs the claims they make: to the

territory's resources and to the legitimate authority they claim having to use and govern these resources (Bebbington et al. 2010; Goldman and Narayan 2019; Sikor and Lund 2009). Therefore, hydrosocial territories are dynamic, fragmented, disputed, always in the make, and go beyond just a legally recognized and physically constructed communal or state territory and its resources, boundaries and relationships.

Any interventions in water management and access conditions promoted by government-led or community-initiated irrigation projects, necessarily involve changes in the social, ecological, and technological elements that make up a hydrosocial territory, affecting different groups of people in different ways. Therefore, diverse conflicts tend to arise from such new forms of ordering the hydrosocial territory, in particular (but not exclusively) in response to intentions and interests largely external to local understandings and acceptance. Many of these conflicts are related to rights to water and infrastructure, inclusion/exclusion of water right holders, water rules and rights and local authority (Rocha et al. 2015; Roth et al. 2015; van Koppen 1998; Zwarteveen et al. 2005), as well as external encroachment and governance control projects (Budds and Hinojosa 2012; Duarte-Abadia et al. 2015; Hidalgo et al. 2017; Hidalgo-Bastidas et al. 2018; Rocha López et al. 2019). Many of these conflicts also arise between different user communities. Behind all these water rights battles, changing and divergent languages of water rights legitimation play an important role.

Based on the case of irrigation development in the Pucara river basin in central Bolivia, this chapter argues that alongside irrigation development processes, multiple languages of water rights legitimation are created and used in multi-scalar political arenas of struggle around water control. This becomes particularly apparent in the analysis of the historical construction and improvement of hydraulic infrastructure in and by peasant irrigation systems, which has led to complex overlapping and conflicting hydrosocial territories. Basic to the construction of hydrosocial territories are the different forms of defence and legitimization of claims over water access and water-based decision-making. Specifically, in the Pucara river basin case, the chapter focusses on how the legitimation of water rights has changed from 'hydraulic property creation'[4] to 'territorial claims'[5].

The next section (3.2) discusses the chapter's central concepts, highlighting the inter-relationship of hydrosocial territorial configuration and the struggles for water rights legitimation. Section 3.3 presents the methodology applied for data collection. Section 3.4 describes irrigation development in the Pucara river basin, considering three periods: from the hacienda to community control of irrigation water (1950–1978), planned re-ordering of peasant irrigation systems through state intervention (1978–1995) and the period of territorializing water (1995-present). Throughout this historical process, water and water control have been defended in different and divergent modes, through establishing hydrosocial territories. The final section discusses results and draws conclusions.

[4] Hydraulic property refers to water rights (privileges to access water, infrastructure, decision-making) claimed and gained by users through their collective and individual investments (labour and capital) in the construction and maintenance of hydraulic infrastructure (Boelens and Vos 2014; Coward 1983, 1986).

[5] Territorial claims refer to the socio-territorial rights over water sources originating in or flowing through a particular territory or political-geographical place (Boelens 2015b).

3.2 Hydrosocial territories and languages of water rights legitimation

Research on water rights has developed significantly during the past decades. While in the Western legal tradition water use rights were (and often still are) rather strict individual or collective entitlements *"to abstract or divert and use a specific quantity of water from a natural source; to impound or store a specified quantity of water behind a dam; or to use water in a natural source"* (Hodgson 2004, 14); and while US-based literature may often concentrate on two basic water rights principles (*"prior appropriation of water"* in the relatively arid Western States, and the "riparian doctrine" in the more humid Eastern States) (e.g., Hutchins 1971; Sax 1990); most contemporary research points at the far greater diversity and complexity of water rights realities around the world. Schlager and Ostrom (1992) introduced the idea of the *"bundle of water rights"* which tie together different principles of access, withdrawal, exclusion and obligations related to water use, but very importantly, also relate water rights to the right to manage water resources and decide about their distribution systems. An important related insight was the idea of *"hydraulic property creation"* (e.g., Coward 1983, 1986; Gerbrandy and Hoogendam 1998, 2002; Guevara-Gil et al. 2010; Vos et al. 2006), whereby groups of water users gain the right to use water by investing labour and other resources in the construction of diversion and distribution works, and maintain their use rights by investing labour in the maintenance and repair of the infrastructure. In later work, the infrastructure related argument was extended to the catchment area where water flows are controlled and 'humanized'. This broader analysis argues that by planning, constructing, operating and maintaining infrastructure to control water, people construct and reproduce water territories or hydrosocial territories as explained below (Boelens and Vos 2014).

Increasing water scarcity, growing competition and conflicts, intensifying groundwater use, and responses to the rise of new policies (e.g. market-environmentalism) added to water governance complexity. In this context, a growing body of studies of actual water rights regimes in colonial and post-colonial countries revealed situations of deep legal pluralism (Benda-Beckmann 2007; Meinzen-Dick and Pradhan 2005; Spiertz 2000), where in one political-geographic location several legal systems operate, overlap and interact. In policy documents, this quickly resulted in classifications of water rights regimes as pertaining to rather clear-cut categories and legal-administrative frameworks, like "community-based", "state-led" or "market-based" (e.g., Bruns and Meinzen-Dick 2005; Ringler et al. 2000). But in-depth studies show how these local rights systems rather need to be conceptualized as 'hybrids' because they combine local customary rights with colonial, governmental and international normative elements (e.g., Benda-Beckmann 2001, 2007; Jackson 2018; Wilson and Inkster 2018). Most of these water struggles originate from the (conflict-ridden) co-existence of, and interaction among, different socio-legal frameworks (Boelens et al. 2005; Roth et al. 2015; Zwarteveen et al. 2005).

The study of the diversity of water rights regimes around the world led to the identification of a number of basic principles to legitimately obtain and maintain water rights. Boelens (2015b), for example, mentions: (1) concessions granted by the state, (2) prior appropriation and/ or historic rights, (3) socioterritorial rights and/or riparian rights, (4) transfer of rights (sale, barter, donation, inheritance, etc.), (5) acquisition of rights by force, and (6) hydraulic property creation. This debate on locally recognized

legitimacy of principles to acquire and practice water rights, obviously, directly connects to the debates on divergent water values, meanings, and governance principles (Castro 2007; Cleaver 2000), the related languages of valuation and legitimation (Duarte-Abadía and Boelens 2016; Martinez-Alier 2009b), and also "nature's right to water" (Rawson and Mansfield 2018; Valladares and Boelens 2017). Since different languages of valuation are often not commensurable, legitimation and prioritization of water rights becomes a matter of political power (e.g., Preciado et al. 2015).

In this chapter, I use the concept of hydrosocial territories as a novel theoretical concept to look at struggle over water, infrastructural projects and water rights. It shows the dynamics of different overlapping hydrosocial territories and the related languages of legitimation of water right claims. The notion of 'hydrosocial territory' interrelates the control of water sources, catchment areas, the hydraulic infrastructure used to conduct and distribute water, and other water-related resources, with the actor groups who manage, use, or steer the water, its knowledge, stories and imaginaries, as well as with the broader political-geographical scales and governance entities. In a given socio-natural setting such as the Pucara river basin, multiple hydrosocial territories exist, representing the diversity and heterogeneity of social groups involved in trying to design, shape and strategize the configuration of the basin, in accordance with their imaginaries and interests, often competing with each other (Baletti 2012; Hoogesteger et al. 2016). Therefore, 'hydrosocial territory' is conceptualized as the *"contested imaginary and socio-environmental materialization of a spatially bound multi-scalar network in which humans, water flows, ecological relations, hydraulic infrastructure, financial means, legal-administrative arrangements and cultural institutions and practices are interactively defined, aligned and mobilized through epistemological belief systems, political hierarchies and naturalizing discourses"* (Boelens et al. 2016, 2).

The underlying conceptualization enables examining how territorial politics finds expression in encounters of diverse stakeholders with divergent economic, cultural and political-geographical interests in water (Meehan 2013; Pfaffenberger 1988; Swyngedouw 1999; van der Ploeg 2008; Vos et al. 2006; Vos and Boelens 2014). Aiming to strengthen the specific claims they have in water control - expressed in dynamics of frictions and alignment, of collaboration and competition, and of subordination and resistance - these actors *"continuously recompose the territory's hydraulic grid, cultural reference frames, and political-economic relationships"* (Boelens et al. 2016, 1). The hydrosocial territory concept allows examining how different modes of power work to governmentalize and repattern water-connected spaces and places – triggered by diverging imaginaries and interests (see e.g., Bleeker and Vos 2019; Duarte-Abadía and Boelens 2019; Goldman and Narayan 2019; Hoogendam 2019; Marks 2019; Seemann 2016a; Vos and Hinojosa 2016).

Conflicts over irrigation intervention projects can be interpreted as struggles to establish new hydrosocial territories or reconfigure existing ones (e.g., Rocha López et al. 2019). As I will highlight, to gain control over water and decision-making, social groups within the river basin struggle over all constituent elements of the hydrosocial territory and interfere in the social, physical, political and symbolic domains, employing specific languages to legitimize their claims to control (cf. Castro 2007; Duarte-Abadía and Boelens 2016; Harris and Roa-García 2013; Hulshof and Vos 2016). These languages are derived from their worldviews and discourses, sometimes used unconsciously but often

strategically. Actors are aware that arguments that 'resonate' with the worldview of others (and in particular with that of decision makers on policy and projects), can be more effective in legitimizing and materializing their own claims (see Benford and Snow 2000).

The compositions, linkages and delimitations of hydrosocial territories are influenced by societal norms and power relationships (see e.g., Agnew 1994; Baletti 2012; Elden 2010; Escobar 2008; Mancano 2009). Here, water rights – their sociomaterial substance, sociolegal relationships and epistemological conceptualization – are fundamental elements of the hydrosocial territorial network. They are immersed in social, political and cultural inter-relationships that determine the nature, function and meaning of water and are closely related with, for instance, rural communities' and/or water governors' and water experts' identities (Boelens and Seemann 2014; Perreault 2008; Rodríguez-de-Francisco and Boelens 2015, 2016). Beccar et al. (2002) assert that water rights constitute an expression of agreements about the legitimacy of water user's claim to water. These legitimacy agreements are negotiated based on a variety of reference frameworks or languages of water rights legitimation (see Boelens and Doornbos 2001; Gerbrandy and Hoogendam 1998)[6]. The concept of legitimacy involves the formal and informal ways in which these processes, structures and authorities are validated and consequently empowered (Gearey and Jeffrey 2006). What follows is that, in the arena of struggles over access to and control over water, different languages of water rights legitimation compete. Understanding the changing languages of water rights legitimation and how these underlay peasant communities' political actions to re-order and defend their hydrosocial territories, helps to better understand the diverging positions, interests and power structures that prevail in irrigation development processes.

As the chapter shows, it is common to find multiple overlapping and competing hydrosocial territories that are related to different discourses and languages of water rights legitimation. This refutes the conventional notions that see water rights as static and fixed elements of water systems or prescriptive tools for water governance. Water rights are dynamic sociomaterial and cultural-political relationships of inclusion and exclusion; and water rights legitimacy is constantly subject to review, assessment and revaluation within a vibrant network of social relationships. Therefore, to understand the underlying forces of government interventions or community struggles over water it is necessary to study the socio-political networks and 'hydrosocial territories' in which water rights are legitimated or de-legitimated.

3.3 Methods

The empirical data on the past water endeavours were collected through intensive fieldwork in 2009–2010, with follow-up visits throughout the years 2011–2018. Three main data collection methods were applied: review of published and unpublished

[6] The relation between a communal territory and resources is complex. An example of this complexity is the claim of informal irrigators along a big irrigation canal in the desert coast of Peru, who claimed they were entitled to pump water from the canal because they were originally from the highlands, some hundred kilometers upstream from the canal intake, where the water in the canal originates (Guimac 2010).

documents, semi structured interviews and participant observation. The document review included the study of scientific literature, irrigation project documents and research reports. This resulted in the construction of a timeline of irrigation development actions in the river basin. In addition, a Geographic Information System (GIS) was established based on maps of irrigation systems and the systematization of information at three levels: water sources, hydraulic infrastructure and irrigated area.

Three types of semi-structured interviews were conducted with key informants in the river basin. In the first round, four leaders of the irrigation users' associations in Tiraque and four in Punata were interviewed. These informants were selected according to the period of leadership. The interviews focused on the historical process of water control in the basin; and how users gained and reproduced their water rights. The second type of interview was conducted with specific key actors involved in irrigation systems development in the basin. Finally, 28 informants were interviewed: two informants (1 leader and 1 irrigator) for each irrigation system selected: six irrigation systems in Punata (3 reservoirs, 1 river and 2 underground water) and eight irrigation systems in Tiraque (6 reservoirs, 1 river and 1 spring). The interviews focused on the system-specific historical process of hydrosocial territorial configuration and how users gained, reproduced and defended their individual and collective water rights. The third type of interview was conducted with government officials and consultants involved in some irrigation development action in the basin. Two former technicians who worked at the Inter Valley Irrigation Program (PRIV) and two consultants of specific irrigation projects were interviewed to examine the process of design and construction of irrigation systems in the basin and the problems faced in the process.

Finally, several meetings of irrigation users' associations in Tiraque and Punata were observed (July-September 2009). In these meetings, notes were taken about the positions, discourses and discussions regarding the new proposals for irrigation projects. The same was done in 2017, through participation in four meetings between the Tiraque association and the highland communities about the future water rights of some highland reservoirs, as well as three meetings of the highland communities only.

3.4 Irrigation development in the Pucara river basin

The irrigation development process in the Pucara river basin is a clear example of the construction and reconstruction of different overlapping hydrosocial territories. The analysis of this (re-)construction process shows that different user groups employ conflicting languages to legitimize water rights' claims and that the influence of these different languages over water use and distribution outcomes changes over time. To understand this more clearly, the basin's development process was divided into three periods, according to changes in most pro-active actor groups and their strategic actions to pursue new irrigation investments, and shifts in legitimation of water rights claims.

3.4.1 From the hacienda to community control over irrigation water (1950–1978)

Before the 1953 Bolivian Agrarian Reform, land and water in the Pucara river basin were mainly controlled by hacienda-owners, most of them descendants of Spaniards. Haciendas were cultivated by indigenous *colonos*, who worked the hacienda land in

exchange for food and shelter. A limited number of indigenous and mestizo families, known as *piqueros*, owned small pieces of land outside the haciendas' dominion.

To solve water scarcity for agricultural production, the Punata and Tiraque hacienda landowners used colonos' labour force to build intakes and canals to conduct water from nearby rivers to their land. Since construction was usually organized by several hacienda owners, irrigation turns were set up for water distribution. The right to use irrigation water was restricted to those landowners who participated in building the hydraulic infrastructure, which was a typical case of 'hydraulic property creation': building collective and individual rights relationships through investments to construct hydraulic infrastructure (monetary and labour).

In view of the variability and unpredictability of river flows, landowners later chose to dam natural lakes in the upper river basin, to store water in the rainy season and irrigate their fields in the dry season. The first reservoir, Laguna Robada, was constructed in 1929 by four Punata landowners on land of one of them, located in the higher part of Aguirre, over 20 km away from the Punata irrigated area. Around 1950, Tiraque landowners built the Pachaj Khocha and Ovejería Khocha reservoirs. Since the reservoirs were situated far away from the irrigated areas, building and managing them required distant territorial control, which was possible since the highland areas were part of one or more haciendas. As in the river intake systems, the right to use water from the reservoirs was restricted to the landowners who took part in constructing the dam.

In this period, the legitimacy of landowners' claims to water was based on hydraulic property created in the construction of hydraulic infrastructure. However, the hydrosocial territories configured by landowners were re-ordered by the 1953 Agrarian reform, which terminated large landholding and the control of water by hacienda owners. The landowners were expelled, and haciendas' land and water rights were distributed among the *colonos* who had worked that land. The indigenous peasants were organized in rural communities. The land of each hacienda was divided among one or more rural communities with clear territorial delimitations. These communities also claimed the right to control the water sources and the hydraulic infrastructure of the former haciendas, even when these sources were located outside the community's territory. In this way, rural communities re-ordered the hydrosocial territories that landowners had set up, enrolling large groups of new users, who had to establish new norms and ways to organize the collective action necessary for managing and using irrigation water. For example, the Ovejería Khocha reservoir was granted to four communities near the reservoir and Pachaj Khocha reservoir to 14 communities in the Tiraque fan. Laguna Robada was taken over by four communities in the Punata fan. Similarly, water taken directly from rivers came under the control of the rural communities on the land of the former haciendas.

After a short period of decline in agricultural production, peasant families intensified land use and expanded the area under cultivation, increasing their demand for irrigation water, which came under further pressure when former *piqueros* (formerly free peasants) started to demand irrigation water as well. To increase water supply for their crops, Tiraque and Punata peasant communities joined efforts to improve the storage capacity of existing reservoirs and construct new ones. In this process, the argument that economic and labour investments in hydraulic infrastructure creates hydraulic property

rights over water was the principal language to sustain claims for both collective and individual water rights.

Table 3.1 Summary of actions by peasant communities to increase control over water of the Pucara river basin in the 1960–1978 period.

Year	Reservoir	Actions	Beneficiaries
1960	Pachaj Khocha	Improving the dam	14 Tiraque communities
	Koari	Damming the natural lake	1 Tiraque community
1964–1965	Ovejería Khocha	Improving the dam (0.8 Mm^3)	9 Tiraque communities, supported by the Ministry of Public Works
1965	Lluska Khocha and Muyu Loma	Damming 2 natural lakes	12 Punata communities
1965–1966	Pachaj Khocha	Improving the dam (1.5 Mm^3)	14 Tiraque communities, supported by the Ministry of Public Works
1968–1969	Lluska Khocha	Improving the dam	12 Punata communities, supported by SNDC[a]
1973–1975	Muyu Loma	Improving the dam (1 Mm^3)	12 Punata communities, supported by SNDC
1975–1978	Laguna Robada	Reconstructing the dam (1.2 Mm^3)	10 Punata communities, supported by SNDC

Source: Based on information from Gandarillas et al. (1994) and Gerbrandy (1991).
[a]SNDC: National Community Development Service (An autonomous decentralized government agency)

Table 3.1 lists the main actions taken by peasant communities in this period. Although initial actions were taken by communities themselves, the complexity and cost of building larger dams required the involvement of governmental entities to provide technical and financial support for construction. This government involvement, at the same time, reinforced the dominance of the hydraulic property language, legitimizing the claims over highland reservoir water for valley communities through the construction and rehabilitation of hydraulic works. In the construction processes, government contracted engineers consistently denied the highland (upstream) communities claims over water, since according to project documents the specific infrastructure was meant for both Tiraque and Punata valley communities. Thus, valley peasant communities in both Tiraque and Punata used the irrigation projects to consolidate and expand their hydrosocial territories, by creating hydraulic property regimes related to these water sources and reinforce its legitimizing language.

The expansion of the hydrosocial territories included, on the one hand, new water sources, and on the other hand new users and irrigated land. New beneficiaries were incorporated to help cover the labour demanded for infrastructure construction and to comply with government requirements. Such was the case in the rehabilitation of the Ovejería Khocha reservoir in 1964. The Ministry of Public Works that financed the project and provided technical support, requested a large number of project beneficiaries to justify public investment. Therefore, the four originally right-holding communities decided to include five more communities as project beneficiaries.

In the struggle to gain access to new water sources (all of them located in the upper part of the Tiraque region), the historical rivalry between Tiraque and Punata played an important role, and was a first indication of the shift in the territorial balance. According

to Barnes and Torrico (1971), there has been a long-standing political and socioeconomic differentiation between Tiraque and Punata. The Punata *vallunos* (valley dwellers) historically had access to better education, markets and other services. By contrast, the Tiraque peasants had much less access to education and other services, relegating them to a lower socio-economic standing. However, in the strive for more water, Tiraque communities took advantage of their strategic position near the water sources to somehow level the playing field.

For Punata peasants it was more difficult to gain and hold control over the water sources in the Tiraque territory, but still, through political influence they were able to do so. A typical case was the participation of Punata peasants in the improvement of the Ovejería Khocha reservoir. Initially 50 Punata peasants participated in project works, attempting to acquire water rights to the reservoir (Reque 1998). When they tried to play a leading role in the project, taking advantage of their higher educational level, the original rights-holders from Tiraque perceived the risk of losing control over their reservoir and excluded them from the project. The Punata peasants reacted violently and demanded rights to the reservoir water because of the work already done (hydraulic property). The conflict required the President of Bolivia, René Barrientos, to intervene. He persuaded the Punata peasants to withdraw from the joint project in exchange for an exclusive Punata one. Based on this agreement, peasants from 12 Punata communities dammed the Lluska Khocha and Muyu Loma reservoirs in the upper basin, getting the farmers in Tiraque to recognize their hydraulic property rights to these sources.

In sum, in the late 1970s Tiraque and Punata communities managed to consolidate their hydrosocial territories in the Pucara river basin and to manage them through overall acknowledged languages of water rights legitimation based on hydraulic property regimes. Many suffered from the fact that water sources were mostly situated outside their community boundaries. As stated above, political (even Presidential) pressure helped Punata peasants to get access to new reservoir sites. To gain local permission and maintain control over the water source and the hydraulic works, the Punata communities in charge of the Lluska Khocha – Muyu Loma reservoirs included users from the two Tiraque highland communities in which the dam and transfer canal are located. Similarly, Punata communities' Laguna Robada users included beneficiaries from the community in Aguirre where the reservoir is located.

As a result of these interventions, Tiraque valley communities achieved control over the water from the Millu Mayu and Toralapa rivers, plus four reservoirs, while Punata communities achieved control over the flow of the Pucara River and three reservoirs, with shared use with highland communities. Figure 3.1 schematically shows the hydrosocial territories configured in the river basin, comprising the seven reservoirs constructed as of late 1978. The hydrosocial territories configured by Punata and Tiraque valley peasants extended to the upper river basin. Their collective and individual water rights' legitimacy were mainly based on the hydraulic property created by capital and labour investments in the construction of hydraulic infrastructure. Only peasants who participated in construction works and had fulfilled their contributions, earned water rights and became partners in the irrigation system. However, the struggles between Tiraque and Punata communities to control the water sources of the upper river basin (Tiraque territory), were a first indication of the gradual shift to more territorially oriented claims over water rights.

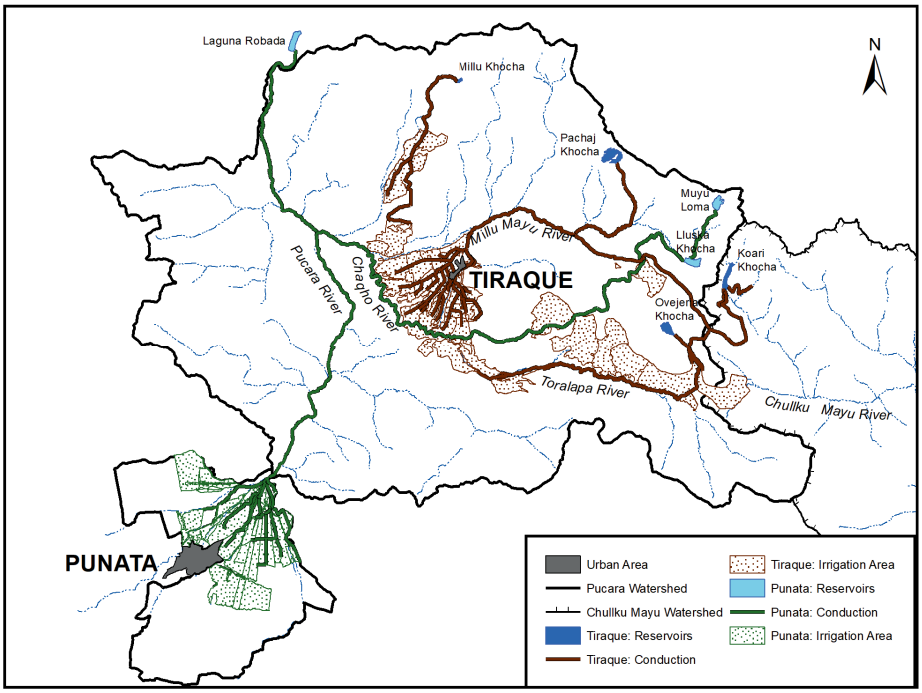

Figure 3.1 Hydrosocial territories formed around the reservoirs by late 1978 in the Pucara river basin.
Source: Own elaboration.

3.4.2 Government planned re-ordering of hydrosocial territories (1978–1995)

By the late 1970s communities from the Punata and Tiraque valleys pressed for greater support from the Bolivian Government to increase irrigation water supply. To attend the potential of the Pucara river basin for irrigated agriculture, in 1978 the Altiplano Valleys Irrigation Program (PRAV) was established. This Program aimed to increase water availability and modernize and re-order the peasant irrigation systems in the Pucara river basin, following economic and efficiency guidelines for irrigation. In their proposals, the designers considered the Pucara river basin as a mere physical-natural space, in which they could prescribe new governance principles, production plans and water distribution schedules. However, the rural communities fiercely defended their historically constituted water rights and hydrosocial territories, forcing diverse changes in the intervention proposals (Gandarillas et al. 1994; Gerbrandy and Hoogendam 2002; Rocha et al. 2015).

Between 1979 and 1991, PRAV implemented four projects (Table 3.2): one for Tiraque (Tiraque Project), two for Punata (Laguna Robada Project and Punata Phase I Project) and one shared project (Tiraque-Punata Project / Punata Phase II Project). The first three projects were oriented towards expanding existing reservoirs and improving the conduction and distribution networks. Although peasant communities demanded these

projects, they faced diverse problems related to planned infrastructure and rules for water allocation, due to disagreements between technicians and communities about the legitimacy of claims for water use rights. PRAV technicians thought that, since public funds were being invested, the water supplied by the projects was a public asset that could be (re-)allocated equally to all peasants, whether they had prior property right or not (Gerbrandy and Hoogendam 2002). This proposal was rejected by the peasant water rights-holders, for whom water use rights were the result of former investments in hydraulic property creation. Following fierce discussions, in Punata it was decided that no new users could be included as beneficiaries, restricting labour contributions and consequent allocation of water rights to farmers with existing rights. By contrast, in Tiraque it was decided to include new users and water rights were allocated according to capital and labour contributions in constructing the new infrastructure.

Table 3.2 Irrigation projects implemented by PRAV in the Pucara river basin.

Year	Project	Actions	Beneficiaries
1979-1981 1984-1985	Tiraque Project	Improving inter-connected reservoirs Koari Khocha (2 Mm^3) and Khewiña Khocha (1.5 Mm^3); conduction and distribution infrastructure	20 Tiraque communities
1983-1985	Laguna Robada Project	Improving Laguna Robada reservoir (2.2 Mm^3)	10 Punata communities +1 community in Aguirre
1985-1988	Punata Phase I Project	Improving inter-connected reservoirs Lluska Khocha (1.25 Mm^3) and Muyu Loma (1 Mm^3); conduction and distribution infrastructure	12 Punata communities +2 Tiraque highland communities
1988-1991	Tiraque-Punata Project (Punata Phase II Project)	Constructing Totora Khocha reservoir (22 Mm^3); transfer from neighbouring Chullku Mayu basin; expanding distribution infrastructure	52 Punata communities 33 Tiraque communities

Source: Based on Salzgitter Consult GmbH (1991).

The fourth project, originally named *"Punata Phase II Project"*, aimed to drastically reorganize historically constituted water rights and hydrosocial territories. Its main component was the construction of a large new reservoir, Totora Khocha, with a 22 Mm^3 capacity, to be built on the site of the existing Ovejería Khocha reservoir (0.8 Mm^3) and aimed to provide irrigation water to the productive land of the Punata valley. The new reservoir would store water transferred from the neighbouring Chullcu Mayu river basin. Its water would form, together with the flows from the other three Punata reservoirs (Laguna Robada, Muyu Loma – Lluska Khocha), an integrated irrigation system that would operate with a single, continuous water flow, determined to cover theoretically calculated crop water requirements. The proposal was based on technical and economic criteria, aiming at efficient irrigation of fertile farmlands to ensure high profits for rural families and justify the investment. The water was proposed to be for the Punata region only, since designers' calculations showed that water requirements for the irrigable land in Tiraque were already covered by the available water.

Tiraque communities objected to the idea that the Totora Khocha reservoir would only benefit Punata communities. First, the nine Tiraque communities that held the Ovejería

Khocha reservoir claimed their hydraulic property rights over the existing reservoir. After tough negotiations, it was agreed to recognize and respect the original hydraulic property rights, entailing the right for these communities to manage and autonomously use the 0.8 Mm^3/year volume stored in the new Totora Khocha reservoir. Second, the 33 communities located in the Tiraque valley questioned the invasion of Punata control in Tiraque territory and collectively claimed their socioterritorial rights to the water of the future reservoir. Under the slogan *"the water is ours, because it is in our territory"*, the Tiraque communities claimed priority usage rights from Totora Khocha. Although including Tiraque communities in the project would reduce the planned water supply for Punata and jeopardize its technical and economic feasibility, PRAV technicians realized that the project could not be implemented without their consent, since Tiraque communities threatened to impede construction works through road blocks and marches. They thus proposed to include the Tiraque communities in the project and share the new reservoir water. After harsh negotiations, in June 1990 a final agreement was signed, establishing shared control and use of Totora Khocha by Tiraque and Punata, respecting the former 0.8 Mm^3 Ovejería volume and distributing the additionally stored volume on a proportional basis according the total number of shares (gained water rights by users) in the reservoir for each zone: 60% for Punata and 40% for Tiraque.

The story of the PRAV intervention shows that in origin the ideas to construct new reservoirs proposed implicit changes in the existing irrigation systems (hydrosocial territories), ignoring existing water rights. In response, Tiraque and Punata communities contested the attempt to enforce a new language of water rights legitimation and claimed the legitimacy of their own languages. Their arguments were based, on the one hand, on hydraulic property creation and, on the other, on territorial claims over the water sources exploited. As a result, PRAV technicians and peasant communities from both Punata and Tiraque negotiated the redesign of the water allocation principles. The evaluation of this contested process led to the creation of a new school of irrigation practice in Bolivia, based on the recognition of a longstanding Andean highlands irrigation tradition, profoundly informed by hydraulic property regimes (Gandarillas et al. 1994; Gerbrandy and Hoogendam 1998).

The PRAV projects changed the hydrosocial territories of Punata and Tiraque communities. Figure 3.2 shows how, in the middle of the 1990s, Tiraque valley communities controlled at least 10 reservoirs, while Punata communities controlled only four, shared with highland communities as strategic partners. Although the Punata communities acquired at least partial control over a new water source, the Tiraque communities clearly managed to achieve signs of socioterritorial control over the water sources in the upper river basin.

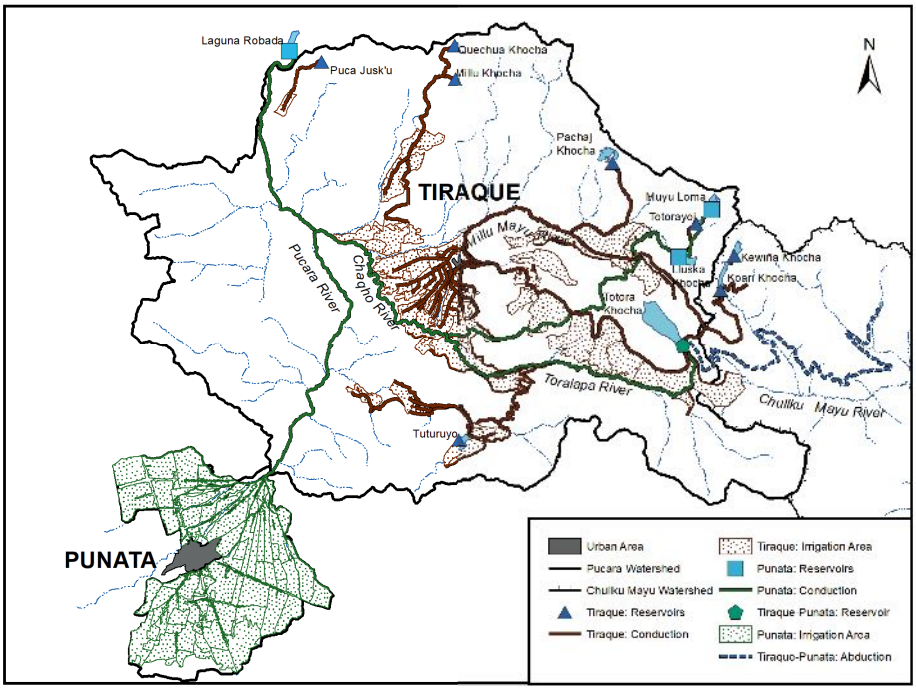

Figure 3.2 Hydrosocial territories formed around the reservoirs by late 1991 in the Pucara river basin.
Source: Own elaboration.

3.4.3 Further territorializing water (1995–2017)

In the last two decades, many new investments in irrigation works have been done in both Punata and Tiraque municipalities. However, the spatial character and dimension of these investments have changed importantly, as well the languages of water rights legitimation, through the increase of socioterritorial control over the water sources in the upper river basin. This is mainly due to the process of administrative decentralization or municipalization (Law of Popular Participation) that started in 1995, and the empowerment of indigenous/peasant communities promoted by the Evo Morales Government since 2006. In this process, planning and investment responsibilities were delegated to the municipal level, introducing systems of participatory planning based on community demands and municipal investment in rural and urban communities proportional to population numbers. Because of the participative planning, the municipalization process visualized the formerly 'hidden' rural communities, which in the case study were the poorer and more remote highland communities from Tiraque, in which main water sources originate and all reservoirs are situated. These communities demanded to invest their share of public funding in health, education and irrigation infrastructure mainly. In contrast, before the municipalization process, rural populations could only obtain state funding through departmental government offices, which were mainly mobilized through political relationships. This was only feasible for rural groups

with departmental ties, such as the more integrated Punata and Tiraque valley peasantry, as witnessed in the formerly mentioned PRAV projects.

Other important characteristics of the municipalization process were the clearer definition of municipal boundaries, the expansion of the mayor's responsibility over the whole municipal territory (before 1995 the mayor's office dealt with urban issues only) and the obligation to invest municipal means within its territorial boundaries only. In a few years, this led to the strengthening of the territorial argument underlying resource claims; for all kinds of resources (wood, cement, gravel, mining, etc.), but for water most strongly, considering the vital role of water for people's livelihoods (drinking and irrigation) in the municipalities. This process was reinforced by Evo Morales Government (2006), which institutionalized and consolidated local and regional governance benefiting indigenous/peasant communities. Through a new Constitution (2009), the Bolivian government restructured democratic representation and governance around indigenous autonomy and communitarian values, empowering indigenous/peasant communities and giving them the right to make decisions about their territories and their resources (Morales 2011).

As a result, highland communities from Tiraque over two decades gained control over ten new small reservoirs (0.05–0.90 Mm^3) by claiming territorial rights over water resources located in their territories. Through these investments practically all surface water flows and sources in the Pucara river basin came to be used, part of the hydrosocial territory controlled by one or various peasant communities. This proliferation of irrigation systems resulted in the virtual closure of the Pucara river basin, meaning that there is no more 'free water' flowing in the river basin (e.g., Molle 2003). This forced all communities to reorient their actions towards alternative sources within their municipal boundaries or towards investments aimed at transferring water from other basins.

Water transfer projects would re-open the Pucara river basin by importing 'new water'. Since the 1990s, one of the possible options was the Yungas de Vandiola transfer project; capturing water from the mountain range north of Tiraque, to be released in the upper Pucara river basin and to be used in the downstream areas (see Rocha López et al. 2019). These waters originate in the highland communities, but were proposed to just pass through them to irrigate land in the Tiraque and Punata valley communities. But to defend the use of these waters, in 2008, the highland communities organized themselves at the local level in the Highland Association (Asociación de Alturas) and at the regional level in the Cochabamba Indigenous Agricultural Irrigators Federation (FRIAC, *Federación de Regantes Indígenas Agropecuarios de Cochabamba*). Both organizations were a clear expression of cultural (*quechua*), socioeconomic and geographical belonging by indigenous, highland, less endowed and formally-educated communities, that did not feel represented by the existing irrigators' organizations and were excluded from all earlier investments in water projects even though taking place in their territories (Callejo et al. 2012). The creation of these two organizations was as a vivid expression of their territorial claim over water and the strategic need to collectively defend it.

In 2011, when the feasibility study for the Yungas de Vandiola transfer project was eventually implemented, the official objective was still to increase the very low water

volume of the Totora Khocha reservoir, since it fell behind original expectations[7]. In official documents it was stated that the additional volume was to increment water availability for the Punata and Tiraque valley communities only. As could be expected, the highland communities from Tiraque opposed this idea strongly, claiming territorial rights over the transfer water and demanding to solve their water scarcity issues first. To underscore their position, they destroyed hydrometric instruments and blocked the (only) road to the catchments at stake. As a result of their protests, the project idea was eventually abandoned, as was the naïve idea that the project was situated in no-one's land. In 2011, the highland communities had already become highly visible as important actors for any future water transfer initiative.

Another interesting detail of the Yungas de Vandiola project was that it reopened the discussion between Tiraque and Punata valley communities about the proportions of water distributed from Totora Khocha reservoir. Taking advantage of the increasingly accepted discourse on territorial water rights, Tiraque communities re-negotiated the terms of the original distribution agreement to 50% for Tiraque and 50% for Punata, to be effective from the moment the Yungas de Vandiola transfer would begin to operate (Rocha López et al. 2019).

In 2013, Tiraque valley communities restarted the discussion on the water transfer project with the highlanders. This time, Punata beneficiaries were left out of the project. To create a project useful for both valley and highland communities from Tiraque, the idea of storing the transfer water in Totora Khocha reservoir was abandoned. Totora Khocha is situated at a lower level (3750 m altitude) than the highland communities (between 3800 and 4000 m altitude) and would thus be useless for them. Instead, eyes were set on the Pachaj Khocha reservoir, situated at 4000 m altitude, controlled by 14 Tiraque valley communities. It has an actual capacity of 1.5 Mm^3 but may be extended to 3 Mm^3 for storing the transfer water. In 2013, the Pachaj Khocha Irrigators Committee signed a secret agreement with the Sankayani community, where the reservoir is situated, consenting on sharing the additional volume in halves. In this way, the actual Pachaj Khocha users would preserve and increase their hydraulic property rights and guarantee the legitimacy of these rights through a strategic association with the territory holders.

When in 2016, public discussions about the Pachaj Khocha enlargement started (involving the mayor's office and departmental government) the other highland communities objected to the narrow territorial interpretation of one single community in the 2013 agreement and the exclusion of the other communities that were members of the Highland Association, while founded to collectively defend their natural resources. In August 2016 a new agreement was signed, stating that the future distribution of additional water would be 48% for the existing rights-holder valley communities and 52% for the highland territorial owners.

In the Punata region, the municipalization process and the closure of the Pucara river basin, left ground water as the only alternative for irrigation, being the only territorially secure water source. After first experiences since the mid-1970s, drilling increased enormously after 1995; groundwater became the foremost water source for Punata. In

[7] From 1991 until 2008, Totora Khocha stored an average of 7.2 Mm^3 per year; 33% of its total capacity.

2010, 205 wells were operating (113 for irrigation, 76 for domestic use, 11 for both irrigation and domestic use and five for industrial use), with a total annual extraction of 16.7 Mm^3 (Mayta 2012). Compared to the previous period, the number of wells had increased by 400%, due to which the water table dropped significantly, and ever deeper wells must be drilled to be effective.

Figure 3.3 schematically shows the hydrosocial territories constituted by 2017, highlighting the increase of reservoirs in the Tiraque highlands and the proliferation of wells in Punata Valley. Compared with the previous period (Figure 3.2) and because of basin closure, Punata could not capture new water sources in the basin. Instead, they lost influence in the upper river basin and were virtually excluded from future transfer projects. By contrast, Tiraque communities controlled ten new small reservoirs, consolidating the socioterritorial right over the water sources of the upper river basin. The winners of the shift in the water rights languages towards territorial claims are the highland communities, which because of their strategic location and organizational efforts, managed to get greater control over the water sources that originate in their communal territories. Their power resides in the impossibilities for others to construct any hydraulic works in their territory without their consent, because of the collective defence of their supra-communal space.

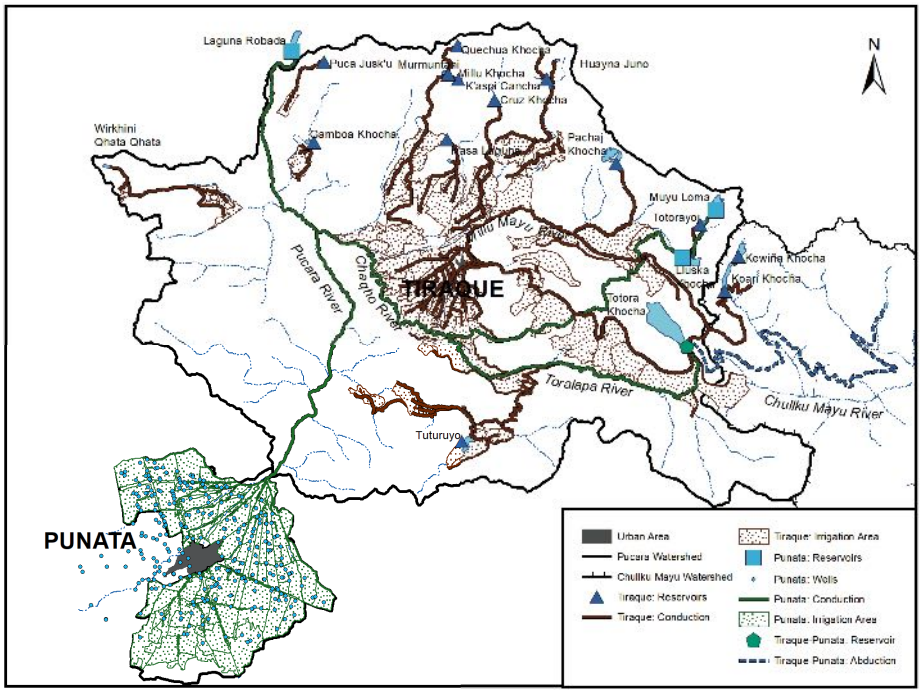

Figure 3.3 Hydrosocial territories formed around the reservoirs by late 2010 in the Pucara river basin.
Source: Own elaboration.

3.5 Discussion and conclusions

In this chapter, I have analysed how peasant communities in the Bolivian Andean region pro-actively searched for new water sources for irrigation and moulded the processes to re-order their hydrosocial territories through a diversity of actions. I used the recent concept of hydrosocial territories as a new theoretical 'lens' to look at dynamically changing water rights frameworks. It enables to see and understand how different actors, who conceptualize and imagine their territory in different ways, strategically deploy particular, corresponding water rights legitimation languages to reinforce their water claims and materialize their wished-for hydrosocial territory.

The irrigation development in the Pucara river basin shows how, as water became scarcer and water demands increased, peasant user collectives required extending their hydrosocial territories by constructing and improving hydraulic infrastructure to capture more water. Some of these actions (often supported by the Bolivian state through irrigation projects) were designed at the expense of affecting water rights and territories of other collectives, but enhanced under the umbrella of the right-giving argument of hydraulic property: those who invest in the construction of the hydraulic works needed, are entitled to use the transported water and govern the system.

Over time, affected peasant communities developed diverse strategic-political actions to defend and legitimate their claims to water rights. In this process, peasant communities and water user collectives managed to gradually change the dominant language of water rights legitimation, and used language that resonated with the changing discourse of the government after the election of president Morales. Along the three studied periods (1950–2017), the preponderant language of water rights legitimation changed from modes based on hydraulic property rights creation to modes stressing territory-based claims. The territorialization of water claims is intimately related to changes in national normative and policies, like the process of administrative decentralization (municipalization), and the empowerment of indigenous peasant communities. The process of municipalization of public planning and investment strengthened the spirit of territorialization, inducing to municipal demarcation of water projects and beneficiaries, and brought in municipal authority to defend territorial claims. In fact, in Tiraque a process of multi-scalar territorialization took place: all Tiraque communities against Punata communities, highland communities against valley communities and within the highland a single community against its neighbours.[8]

This historic development around water also reflects the changing power structures in the river basin, as expressed in specific patterns of access to water and dominant discourses about water control. The political and economic power exercised first by the landowners and then by the Bolivian government, allowed the Punata communities to expand their hydrosocial territories and control water sources upstream in the river basin. However, new attempts to expand Punata hydrosocial territories, following discourses of 'economic logic' and 'efficiency', were fiercely contested by Tiraque communities claiming socioterritorial rights over the water sources in the basin.

[8] For now, only the last contradiction (between a highland community and its highland neighbours) has been 'solved'. Highland communities feel empowered; their need for collective defence based on cultural, socio-economic and geographical belonging has enabled them to generate a new space for collective action within and among the highland communities.

Favoured by the administrative decentralization process, Tiraque communities positioned the socioterritorial discourse to defend and legitimate their claims over water rights. The favourable location of Tiraque communities (upstream) entailed being in a relatively better position whenever future plans for water development materialize in the river basin.

In this context, for peasant communities the languages of territorial rights legitimization include the right to take control and use of the resources within their territory (water, land, grazing lands, etc.) and the right to take decisions about them. The latter is especially true for the highland communities, which until recently, were socio-economically and culturally subordinated to the valley communities of both Tiraque and Punata, and thus neglected in external decision making about their territorial resources. Their current empowerment makes it impossible to deny them in future water projects and urges to reach consent about equitable distribution of future water benefits.

In this chapter, I have shown the dynamic nature of water rights claims (and their acceptance) within and among key water governance actors, contesting prevailing notions of water rights frameworks that focused on static legal doctrines; age-old ('traditional') customary peasant and indigenous rights; or overwhelming market forces. The newly established (but continuously contested) languages for water rights legitimation in the Pucara river basin shifted from modes based on hydraulic property creation to territory-based modes, as a basis for defending claims to water. Contributing to the water rights literature, the approach deploys the concept of hydrosocial territories to analyse these strategic languages that legitimize and strengthen claims regarding water use rights. Hydrosocial territories are not merely biophysical, legal-administrative and political-geographical constructs but equally build on imaginaries, epistemologies and discourses that relate to specific values and languages of water rights legitimization. These dynamically take shape in the essence of water technology, and become deeply ingrained in irrigation as human-made-nature.

CHAPTER 4 RE-ENGINEERING CLOSING RIVER BASINS: THE NEGOTIATED EXPANSION OF A DAM-BASED IRRIGATION SYSTEM IN BOLIVIA

A general view of the Totora Khocha dam in April 2010. The Totora Khocha dam is the biggest and most important dam in the Pucara river basin. It was constructed as an attempt to reopen the river basin (April 29th 2010).

Source: Centro AGUA, 2010

This chapter is based on: Rocha, R., L. Vincent, and E. Rap. 2015. Re-engineering closing watersheds: the negotiated expansion of a dam-based irrigation system in Bolivia. *International Journal of Water Resources Development* 31 (1): 50-63.

4.1 Introduction

A first response to growing water demand is often to expand or construct new hydraulic infrastructure to capture more water. However, many river basins around the world do not have enough water to meet the growing demand, and consequently such supply-oriented water development results in 'basin closure' (Falkenmark and Molden 2008). Nevertheless, many river basins do not remain closed, because irrigation projects expand the infrastructure systems beyond their boundaries by importing water from other river basins. The problem under review here is that this irrigation system expansion seldom follows a prescribed and orderly intervention process. Conventional project design understandably assumes a circumscribed number of beneficiaries depending on the definition of the project area. However, the unintended consequence of infrastructural expansion is often that it not only increases water supply but also creates new demands for inclusion and services from groups that were previously excluded but whose territory and water resources are involved. Enlarged dam systems and increased numbers of regulating and transfer structures are often key features of these expanded networks. In the last two decades, there have been several studies on the role and impacts of large dams (Altinbilek 2002; Cariño and Colchester 2010), leading Biswas and Tortajada (2001, 9) to argue that the main issue *"is not whether large dams have an important role to play ... but rather how best we can continue to improve their overall effectiveness for human welfare, eradicate poverty and preserve the environment"*. Yet, there are few actual studies of the construction and continued expansion of dam-based irrigation systems.

This chapter therefore aims to provide further insights for the debate on closing basins, which has also been highlighted by several authors (Falkenmark and Molden 2008; Molle 2008), especially on actual experiences of negotiation between water users and water development project agencies as water infrastructure systems expand. It focuses on the evolution of the Totora Khocha dam irrigation system in the Pucara river basin, in the central region of Bolivia. The Pucara river basin has a long history of irrigation development. At present, most of the available water is committed and managed by different groups of irrigators, with the result that during the dry period (April–October) all the water is utilized and the river basin is closed (Rocha et al. 2014).

The Totora Khocha Dam is the biggest and most important dam in the Pucara river basin. It was developed as an attempt to reopen the river basin through inter-basin transfer. This dam was constructed over the site of an older dam to both expand the irrigation area and improve water supplies to irrigated areas in the basin, involving the reopening of the river basin through water transfer. The case allows us to analyse how this intervention process was fiercely contested by emergent local actors who forced the redesign of the planned infrastructure network. In this sense, the chapter builds on earlier studies of intervention processes, particularly in irrigation system design (Gerbrandy and Hoogendam 2002; Long and van der Ploeg 1989). Such analysis reveals how irrigation development can be understood as a negotiated construction process of water networks. I argue that the spatial expansion of water networks, with the aim of increasing water supply in a closing river basin, can generate contestation and a negotiated redesign of the planned network by existing and emergent actors. Thus, this study wishes to add to the learning tools for water resources development engineers

and planners, and to offer an additional perspective on improved frameworks for the successful development of irrigation projects.

Original empirical data were collected in 2009–2010. These findings were compared and contrasted with earlier documented observations, historical maps, and archival material. Through the application of research methods such as semi-structured interviews, participant observation and document analysis, the 'life' of the Totora Khocha irrigation system was reconstructed, tracing contextual changes and the actions of different actors in (re)shaping the water network.

Irrigation development in closing river basins is particularly complex in the Andean region for reasons relating to time and space. Firstly, most of the water resources in Andean river basins are often already committed, sometimes even to users outside the basin boundaries. New claims to water and territory that emerge from irrigation development affect these pre-existing water rights. Secondly, the expansion of water supply networks and water transfer across boundaries and territorial spaces reopen the receiving river basin but also contribute to closing the supplying river basins. The dynamic reordering of the Totora Khocha water network that results from these complexities is analysed in the following sections. The section 4.2 defines the concepts used in the research analysis. The section 4.3 reviews the origins of the reservoir dam, describing the construction and establishment of the Ovejeria Khocha Dam to supply irrigation water to particular communities. Section 4.4 discusses the proposed design of the Totora Khocha dam and its irrigation system as an attempt to reorder the local water networks, and the section 4.5 analyses the process of contestation and negotiated redesign of the Totora Khocha water network.

4.2 Re-engineering water networks

River basin closure is essentially a human-induced process. As the population grows, abstraction of water for human purposes increases, approaching or even exceeding the threshold of renewable water resources in a basin (Falkenmark and Molden 2008). The term 'river basin' is used here as the common alternative used to describe a basic hydrological drainage unit in the Andean area. As a river basin approaches closure, there is no possibility of capturing and allocating 'new water'. Hence people become increasingly dependent on the available water. Molle (2003) differentiates three categories of societal responses to water scarcity – supply augmentation, conservation and allocation – which are implemented at both local (individuals and groups of users) and state levels. Clearly, the Bolivian state assumed a supply-augmentation approach in responding to the irrigation demands of the people in the Pucara river basin, planning the re-engineering of local irrigation systems through water transfer and infrastructure expansion. However, irrigation development in a river basin should not be understood as simply a rational sequencing of demand and supply adjustments. Instead, it often involves a socially contested and politically negotiated process of network construction, shaped by a variety of driving forces, which delimit the responses and actions implemented by local and state actors (Komakech et al. 2011).

When almost all water resources in a river basin are committed, as in the case of the Pucara river basin, any intervention to supply new irrigation water involves the re-engineering of existing sociotechnical associations shaped around the control of water. These sociotechnical associations can be seen as networks held together by people through a diverse set of relationships to control and use water (Vincent 2001). From the perspective of actor-network theory (Latour 2005; Law 1994), irrigation systems can be seen as water networks that tie people, their knowledge and labour, infrastructure, water, rules and norms, and other material and non-material resources together in some kind of working order (Bolding 2004; Rap and van der Zaag 2019; Veldwisch et al. 2009). This way of thinking conceptualizes irrigation projects as attempts to create new modes of ordering (Wester 2008) – that is, self-reflexive strategies for patterning water networks (Law 1994). This undermines the classical conception of irrigation projects as discrete projects in time and space; instead, they are dynamic processes of contesting and negotiating modes of ordering. Murdoch (1998) asserts the political character of network ordering processes, affirming that these processes are developed in two linked and simultaneous spaces: prescription, where the elements of the network are effectively aligned and the network is stabilized according to the prescribed modes of ordering; and negotiation, where the prescribed modes of ordering are contested, actors continually renegotiate, and the network assumes changing shapes. This means that irrigation systems are dynamic in essence as a result of continuous processes of redesign and contested use. The processes of design and redesign documented here show the struggle between meanings and key criteria used in design. As this study shows, to provide for this dynamic element of negotiation, substantial ongoing capacity for facilitation and participation is required in the development of large irrigation projects. The older institutional arrangements in place to operate infrastructure, and the challenges to transform or reform them, must also be understood. Particularly in the Andean region, local institutional arrangements for irrigation management are fiercely protected, and new institutions and organizations are often contested and renegotiated (Vos et al. 2006).

4.3 The origin: the Ovejeria Khocha dam

An irrigation system is the result of historical and dynamic interactions among human, technological and natural elements to control water for irrigation. Bolding (2004) affirms that irrigation systems have ‘phases of life’, where periods of change alternate with periods of relative stability. Therefore, it is important that designers explore the dynamic modes of ordering in targeted water networks, understanding how they have come to be patterned as they are (Law 1994). In the following, the origin of the Totora Khocha dam irrigation system is explained, focusing on the initial construction of the older Ovejeria Khocha dam. During this initial life phase of the water network, users’ investments (of labour and capital) to construct or improve infrastructure implied the creation of hydraulic property rights (Coward 1990; Komakech et al. 2011), whereby users claim and gain water rights. These water rights constituted the basis of the network construction and subsequent stabilization.

The origin of the Totora Khocha dam goes back to the beginning of the twentieth century, to the construction of the Ovejeria Khocha dam during the period of the large

estates (haciendas). The landlord of the El Churato estate, situated in the Tiraque region, commanded his labourers to construct an earthen dam in the natural lagoon called Ovejeria Khocha as an alternative way of storing water in the rainy season to irrigate their fields in the dry season (Reque 1998). The stored water was conveyed through rivers and unlined canals to irrigate the estate's fields. The water network was totally controlled by the landlord, and the estate's labourers operated and maintained the infrastructure on his behalf.

The landlord's domination ended with the agrarian reform of 1953, which enabled the distribution of the estate's lands among the peasant families settled on the property. The El Churato land was assigned jointly with water rights to Ovejeria Khocha, and the peasant families organized themselves into four communities. The new owners of the reservoir established a novel mode of ordering the water network, shifting from individual landlord to collective control by peasant communities, but also including new users and new rules, and expanding the irrigation area. From this period onwards, collective action constituted the basis for the development of the water network.

At the beginning of the 1960s, land use intensified as a result of land distribution and parcelling. This in turn increased irrigation-water demand and the pressure on water resources in the basin. The water stored in the Ovejeria Khocha reservoir was insufficient to cover the growing irrigation demands, and the users thus looked for ways to increase the reservoir's storage capacity. Because improvement of the old dam demanded technical knowledge, the peasant communities asked the Bolivian state for technical support. In 1964–1966, the dam was improved with the support of the Ministry of Public Works and the labour investment of users, increasing the storage capacity of the reservoir to 0.8 Mm^3. In this process, the governmental agency asked the users to include new users in the project and expand the irrigation area, to provide better economic justification for the project. Hence, peasants from two new communities were included, and one of the original communities was divided into four separate communities. This creative way of including 'new' users in the system meant that in total 394 users from nine communities would benefit from the project. In this process, a number of peasants from Punata participated in initial labour activities to improve the dam, but the original users from Tiraque perceived the risk of losing control over the reservoir and decided to exclude Punata's peasants from the project. This strategy led to serious conflicts between Tiraque and Punata, and could only be resolved through the intervention of the Bolivian president, Rene Barrientos, who promised to support the construction of another reservoir (Lluska Khocha) for Punata's peasants (Reque 1998).

After a period of substantial reordering of the network around the Ovejeria Khocha dam, a relatively stable water network was shaped. Figure 4.1 shows the water-network scheme as it was in the 1970s, when the dam stored 0.8 Mm^3/y and the irrigation area spanned the fields of users from nine Tiraque communities organized around an irrigation committee. The network was consolidated through the years, with the continuous operation and maintenance of the system and the recognition of the Tiraque communities' rights to this reservoir by other peasants and communities elsewhere.

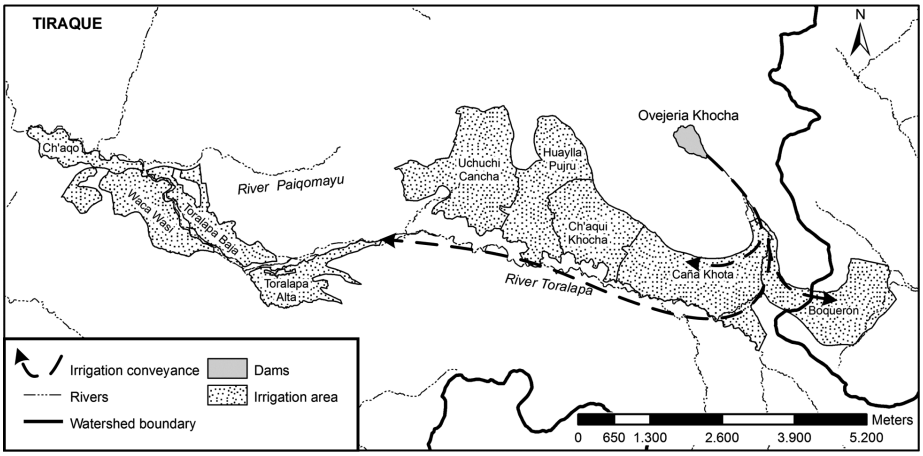

Figure 4.1 The nine communities and irrigation areas of the water network in the 1970s.
Source: Own elaboration.

4.4 The prescriptive design of the Totora Khocha dam irrigation system

Irrigation projects can be conceived as attempts to create new modes of ordering in water networks (Wester 2008). Designers have a sense of order, according to which they plan to pattern the water networks, introducing new infrastructure and other new elements, possibly changing cropping patterns, irrigation allowances and management organizations, in line with the type of water control aimed for. This section shows that the original design of the Totora Khocha dam irrigation project clearly had top-down and prescriptive characteristics. Project designers assumed the authority to both define the problem and design the appropriate solutions. As if writing a *"script"* (Akrich 1992), designers planned the construction of the new Totora Khocha reservoir dam over the older Ovejeria Khocha reservoir, predetermining the characteristics, settings and roles of actors and entities in the expanded network, and assuming that all actors would follow their assigned roles. The following paragraphs describe the original design of the Totora Khocha dam irrigation project as it was formulated in the project's feasibility study (Salzgitter Consult GmbH 1991).

The Totora Khocha dam irrigation project originated from the Punata peasants' demands for irrigation, addressed to the Bolivian state. At the end of the 1970s, most of the water resources in the Pucara river basin were already committed, and the available irrigation supply downstream of the basin was insufficient to cover the irrigation demands of Punata's fields. In particular, peasants from Punata demanded an increase in the irrigation supply through the improvement of their old dams and the construction of new dams upstream of the river basin. In 1977, these demands, as well as the demands of Tiraque peasants, were included in the Altiplano Valleys Irrigation Programme (PRAV) managed by the Ministry of Rural and Agricultural Affairs through the National Community Development Service (SNDC) and financed and supported by

two German agencies: the German Development Bank (KfW) and the German Technical Cooperation (GTZ). The programme started with the appointment of the German consulting engineers Salzgitter GmbH to provide technical support to SNDC technicians for the elaboration of feasibility studies for Punata and Tiraque. The initial studies identified diverse problems in the traditional irrigation systems, relating mainly to infrastructural faults in older dams and inefficient water management. In 1978–1980, three irrigation feasibility projects were elaborated (Table 4.1), one for Tiraque and two for Punata. These studies focused mainly on improving the existing dams and constructing 'modern' dams around them to increase the storage capacity.

Table 4.1 Feasibility studies of irrigation projects elaborated by the PRAV program in 1978-1980.

Year	Irrigation project	Intervention	Irrigation area
1978	Laguna Robada	Increase the storage capacity of the Laguna Robada reservoir (2.2 Mm^3)	Punata
1979	Tiraque	Increase the storage capacity of the Koari Khocha (2 Mm^3) and Khewiña Khocha (1.5 Mm^3) connected reservoirs, and improve the infrastructure in the irrigation area	Tiraque
1980	Punata	Increase the storage capacity of the Muyu Loma (1 Mm^3) and Lluska Khocha (1.25 Mm^3) connected reservoirs, and improve the infrastructure in the irrigation area; increase the storage capacity of the Ovejeria Khocha reservoir through the construction of the new Totora Khocha dam (22 Mm^3) and expansion of distribution infrastructure	Punata

The Totora Khocha dam in the Punata Irrigation Project was oriented towards supplying additional irrigation water to the Punata Valley through an inter-basin water transfer. Given the irrigation deficit and high potential for irrigated agriculture in the Punata Valley, and the abundance of water in the Tiraque region, the Punata Irrigation Project initially made good sense. The initial design of the project (Figure 4.2) proposed four major adjustments to the older Ovejeria Khocha water network. Firstly, the older dam would be expanded through the construction of the new Totora Khocha dam, increasing the storage capacity from 0.8 Mm^3 to 22 Mm^3 (the surplus over the older storage for Tiraque was almost five times the storage capacity of the three reservoirs used by Punata up to that time). Secondly, the new reservoir would be filled by transferring water from three small catchments located in the Chullku Mayu river basin, through a collector canal 23km long. Totora Khocha would also be connected with five other reservoirs to receive their excess water: Muyu Loma and Lluska Khocha managed by Punata, and Koari Khocha, Khewiña Khocha and Pachaj Khocha managed by Tiraque. Thirdly, the infrastructure network and the irrigation area would be expanded, including new users in the Punata Valley. In this plan, the designers ignored the existence of the original Tiraque users. This aspect was the project's most controversial proposal, given the historical conflicts between Tiraque and Punata over water resources. Fourthly, incrementing irrigation supply and modernizing irrigation control structures would in theory make continuous flow possible, enabling water delivery according to crop water

requirements. Given the complexity and costs of the Punata Irrigation Project, it was split into two phases: Phase I, including the improvement of Lluska Khocha and Muyu Loma; and Phase II, including the construction of the new Totora Khocha dam (Salzgitter Consult GmbH 1991).

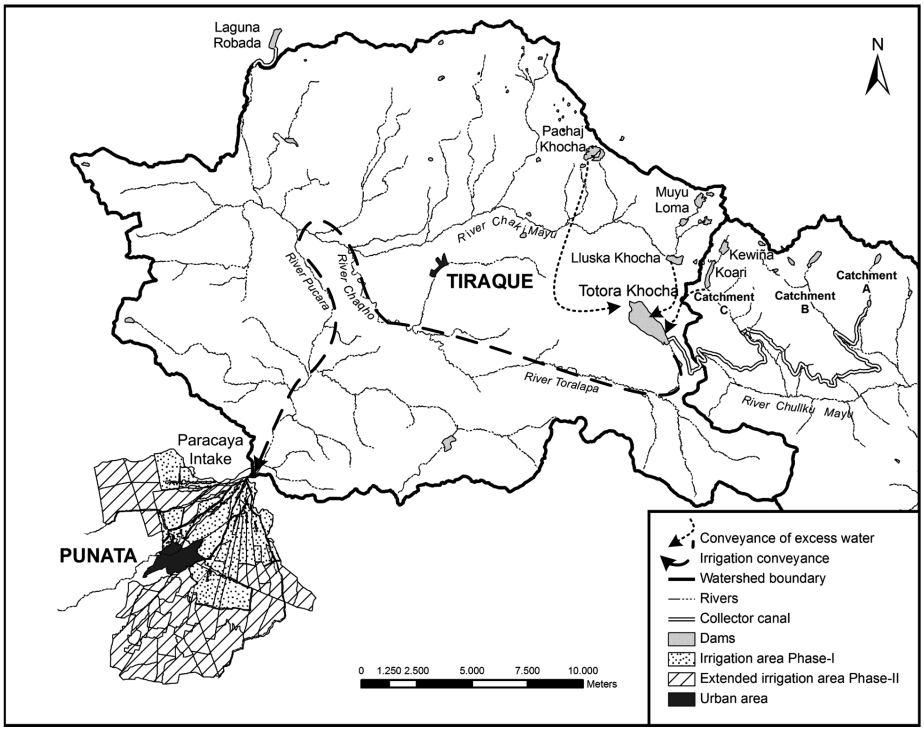

Figure 4.2 The proposed Totora Khocha water network.
Source: Own elaboration based on Salzgitter Consult GmbH (1991).

The changes proposed for the Punata Irrigation Project, Phase II, implied the creation of a new mode of ordering of the older Ovejeria Khocha water network, changing even the name of the reservoir. Even though the designers were aware of the original users of the Ovejeria Khocha reservoir dam, they ignored them in the design of the new water network. According to the previous feasibility studies, the increment in irrigation supply from the Tiraque project (Koari and Khewiña Khocha) was sufficient for the irrigation requirements of the peasants of Tiraque. Also, the Punata Valley's high potential for irrigated agriculture made this zone perfect for modern and highly profitable agriculture, justifying the feasibility of the project to the consulting agency.

4.5 Negotiating the expansion of the Totora Khocha dam water network

Once the feasibility study for the Punata Irrigation Project, Phase II, was finished and approved by the funding agency (KfW), the final design started at the end of 1984. In contrast to the feasibility study, which was elaborated as a seemingly apolitical scenario dominated exclusively by the group of designers, the final design and construction stages developed in a complex political arena of contested redesign by diverse actors. The case shows that irrigation development is not just a matter of applying the right materials and natural laws to produce technologies for particular purposes (Bolding 2004; Veldwisch et al. 2009). I analyse it as a process of network building negotiated between different social groups, in which irrigation schemes allow for various degrees of interpretative flexibility. From this point of view, the expansion of the Totora Khocha dam network is analysed as a prescription/negotiation process (Murdoch 1998) in which the prescriptive mode of ordering defined in the feasibility study was contested by emergent actors. The continuous renegotiation resulted in changing forms of the water network, as is shown in the next three subsections.

4.5.1 Encountering and recognizing the original Ovejeria Khocha water network

Initially, the designers ignored the historical sociotechnical associations clustered around the Ovejeria Khocha dam, assuming that the river basin was an open natural space where further technical development for particular water control would be possible. The consultants experienced the first contestation of the proposed design when they went to the field and started to work near this reservoir. The original users and owners of the Ovejeria Khocha dam, who had not been informed of the project, reacted to the presence of foreigners around their reservoir, and the work was stopped (Gandarillas et al. 1994). Only at this stage did the designers encounter and perceive the local water networks and their actors.

After that incident, the designers organized a meeting with the original users of what was now called Totora Khocha dam. The designers explained to them the characteristics and objectives of the Punata Irrigation Project, Phase II, informing them about the construction of the new dam to increase the storage capacity of the older dam. The new dam could store enough water to irrigate the Punata Valley as intended, as well as the fields of the original users from the nine Tiraque communities. Initially, the original users rejected the project and claimed their historical property rights to the older dam. The designers hardly understood that the small dam was not just a physical element but that it also embodied a historical claim to water rights tied to specific local people, fields, water resources, management rules, and other elements, comprising all together a relatively stable water network. Therefore, the only way to continue with the project was to negotiate some agreement to include the original water network in the project.

After many discussions, the original users finally accepted the designers' proposal. The project would respect and guarantee the 0.8 Mm^3/y of water stored by the older dam, to be managed and used by the original users. In this way, the water from the planned dam was divided into 'old' and 'new' water, leaving the old water in the hands of the nine Tiraque communities, and planning the conveyance to Punata fields of only the new

water to be stored in Totora Khocha. The designers recognized the original water network, including the users and fields of the nine Tiraque communities in the larger irrigation project and giving these users autonomy in managing their water. In practice, these changes were not dramatic for the project, given that 0.8 Mm^3/year was just 3.6% of the planned storage volume. These changes were included in the final design, which was finished at the beginning of 1986.

4.5.2 Emergent actors and new claims: reordering the planned Totora Khocha water network

The final design of the Punata Irrigation Project, Phase II, was approved, and PRAV technicians started the preparation process to construct the planned infrastructure network. However, suddenly a new problem emerged. Other peasant communities from Tiraque became aware of the project to construct the new dam and of the agreement reached with the original users. They expressed their opposition to the project, claiming their right to be included as well. In this situation, the KfW asked the Bolivian state and PRAV to get prior agreement with local actors before disbursing the committed budget for project construction. Thus, PRAV started a two-stage negotiation process with peasants from Tiraque and Punata.

The first stage focused on the inclusion of new users from Tiraque in the planned water network. However, it implied a serious change in the project design and reduced the project's viability, because the water for Punata's productive lands would be reduced. Therefore, PRAV's technicians made many attempts to convince Tiraque peasants to abandon their opposition to the project, but both sides remained completely opposed. On the one side, PRAV argued that the project was designed to irrigate the Punata Valley, given that Tiraque had enough water to irrigate their available irrigated lands. Punata peasants supported PRAV's position, arguing that they had no other additional water resources for irrigation, and also that they had been included in the project by the government. On the other side, Tiraque peasants counter-argued that they needed irrigation water too and also that they had the prior right to the reservoir water because it was located in their municipal territory. The designers' assumption of the sufficient availability of water for the Tiraque communities was based on overestimation of the potential water supply and underestimation of irrigation-water demand. The designers had ignored the variability and unpredictability of rainfall in the region, which in practice meant less irrigation water was available than was assumed. Also, they failed to consider that many peasants from Tiraque did not yet have access to irrigation water, despite the increment in the irrigation water supply inherent in the new design. These peasant farmers without water rights were the main stakeholders in this contestation process. Such overestimation is not uncommon in these kinds of design processes; it might have to do with cost-benefit analyses and the need to inflate benefits to legitimize investments in irrigation projects.

The KfW and PRAV understood that the project would not be implemented without the inclusion of the new users from Tiraque and opened the possibility of sharing the Totora Khocha dam water by redesigning the irrigation system supply network. However, Tiraque and Punata continued to oppose the proposed change. Neither was disposed to negotiate their claims on the planned reservoir. Finally in 1987, after almost a year of

failed negotiations, the leaders from Tiraque and Punata achieved the needed agreement through the mediation of the Cochabamba Peasants' Federation (Gandarillas et al. 1994).

The signed agreement established the shared use of Totora Khocha by the Tiraque and Punata peasants, resulting in a reduction of irrigation supply to Punata. Hence, the designers again had to redesign the planned water network, including the new users and fields in Tiraque and even changing the name from the Punata Irrigation Project to the Tiraque-Punata Irrigation Project.

The second stage of the negotiation process focused on how to share the new Totora Khocha dam water among Tiraque and Punata users. In 1988, when construction of the dam was initiated, Tiraque and Punata also started to negotiate how to share the new Totora Khocha water, with the mediation of technicians from a new governmental entity, the Inter-Valley Irrigation Programme (PRIV). Both groups' positions emerged again, and each group tried to get the largest 'slice of the cake'. After many meetings, a final agreement was reached in June 1990, just one month before dam construction was finished. The agreement established proportional sharing of the new water stored by the dam between the Punata users and new Tiraque users, respecting the fixed 0.8 Mm^3/year for the original users of the old dam. The remaining water was to be shared according to the amount of each region's individual rights: 60% for Punata users and 40% for new users in Tiraque. In this way, three groups of users were recognized and included in the water network: original (old) and new users in Tiraque, and users in Punata.

4.5.3 The outcome: dynamic water networks

In 1991, when the Totora Khocha reservoir dam was finally ready to operate, the Totora Khocha dam irrigation system was different from how it had been designed in the feasibility study. The designers failed in their attempts to create a new mode of ordering in the river basin. Instead, the planned infrastructure network was redesigned to fit the local water networks. Figure 4.3 shows the resulting Totora Khocha water network. In line with the original designs, the new Totora Khocha dam was constructed, as well as the collector canal, to transfer water from the Chullku Mayu river basin. However, instead of distributing water to one user group in a specific irrigated area (Punata), the network now distributed water to three user groups and irrigated areas. Therefore, the infrastructure network was expanded with the construction of additional infrastructure to irrigate the new irrigated areas. The management of the Totora Khocha dam was left in the hands of the three groups of users, organized in two user associations: the old and new Totora Khocha users in Tiraque, in the Association of Irrigation and Services Tiraque (ARST), and the (new) Totora Khocha users in Punata, in the Association of Irrigation and Services Punata (ARSP).

For many users, and especially those in Punata, the new Totora Khocha dam was just a 'dream dam'. The most important element of the planned network did not materialize: water supply. The water supply had been overestimated, and the reservoir never stored the planned volume of water; in consequence, the users did not receive the promised amount of irrigation supply. Between 1991 and 2008, Totora Khocha stored on average

just 7.19 Mm^3/y (Cruz 2010). The local water networks continued functioning in the same way as before the intervention: in practice, each group of users functioned as an autonomous water network, managing and using their respective annual share of water from Totora Khocha according to their own local rules.

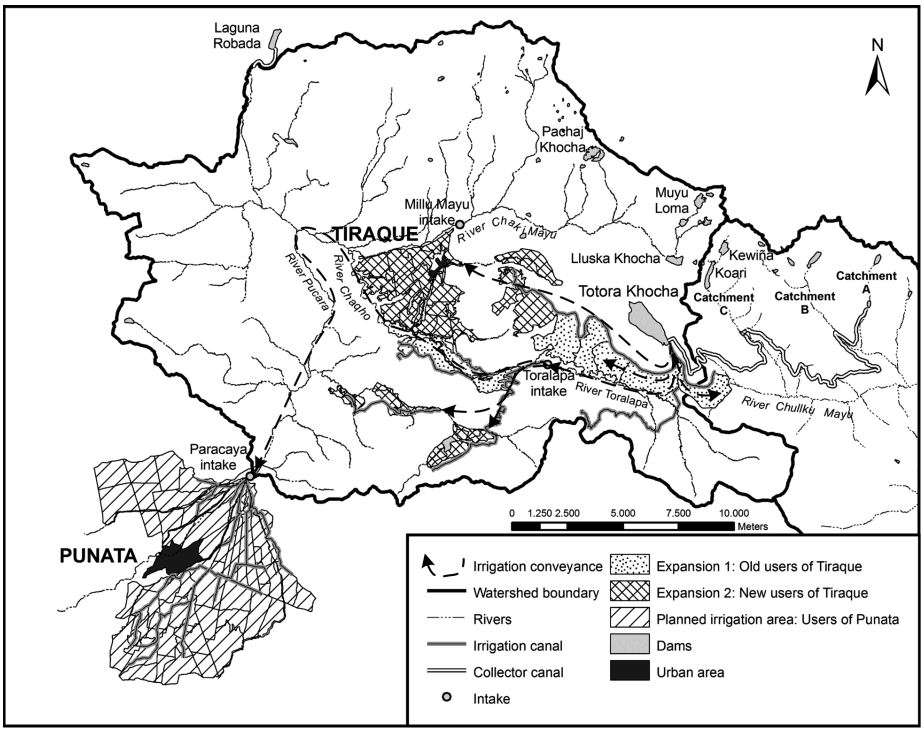

Figure 4.3 The negotiated Totora Khocha water network.
Source: Own elaboration based on PRIV (1992).

It is in this situation that, with the objective of covering the full capacity of Totora Khocha dam, a new irrigation project has been formulated: the Vandiola Transfer Irrigation Project. This project plans to transfer water from the Vandiola region to the Totora Khocha dam through a collector canal around 40 km long. And as in the case presented here, this new expansion project is developing in a conflictive setting where unanticipated actors are opposing the project and asking to be included in it.

4.6 Conclusions

The case study presented here analysed the expansion of a water network through its different phases of life and modes of ordering. Originally, at the beginning of the twentieth century, the water network started as an earthen dam under the command of a landlord to irrigate his estate. The water network entered a second phase after the

land reforms of 1953 and shifted from monopolistic control to collective control by peasant communities. A third phase arrived in the 1960s when peasant communities involved the Bolivian state to increase the storage capacity of the reservoir. The dam was improved with state support and communal labour. A relatively stable water network was shaped towards the end of the 1970s, but in a closing river basin. This phase subsequently intensified when the downstream users asked for an increase in irrigation supply, and this launched a state project that authoritatively planned a new and much larger dam over the original reservoir, which implied an inter-basin water transfer and reopened the river basin. During the 1980s, the design and its implementation enrolled international donors and their technical and financial support. The prescriptive mode of ordering underlying this phase was severely contested at different junctures by existing and emergent user communities that negotiated their inclusion in the expanding water network. During the fourth phase, in the 1980s and 1990s, the latter mode of ordering thus resulted in the negotiated redesign of the planned water network.

This case further shows the complexity of planned re-engineering of closing river basins through inter-basin water transfer. In a closing river basin, actors and networks become increasingly dependent on the available water, and any intervention to reopen the basin and supply 'new' irrigation water involves the re-engineering of local water networks. In this sense, it is important to change irrigation design and intervention approaches towards a better coordinated irrigation development process that takes as its point of departure, and reconstructs, local water networks. It implies a change in the classical conception of irrigation projects as a linear and discrete process in time and space. Instead, this study has shown how they can be understood as dynamic processes of contested and negotiated redesign in which the infrastructure network allows for various degrees of interpretative flexibility. In sum, the design and intervention process in a closing river basin needs to be understood, rather than as a prescriptive process, as a dynamic process of renegotiation of engineering.

Given that dam systems and inter-basin transfers are still the preferred solutions to reopen closing basins, this study highlights two analytical points of more general relevance to the re-engineering processes that arise in such contexts. Firstly, irrigation systems are complex and dynamic water networks constituted by heterogeneous elements clustered together for particular water-control purposes. Any planned change in one element in a water network implies the reordering of the entire network. To avoid the long delays and heavy transaction costs in large projects, it can help if irrigation projects are conceived not as prescribed actions to implant a new water network but rather as attempts to create new modes of ordering, which may be the object of resistance, contestation and negotiation.

Secondly, when irrigation systems expand in space and across boundaries to capture new water, they may also involve new actors and claims to the water conveyed. This case contests the classical conception that irrigation development is simply a matter of listing the entitled beneficiaries and applying the right technologies to capture the required water for irrigation. This chapter has shown how existing and emergent actors claimed the new water, contested the proposed design, and resisted following their assigned roles. A complex process of contested interactions and negotiations among

designers and planned and unplanned actors resulted in the redesign of the proposed water network.

CHAPTER 5 HYDROSOCIAL TERRITORIES IN DISPUTE: FLOWS OF WATER AND POWER IN AN INTERBASIN TRANSFER PROJECT IN BOLIVIA

A general view of the Totora Khocha dam in June 2010. The dam is practically empty after the irrigation period. In a regular year like 2010, the dam stores less than 30% of its storage capacity (June 14th 2010).

Source: Centro AGUA, 2010

This chapter is based on: Rocha López, R., R. Boelens, J. Vos, and E. Rap. 2019. Hydrosocial territories in dispute: flows of water and power in an interbasin transfer project in Bolivia. *Water Alternatives* 12 (1): 267-284.

5.1 Introduction

Irrigation projects distribute and provide access to an increasingly scarce, politically disputed resource. Their dynamics relate profoundly to the way in which power relationships provide substance to the conception and configuration of territory (Budds 2012; Hommes et al. 2016; Molle et al. 2009; Swyngedouw 2004b). This chapter explores the case of the Interbasin Irrigation Water Transfer Project Yungas de Vandiola (*Proyecto de Riego Trasvase Yungas de Vandiola,* PRTYV), which aims to fill the under-utilised Totora Khocha reservoir in the Pucara river basin (upper Cochabamba Valley region). This study of the project's historical background analyses the dynamics of hydrosocial territorialization pursued by peasant communities that aim to strategically claim and create water rights, while interacting with state governments and international cooperation agencies.

In the history of the Pucara river basin, water rights claims and demands were based on constructing particular territorial imaginaries and the strategic political alliances to materialise them. During the design of the interbasin transfer canal, communities located in the upper basin region became relatively successful in demanding water rights, although they were initially not included in the project (Saravia et al. 2006). They formed political alliances with other power groups, including the state, in a sociopolitical context that was favoured by national policies put in place to recognise and support rural and indigenous communities (Morales 2011; Perreault 2008). The project's different stages and corresponding design proposals reflect interest groups' divergent territorial imaginaries and the corresponding disputes over legitimacy of each group's territorial claims and arguments. The chapter highlights how local stakeholders, when dealing with the government in the implementation of irrigation projects, try to construct different hydrosocial territories and materialise them through multiscalar alliances. The case shows a clear shift in the moral basis of the water right claims by different stakeholders, based on shifts away from the accepted hydrosocial territorial imaginations, dominant policy discourses, and evolving stakeholder alliances.

The dynamics of designing and constructing the Totora Khocha irrigation system and the negotiations around the Yungas de Vandiola Irrigation Project, make this a relevant case to study the complexity of irrigation development: it involved complex negotiations followed by redesign (Rocha et al. 2015), and provided key lessons to irrigation professionals in Bolivia about interactive design, co-construction, and joint management (Gandarillas et al. 1994; Gerbrandy and Hoogendam 2001)

The chapter continues in section 5.2 by outlining the conceptual framework orienting this case's analysis. Then, the section 5.3 describes the research methods. The section 5.4 presents the results, starting by presenting the hydrosocial territory as envisioned by the initial project design, and then describing the conception and production of three alternative hydrosocial territories. The conclusions section (5.5) then discusses how, during these sociotechnical water design struggles, newly emerging stakeholders disputed the control over water and the legitimacy of territorial reconfiguration. The chapter concludes that interbasin water transfer projects are arenas in which hydrosocial territorialization disputes become manifest, and where territorial transformation is profoundly impacted by the incorporation of new water sources and

new stakeholders with divergent territorial imaginaries and normative, distributive, and representational interests.

This chapter offers a conceptual and analytical approach to understanding the sociotechnical complexity of interbasin water transfer and irrigation projects' development, especially in the Andean region. The study of the hydrosocial territorialization affecting intervention projects in the water sector allows for a better understanding of who, how, and with what interests actors resist and force changes in water projects and the ways that water and power flows, and also offers a better understanding of the territorial imaginaries, and the juridical or moral arguments to which actors are referenced.

5.2 Water, power, and hydrosocial territorialization

A fundamental notion underlying this thesis is that water is an eminently political resource, disputed through power and authority relationships (Bakker 2012; Mollinga 2008; Vos and Boelens 2014). In this regard, water flows are organised and steered by means of technopolitical power relations that involve domination and subordination, access and exclusion, emancipation and repression. They simultaneously produce the physical – geographical, cultural, and symbolic landscape, and consequently the hydrosocial cycle (Budds 2012; Hommes et al. 2016; Hoogesteger et al. 2016; Swyngedouw 2004b). Construction of hydraulic infrastructure to materially control access to, and exclusion from, water flows establishes control by one group over another and reinforces or challenges established power structures (Crow-Miller 2013; Hommes and Boelens 2017; Meehan 2013; Sanchis-Ibor et al. 2017). With this understanding, irrigation projects are sites and arenas of resistance and social struggle.

Interbasin water transfer and irrigation projects produce and transform hydrosocial territories through the construction of hydraulic infrastructure, as well as through the connection of water sources, cropland, and groups of people, and the management of water flows. Boelens et al. (2016, 2), conceptualise the notion of 'hydrosocial territory' as:

> The contested imaginary and socio-environmental materialization of a spatially bound multi-scalar network in which humans, water flows, ecological relations, hydraulic infrastructure, financial means, legal-administrative arrangements and cultural institutions and practices are interactively defined, aligned and mobilized through epistemological belief systems, political hierarchies and naturalizing discourses. (See also Mosse 2008; Swyngedouw and Boelens 2018).

The concept of hydrosocial territory is useful in the exploration of the trajectory of intervention projects, and in the related arena of constructing water governance on the ground (cf. Agnew 1994; Baletti 2012; Brenner 1998; Elden 2010; Hommes and Boelens 2017). Hydrosocial territories are actively and historically constructed through the interrelationship between society, technology, and water (Boelens et al. 2016). The concept enables the examination of how water projects interconnect technological designs and power relations, thereby negotiating and materialising hydrosocial configurations. At stake are disputed territorial interests, perspectives, designs, and

modes of concretising them: changing water flows can disrupt the political order and can challenge until-then stable ways of imagining the hydrosocial territory – all of which affects the various stakeholders in different ways (Hommes et al. 2016).

Hydrosocial territories are continuously reconfigured and highly contested in terms of their borders, elements, and interrelations (Seemann 2016a). Therefore, a specific hydrosocial territory, at any given time, can be imagined (but also planned or materialised) differently by different actors, depending on their respective interests, visions, and power. This chapter shows that the prevalence of a specific configuration depends on the support and power of an interlocked multi-scalar coalition of stakeholders that provides the discursive, moral, and material support to this configuration (Swyngedouw 2007).

Water struggles and conflicts often originate from attempts to reorganise local forms of collective self-governance and territorial autonomy, for example around irrigation or extraction projects. Such projects try to align local people and their territories with hydro-territorial projections and external mindsets, which are presented as more rational and efficient while, in actual fact, following the interests of powerful groups (Boelens 2014; Hommes et al. 2016). In response, as I describe in this case study, groups of affected stakeholders promote changes in technological proposals, negotiate agreements, and build political alliances to configure and strengthen alternative hydro-territorial designs: they dispute control over decision-making about developing and tapping water sources. These disputes over hydrosocial territorialization lead stakeholders to incorporate and strategically position arguments and narratives that legitimise their particular arguments and proposals, while recognising so-far excluded stakeholder groups.

Therefore, the analytical focus does not reside in a particular hydrosocial configuration, but rather in the process through which particular hydrosocial territories become constituted, transformed, dominant, and materialised (Swyngedouw 2004a). Following the guidelines proposed by Brighenti (2010) to describe the social production of territories, in this study I analyse hydrosocial territorialization dynamics through the following four aspects (see also Roa-García 2014; Rodríguez-de-Francisco and Boelens 2016; Seemann 2016a):

i. *Who produces the territory? – which individual or collective stakeholders produce the territory?*
ii. *How is the territory produced? – which concrete actions produce the territory?*
iii. *What type of territory does this produce?* – what specifically characterises the organisation of the hydrosocial territory and its associated ownership, distribution, and access to natural resources?
iv. *Why produce the territory?* – what is the purpose of producing the territory?

An analysis of these four elements together – that is, the historical production of hydrosocial territories through irrigation project development – highlights the social and material power relationships underlying these projects and enables a more in-depth understanding of their political dimensions.

The conceptual framework combines the sociopolitical production of territory with notions about shifting legitimacy of water right claims. Rather than seeing communities' claims to irrigation water as based on established common property rights or national legislation (see, for example, Meinzen-Dick 2014), this case examines water claims as part of the struggle over legitimacy of territorial imagination.

5.3 Methods

Most empirical data for this chapter was gathered in 2009 and 2010, and several additional field visits were made between 2011 and 2017. Three data-collection methods were used to reconstruct the different phases of territorialization: semi-structured interviews with key informants (six interviews with leaders of irrigators' associations, six interviews with irrigators, two interviews with engineers of the departmental government, and two interviews with project directors); participant observation of assemblies discussing project developments; and a documentary review of project reports, press releases, and archival research.

5.4 The Yungas de Vandiola irrigation project and the production of hydrosocial territories

The PRTYV, conceived and managed by the regional government (the Prefecture, or *Prefectura*[9]) of the Department of Cochabamba, proposed to expand the catchment zone for the Totora Khocha reservoir by constructing a new supply canal to increase the availability of water and fill the Totora Khocha reservoir. Hydraulic design deficiencies (overestimating available water because of poor climatic and hydrometric data) and external impacts on the supply system (disputes over water sources and supply canals in catchment zones) resulted in less available water than had been projected, and consequently the construction of the Totora Khocha on an overly large scale. Between 1991 and 2010, the reservoir contained, on average, no more than 30 percent of its maximum storage capacity. In response, a new project was proposed to fill the Totora Khocha reservoir: The Interbasin Transfer Project Yungas de Vandiola. The aim of this project was to expand the catchment zone by constructing a new supply canal to collect water from the Yungas de Vandiola region (another basin). This chapter studies the design and negotiation process of this new interbasin water transfer project. The project's historical trajectory is analysed below to show the dynamics of hydrosocial territorialization by rural communities opposing the project. Starting by describing the hydrosocial territory proposed by the project, I analyse proposals for alternative hydrosocial territories produced at three key moments in the project's development, which largely determined how the project unfolded.

5.4.1 The hydrosocial territory proposed by the project designers

In 1993, two years after the Totora Khocha reservoir began operating, the idea arose of expanding the catchment zone by building a new supply canal. The preliminary study

[9] The Prefecture is the regional government of a Department in Bolivia. In 2010, the Prefecture was converted into the Departmental Autonomous Government.

proposed to tap water from the Yungas de Vandiola region (CES-GFA 1993) – with a mean annual rainfall of about 1500 mm/year – by building a transfer canal 28.1 km long at an elevation of 3800 m altitude. The new supply system would contribute a total of 27.6 Mm^3/year to the Totora Khocha reservoir, to finally fill its storage capacity. During those years, Bolivia was undergoing a period of difficult economic structural adjustments (Kohl 2002), and the project proposal was not supported by the government, notwithstanding the claims of irrigators' organisations. In 1994, through the Popular Participation Law, the state's role in irrigation development shifted from a top-down model to a more flexible demand-driven one. Through participatory planning, this law increased opportunities for peasant communities to participate in municipal decision-making, particularly in the irrigation sector, empowering new groups of underrepresented peasant communities (Kohl 2003; Perreault 2005). Over seven years, Punata and Tiraque's irrigators increased the pressure, and in 2000 the Cochabamba Prefecture decided to finance the 'final project design study' for the PRTYV.[10] After the so-called 'Cochabamba's Water War' in April of 2000, water became a central political issue in Bolivia and a priority for national and regional governments. The project was always understood by the users of Totora Khocha as a complementary project, or as a continuation of the previous Tiraque-Punata Project, by which *"the engineers who had designed and constructed the reservoir would fix the previous project's failure"*.[11]

From the outset, the shared Totora Khocha reservoir was built on the basis of agreements negotiated between the irrigators' associations in Tiraque (ARST) and Punata (ARSP). As described in chapter 4, these agreements resulted from complex water control disputes and struggles, marked by the two user groups' clashing positions and interests in the Pucara river basin. The first steps toward the PRTYV provided the opportunity to reopen discussion of the reservoir's shared-use agreement. In this context, ARST proposed to take control of the new project and change the future water allocation from Totora Khocha: 60 percent for Tiraque and 40 percent for Punata. The upstream ARST based their demand on their socioterritorial rights[12] to water sources and the reservoir, and the need to include new users who had not been taken into account in the Tiraque-Punata Irrigation Project. The proposal was resoundingly rejected by the downstream ARSP, who asserted their rights to the hydraulic property that had been obtained by building the dam (cf. Boelens and Vos 2014; Gerbrandy and Hoogendam 2001; Meinzen-Dick 2014).

In this conflict situation, the Prefecture demanded that both parties had to reach an agreement prior to beginning the final design study. Between March and July of 2001, ARST and ARSP negotiated intensely, and finally signed an agreement to adjust the future water allocation from Totora Khocha (Saravia et al. 2006). The agreement established that once the water from Yungas de Vandiola arrived, the water from Totora Khocha would be divided into equal parts (while respecting the existing use rights): 50 percent for Tiraque and 50 percent for Punata. Both user sectors had to adjust their positions, understanding that they were mutually dependant on the project's success.

[10] This 'final project design study' never really became final and continued to be adapted.
[11] Quoted from an interview with ARSP's leader, Punata, May 2009.
[12] Socio-territorial rights to water are authorized claims over water sources that originate in, or flow through, a particular territory or political-geographical place (Boelens 2015b).

Although Punata needed Tiraque because the water sources are located in what they consider their hydrosocial territory, Tiraque also needed Punata in order to justify the investment to funders. The new agreement meant that ARSP gave ground in their control of the new project and reservoir, which reinforced ARST's leadership.

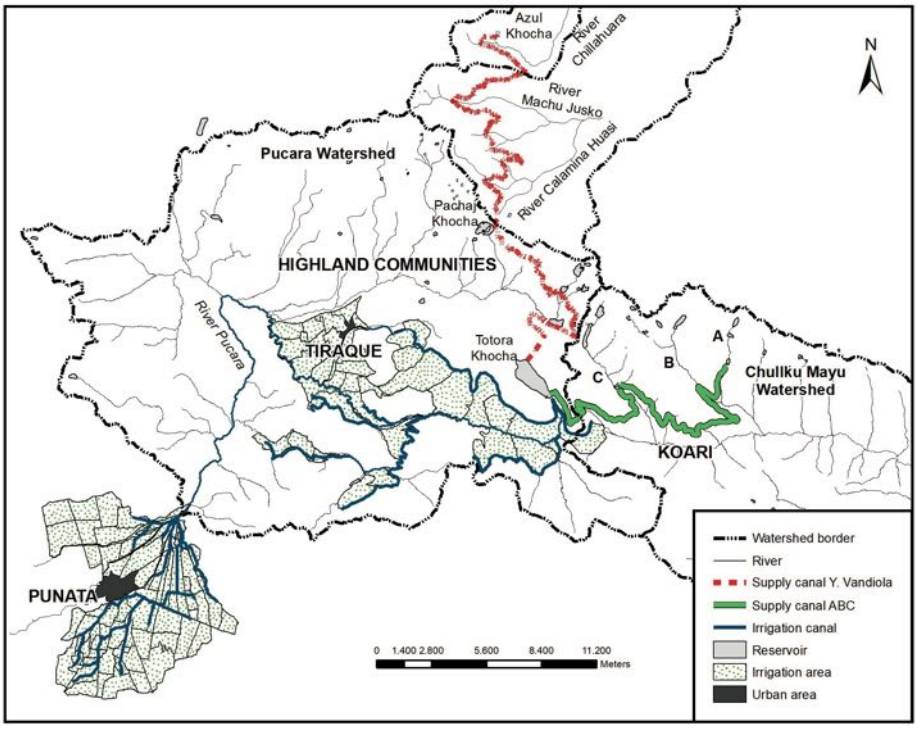

Figure 5.1 Overall diagram of the PRTYV final project design study.
Source: Own elaboration based on CPM-CONAM (2002).

Once the new water allocation agreement was reached in 2001-2002, the final design study for the PRTYV was executed by the CPM-CONAM[13] consulting consortium. Aware of the previous conflicts about the project, the study avoided socio-political matters; it focused totally on the project's technical and agronomical design, and ignored water division and distribution issues (CPM-CONAM 2002). The final design study proposed a 39.22 kilometre supply canal built at an elevation of 4040 m altitude,[14] to collect runoff water from seven catchments, contributing an additional 15.1 Mm^3/year[15] to Totora Khocha at a cost of approximately US$11 million. Figure 5.1 shows the overall project

[13] Multidisciplinary Professional Center S.R.L. (CPM) and Multidisciplinary Associated Consultants S.R.L. (CONAM).
[14] The final design study analyzed five alternative routes for the supply canal (at 3840 m altitude, at 3940 m altitude, at 4040 m altitude, and two combinations), and the 4040 m altitude alternative was found to be the most technically and economically viable.
[15] Compared to data from the General Irrigation Plan for the Upper Valley, the final design study calculated a lower effective volume to fill Totora Khocha reservoir (13 Mm^3/year less) by conducting a more detailed hydrological study and including local precipitation data.

diagram, with two supply systems: the existing supply system built in 1989-1991 (the green line) and the newly proposed supply system (the dotted red line). The indicated irrigation area is the area irrigated as of 2018 by the Totora Khocha irrigation system in Tiraque and Punata.

Considering that the project's main purpose was to catch water to fill the Totora Khocha reservoir, the hydrosocial territory projected by designers (consultants and technical staff of the Cochabamba Prefecture) focused on capturing new water sources, thereby expanding the system's catchment zone. With this understanding, the designers had no great problems, at least on paper, in aligning all the user communities of the Totora Khocha reservoir with the project, assuming that the new territories incorporated into the catchment zone were controlled and represented by ARST. Although designers avoided introducing changes into the existing irrigation system management, ARST took advantage of the juncture to renegotiate the future water allocation of Totora Khocha according to their own vision of the projected hydrosocial territory, adding water from Yungas de Vandiola. This negotiation and the new water distribution agreement earned ARST new decision-making power over the project, using their discourse about socioterritorial rights to claim water.

5.4.2 Hydrosocial territory proposed by communities in Upper Tiraque

Shortly after the final design study was publicly presented (in 2002), highland communities in Tiraque which had been excluded from this process expressed their opposition to the project. They questioned the legitimacy of ARST's authority and representation to control water resources belonging to the entire Tiraque Municipality. Alleging that *"Tiraque's water must be for Tiraque's people"*,[16] they demanded that the Yungas de Vandiola water be used exclusively to irrigate land in Tiraque, leaving Punata out of the project. This gave rise to a movement led by the highland communities which did not belong to ARST and which had been excluded from previous irrigation projects. These highland communities in Tiraque are located in the north-eastern part of the basin, at elevations of from 3500 to 4000 m altitude (Figure 5.1). Initial discussions around the PRTYV coincided with a period of struggle against neoliberal water reforms in Bolivia, which resulted in the re-institutionalisation of water governance at the national level (Perreault 2005, 2008), and the promulgation in 2005 of the Law of Promotion and Assistance to the Irrigation Sector for Agriculture and Forestry (Law 2878). According to Perreault (2008), through this law, Bolivian irrigators achieved, first, the legal protection of customary water uses through collective water rights and, second, the institutionalisation of irrigators' control over the irrigation sector (see also Oré and Rap 2009).

To balance forces and dispute the power of ARST and ARSP, the groups opposing the project formed strategic coalitions that played a leading role at different stages of project development. In 2004, the Chillawara – Azul Khocha Irrigation and Service Association was founded, demanding that the Cochabamba Prefecture radically change the PRTYV in favour of its exclusive use by Tiraque communities (Saravia et al. 2006). ARST and ARSP responded that the PRTYV was not a new project, but rather was complementary to Totora Khocha. In November 2005, to show their strength and unity,

[16] Quoted from an interview with the highland communities' leader, Tiraque, August 2009.

ARST and ARSP signed a new agreement with three components: (a) the implementation of the Yungas de Vandiola Project for equal use by Tiraque and Punata; (b) the project's respect of possible third parties' water rights, opening the possibility for water from the supply zone to be utilised by other users during the dry season; and (c) an agreement to sue the Cochabamba Prefecture for the supply canal to be constructed not at an elevation of 4040 m altitude but rather at 3800 m altitude (as originally proposed in the preliminary study), mainly with the purpose of increasing the water catchment and reducing the possibility of new demands for utilisation of water from the supply canal. Although the Chillawara – Azul Khocha Irrigation and Service Association appeared newly on the scene and made their demands, this new organisation did not receive support, and their demands were watered down as their appeal to their constituency dwindled. This loss of support was mainly because, in practice, the association did not control any water source or any specific territorial area, so they lacked a solid mobilising foundation.

In 2006, a new organisation called the Highlands Association was formed by three communities that did control various small water sources at the higher elevations. Taking advantage of these communities' strategic location in the supply zones, the Highlands Association demanded inclusion in the project and to be granted rights to use water from the conveyance canal, according to the canal route outlined in the final project design (at 4040 m altitude).[17] Agricultural production in this zone was mainly limited by the availability of irrigation water in the dry season, therefore access to this new water source would allow these communities to extend their cultivated area. Considering the low number of users in the Highlands Association (as compared to ARST and ARSP), the Highlands Association decided to include the Koari Irrigation and Service Association (ARSK) in their demand. ARSK grouped communities from the Chullku Mayu river basin (the catchment zone of the Totora Khocha reservoir, see Figure 5.1). It had initially been formed to defend their water sources from Totora Khocha (ARST and ARSP) users. In exchange for not claiming water-use rights from the PRTYV's supply canal, ARSK claimed increased rights in the existing Totora Khocha's catchment zone: the right to draw water from the supply canal ABC (see the green line in Figure 5.1). They now combined their claims to be included in the project.

The Cochabamba Prefecture asked the conflicting parties to negotiate an agreement to make the project viable, since they were already discussing project funding with the German International Development Cooperation. In these negotiations, the Highlands Association made it clear that if they were not included in this project, they would not let more water (*"not even a single drop"*[18]) through their territorial area, which would affect the existing Totora Khocha irrigation system. After deliberation and heated meetings, and pressured by the arrival of a mission of the project's funders, in October 2006 ARST and ARSP had no alternative but to finally agree to include the Highlands Association in the project (CES-GFA 2008). At the express request of the new groups of

[17] The elevation of the supply canal had implications for the project. The construction of the supply canal at a higher elevation (4040 m altitude as proposed by the final design study, instead of 3800 m altitude as proposed by the preliminary study) could allow highland communities to irrigate more land, increasing their water demand and reducing the water available for Totora Khocha (see Figure 5.2).

[18] Expression of a highland community's leader in a meeting of Highlands Association, Tiraque, May 2009.

communities joining the project, a combined commission was formed involving all four organisations equally in decision-making and project management.

A new power balance in decision-making arose out of the alternative hydrosocial territory (Figure 5.2) reconfigured in response to demands for inclusion and claims of socioterritorial rights to water by communities grouped under the Highlands Association and ARSK. By forming a strong coalition which united the communities with territorial areas in the two supply zones of Totora Khocha, these communities forced their way into the project. The new reconfiguration of the hydrosocial territory included these new groups in the water allocation from the Yungas de Vandiola project, implying a reduced water allocation for Totora Khocha and therefore for Tiraque and Punata. Under the new agreement all four organisations had the same decision-making power as project beneficiaries.

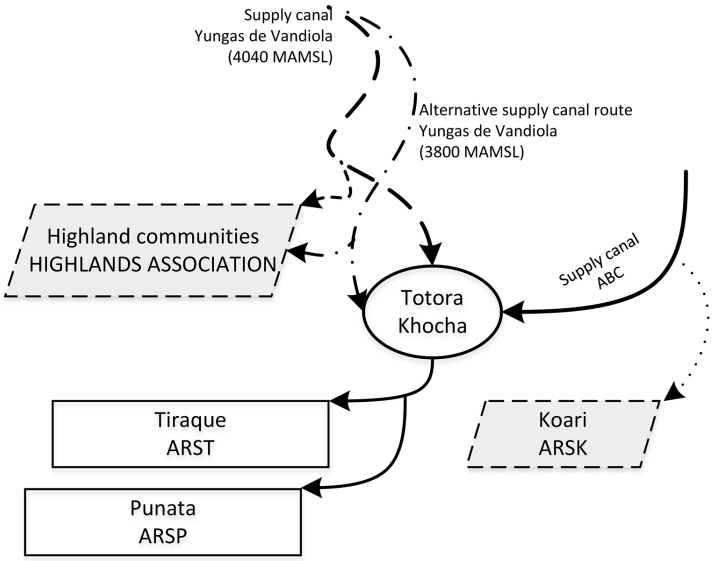

Figure 5.2 The alternative hydrosocial territory proposed by the highland communities of Tiraque, showing two alternative routes for the supply canal (at 4040 vs. 3800 m altitude), and the claim of ARSK to water from the existing supply canal.
Source: Own elaboration.

5.4.3 The new hydrosocial territory proposed by the project designers

In June 2006, the Governments of Bolivia and the Federal Republic of Germany agreed to finance (via the KfW Development Bank) the implementation of the PRTYV, at a cost of €6 million. In view of the Totora Khocha experience (see Rocha et al. 2015), funders required a study to evaluate technical, social, and financial aspects of the project's final design, as a prerequisite to begin construction. The technical staff of the Cochabamba

Prefecture and the Sustainable Agricultural Development Program (PROAGRO-GTZ) conducted this evaluation study (Saravia et al. 2006). It concluded that, although the project had favourable conditions for implementation, complementary studies and adjustments were required to ensure feasibility. Specifically, the study observed three problematic aspects: insufficient knowledge about catchments' hydrological behaviour, lack of topographical measurements and geological field analyses to define the final elevation of the interbasin supply canal (at 4040 or at 3800 m altitude), and conflicts over the inclusion of, and future water allocation to, highland communities.

In response, funders made financing conditional on a further pre-investment study to resolve the flaws detected in the final design study. Initial findings from this pre-investment study (CES-GFA 2008) set aside the discussion regarding the two alternative routes for the supply canal, and observed two main aspects. First, after adjusting the hydrological models, the amount of transferred water would total only 12.5 Mm^3/year, and thus would fall short of filling Totora Khocha reservoir as planned. Hydrometric field data revealed that prior studies had overestimated the available water, which seriously handicapped the project's feasibility considering the additional reduction in water for Totora Khocha from the project's inclusion of the highland communities. Second, the study observed that most of the catchment infrastructure would be inside the Carrasco National Park (Parque Nacional Carrasco, PNC), and partially inside its strict protection zone where national norms did not allow construction of any type of infrastructure. None of the previous studies had noticed this fact, although the PNC had been created in 1991.

This new information made KfW uncertain about the funding they had committed to, as the project design violated their financing policies. The consulting consortium suggested, as remedial action, that an alternative way to fill Totora Khocha reservoir should be studied: improving and expanding the current supply system (canal ABC in Figure 5.1). In this sense, the consulting group conducted complementary studies which considered two alternatives: building the PRTYV canal (excluding the protected PNC area), or improving and expanding the current supply canal ABC, possibly including new catchment sources (CES-GFA 2008).

When ARST and ARSP learned of the pre-investment study's preliminary findings, they reacted against the new project direction, interfering with the pre-investment study. The ARSK (Koari) irrigators also tenaciously opposed the option of expanding and improving the current Totora Khocha supply system, prohibiting consultants from entering the canal ABC zone and demanding the renegotiation of the agreement to operate the Totora Khocha supply system.[19] ARSP and ARST reacted quickly. They were aware of the fatal consequences that renegotiating the supply agreement could have for them. They asked that the supply system study (the second alternative) be disregarded, and that the focus be placed on studying only the new Yungas de Vandiola (irrespective of the problem with the protected area), which the consultants eventually did.

[19] According to this agreement, ARSP and ARST had the right to use the canal ABC, and to catch water for Totora Khocha, from December to April (rainy season); whereas Koari was entitled to use the canal ABC and tap this water from May to November (dry season).

Consequently, the pre-investment study resumed its focus on the water supply from Yungas de Vandiola as the only viable alternative. However, the inclusion of the PNC as a new element in the project's new hydrosocial territory (Figure 5.3) completely shattered the project's initial objectives. According to the data presented by the consultants, leaving out the catchment area located in the PNC core zone would reduce the amount of water transferred from Yungas de Vandiola from 12.5 to 3.5 Mm^3 (CES-GFA 2008). This reduction in the amount of water transferred would practically defeat the project's viability, considering that Totora Khocha would also receive less water because of the highland communities' demands. ARST and ARSP therefore completely rejected the proposal to reduce the supply canal and the project's water availability. They demanded that the final design proposed in 2002 be maintained, which included the National Park in the catchment area.

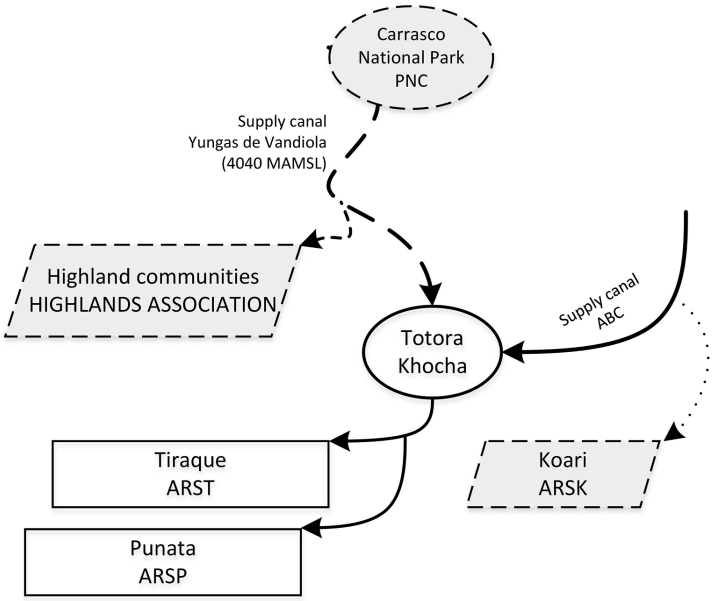

Figure 5.3 Alternative hydrosocial territory resulting from taking the Carrasco National Park into account.
Source: Own elaboration.

After the National Service of Protected Areas (SERNAP) – which is the government agency for managing national parks – issued a legal ruling that the project design was not viable, irrigators pressured SERNAP to reverse what they called its 'veto'. Contesting SERNAP's argument about environmental protection and biodiversity conservation, irrigators insisted on the project's importance for rural families' livelihoods. Under the slogan *"What matters more – wild plants and animals, or people's lives?"*,[20] irrigators

[20] This argument was expressed by a leader from Tiraque at a meeting to discuss the PRTYV, in October 2009.

demanded that SERNAP reverse its ruling and enable the project to go ahead with its full supply system.

ARSP and ARST were politically well connected to the country's ruling party. Rural sectors in Tiraque and Punata in general, and irrigators in particular, were strong supporters of the ruling party (Movement Toward Socialism – Instrument for Peoples' Sovereignty, MAS-IPSP). Unswerving participation by Punata and Tiraque irrigators in the movement that made Evo Morales President (the first indigenous president in Bolivia, from January 2006) and later the support of the communities in the impeachment of the opposing-party Prefect of Cochabamba (in 2007), had positioned the irrigation sector in close relationship to the national and departmental governments. Through the new Constitution (2009) the Morales government restructured democratic representation and governance around indigenous autonomy and communitarian values, empowering indigenous/peasant communities and giving them the right to make decisions about their territories and their resources (Morales 2011). In this context, several irrigator leaders held key government positions (Parliament, Vice-Ministry of Irrigation, National Irrigation Service, and others). In consequence, irrigators backed by the politically influential Cochabamba Irrigators Federation (FEDECOR) brought tremendous political pressure on SERNAP to revisit its ruling, and on the Prefecture's technical staff (now under MAS-IPSP control) to declare the project viable.

After several meetings with consultants and governmental authorities, with threats of mobilising to block roadways, finally in late 2009 SERNAP issued a new resolution, stating that the supply system located in the PNC would not affect the Park's core zone (contradicting the initial ruling). Hence, providing that remediation and protection measures were taken, it would be possible to construct infrastructure. This new resolution enabled the project to proceed, and the process continued. Notwithstanding its doubts about the SERNAP ruling reversal, KfW remained interested in funding the project and decided to wait for the final findings from the pre-investment study to make their decision.

5.4.4 Hydrosocial territory proposed by FRIAC: the project's 'death sentence'

Although the 2006 agreement included the Highlands Association communities as beneficiaries of the PRTYV, this group of communities felt that the project limited their control over their territory and water sources, because the project's main beneficiaries were still ARST and ARSP. Although most water sources to be tapped were not included within the boundaries of their community's territory, the new supply canal would run right through it, and would thereby take away part of the water that these communities saw as potential sources for their own future irrigation systems. To ensure that they maintained full control over what they considered to be their hydrosocial territories, the Highlands Association designed alternative proposals to utilise water from Yungas de Vandiola.

In 2007, the NGO *Mano a Mano* helped the Highlands Association draft their own irrigation project to tap water from the Encañada sub-basin, which was included in the catchment zone for the PRTYV within the Highlands Association community territory. That year, the project's design was completed and presented to the Tiraque Municipality for financing (CES-GFA 2008). The designed route of the conveyance canal would closely

match the canal that was designed for the PRTYV (the 2002 design, at 4040 m altitude). Thus, building it would require changes in the later project. Because the Encañada Irrigation Project could make the PRTYV technically and financially inviable by reducing water for the project, ARST and ARSP initially opposed it. The Tiraque Municipality declined to finance the project, because it exceeded their financial capacity and because it would cause new conflicts.

However, the Highlands Association and Mano a Mano insisted on implementing the Encañada Project and began building the supply canal with their own resources, hoping to raise further resources later. Building this canal would also consolidate their rights to the disputed water. They threatened that if the Encañada project were not implemented, then the PRTYV would not happen either. So, in June 2008 ARST and ARSP suspended their opposition to the Encañada Irrigation Project, and signed an agreement stating that the two projects were compatible, and both should be financed. Although the Encañada project would reduce the catchment area for the PRTYV, ARST and ARSP agreed to this new project because they thought it was unlikely to be funded, and they also felt that the planned construction of the Encañada project's canal route would also support their position that the interbasin transfer canal should be built at 3800 m altitude to avoid interfering with it.

Despite gaining ground, the Highlands Association considered that it was losing the power struggle over the basin's resources, and that they thus needed a new political ally. With the support of FEDECOR, ARST and ARSP had political influence in departmental and national government agencies, and could maintain and expand their control over territorial areas and water sources in the Pucara river basin. The leaders of the Highlands Association thus knew that they needed to consolidate their political power within the state. For this reason, the Highlands Association chose to capitalise on claims and demands by other communities in Upper Tiraque that did not belong to ARST, and who felt marginalised by the new agreements over water control in the Pucara river basin. On 16 August 2008, the Cochabamba Federation of Indigenous Agricultural Irrigators (FRIAC) was founded, bringing together a total of eight irrigation associations, including the Koari Association and the Highlands Association. FRIAC claimed to defend Tiraque water resources, which they felt ought to be used by the basin's indigenous farmers. FRIAC's discourse was clearly influenced by the discourse of the ruling party, MAS. FRIAC's members claimed to be *"the true water warriors"*[21] and legitimate stakeholders in the Bolivian process of change, because they took part in the mobilisations backing the ruling party's rise.

Quickly asserting its position in negotiations about the PRTYV, FRIAC became the new voice of highland communities in Tiraque. From the first meetings, FRIAC firmly expressed their opposition to the PRTYV as it was originally conceived, and demanded that Yungas de Vandiola water should exclusively irrigate land in Tiraque. They called for the supply canal to be dug at 4040 m altitude, to benefit the eight-member irrigation association and the current users of Totora Khocha in Tiraque – leaving Punata out of the project. The strength and fast strategic positioning of FRIAC in the PRTYV negotiations was mainly based on two aspects. First, FRIAC strategically used the

[21] Quoted from an interview with FRIAC's leader, Tiraque, November 2009.

discourse that promoted the need to defend water resources for Tiraque, which ARST leaders could not object to, resulting in the union of Tiraque communities around it. Second, FRIAC was made up mainly of communities which controlled the upper river basin where most of the water sources are located, so they threatened ARST and ARSP with blockage of access to the water sources located in their territorial areas. The alternative hydrosocial territory proposed by FRIAC (Figure 5.4), without Punata (previously the most powerful stakeholder in the river basin), aimed for total control over PRTYV, which would consolidate their water control in the Pucara river basin as well as political power as the main representative of its irrigators.

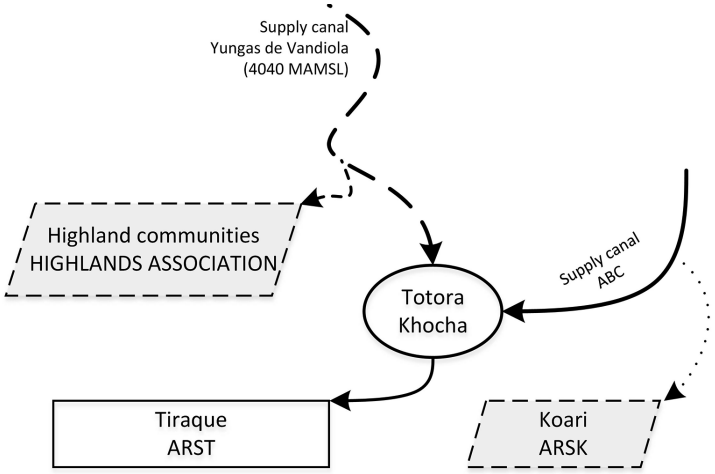

Figure 5.4 Alternative hydrosocial territory proposed by FRIAC.
Source: Own elaboration.

Consequently, FRIAC called for stopping the pre-investment study until the project's orientation could be redefined. This position jeopardised the project's continuation, so the KfW warned that if these conflicts were not resolved promptly, allowing the completion of the pre-investment study, they would withdraw funding from the project. FRIAC's proposal – to only irrigate Tiraque lands and leave Punata out – was a radical change that the KfW viewed as a whole new project, quite different from the initial purpose of filling Totora Khocha. During several meetings in 2009 and 2010, an attempt was made to reconcile the parties in order to continue the pre-investment study. However, positions became entrenched and resolution of the conflict became an increasingly remote prospect. Ultimately, the preinvestment project was never concluded as planned. The partial report by the consultants, CES-GFA, was not accepted by the Prefecture of Cochabamba and the KfW withdrew the funding they had committed. Consequently, by mid-2012, the development of PRTYV was halted by the Cochabamba Prefecture. Nevertheless, Totora Khocha irrigators still hope that one day the project will be reactivated, and that the engineers will finally keep their promise to fill Totora Khocha. At the time of finishing this chapter (2019) no new project proposals had been developed.

5.5 Conclusions

The chapter concludes that interbasin water transfer projects are arenas of profound hydrosocial territorialization, as they incorporate new water sources and stakeholders with divergent territorial imaginaries and changing multi-scalar alliances. The eventful course of PRTYV's development highlights political struggles over irrigation planning and design. Different stakeholders establish strategic alliances to cultivate, mature, and support their imaginaries of hydrosocial territories that they feel must materialise through the irrigation project, with particular water management and usage suited to their interests. The chapter shows how the plan to expand the Totora Khocha irrigation system through the PRTYV produced opposition from marginalised highland communities in Tiraque, which then formed strategic coalitions to claim rights to the water sources included in the project. Configuring alternative hydrosocial territories was a means of resistance that emerged in order to dispute representational arrangements and project control, and to mobilise other communities with shared interests. Table 5.1 describes this dynamic configuration, breaking down the four fundamental components of the production and conception of hydrosocial territories (Brighenti 2010). The first territory is the proposed layout from the project's final design study. The second and fourth are alternative hydrosocial territories proposed by coalitions of highland communities. The third is the alternative hydrosocial territory proposed in response to the Carrasco National Park's presence and related norms.

Coalitions formed to oppose the project's technological and normative design brought increasing pressure on project negotiation, geographically building and politically fortifying their proposed alternative hydrosocial territories. Although the main purpose of the opposition was initially to include highland communities in the project and demand water-use rights, it ultimately expanded to bolster FRIAC's political power to control water resources in the Pucara river basin. Although in the end PRTYV had not yet been implemented, the process yielded a new array of political power relations for water governance in the Pucara river basin. This strengthened highland communities in Tiraque and established their territorial control over water sources, disputing ARST's representation and water control. Further, ARST and ARSP not only lost their opportunity to access Yungas de Vandiola water, but also lost ground for future negotiations to tap the basin's water. For the highland communities, gaining political control over the Tiraque water resources was more important than reaching a compromise over an interbasin water transfer project that would benefit mainly other communities. In the eyes of the highland communities, their increased political control over the hydrosocial territory would guarantee a better starting point for any future irrigation projects.

The application of the hydrosocial territory conceptual framework in the case of the Yungas de Vandiola irrigation project yields three insights: (1) rural communities in Bolivia change their water right claims based on their evolving visions of their hydrosocial territory, (2) stakeholders dynamically forge multi-scalar political alliances to further their interests based on their imagined hydrosocial territories, and (3) the project formed an arena where stakeholders struggled to get their imagined hydrosocial territories accepted and dominant. During the project the dominant vision of what constituted the legitimate hydrosocial territory changed constantly, based on the

political struggles of the different multi-scalar stakeholder alliances articulating this vision with wider political and cultural developments at the national level.

Table 5.1 Analytical description of the hydrosocial territories produced regarding the PRTYV.

	Hydrosocial territory (year and figure)	Who produces the territory?	How is the territory produced?	What type of territory does this produce?	Why produce the territory?
I	Hydrosocial territory proposed by the PRTYV final design study (2002, Figure 5.1)	Project designers (CPM-CONAM), with assistance from irrigators of Totora Khocha (ARST and ARSP)	By preparing the project's final design study. By negotiating the new Totora Khocha water allocation agreement	A territory to use water from the Vandiola region in Punata (50 percent) and Tiraque (50 percent)	Interbasin water transfer project to fill Totora Khocha and use irrigation water in Punata and Tiraque
II	Hydrosocial territory proposed by highland communities (2006, Figure 5.2)	Highland communities from Tiraque, organised as the Highlands Association	By a coalition of the Highlands Association and ARSK, mobilising against the project By negotiating the agreement for inclusion in the project	A territory to use water from the Vandiola region in the highland communities, Koari, Tiraque and Punata. All four groups with equal participation in decision-making about the project	Demanding water-use rights, to include highland communities in the project
III	Hydrosocial territory proposed by the PRTYV new preinvestment study (2008, Figure 5.3)	Consultants for the preinvestment study (CESGFA), following resolutions by SERNAP and KfW	By conducting the pre-investment study By inserting the PNC and environmental norms in debate By redesigning the project	A territory to reduce the catchment zone in Vandiola (and reducing the amount of water) respecting the boundaries of the PNC core zone	Redesigning the project according to environmental norms to protect the national park
IV	Hydrosocial territory proposed by FRIAC (2009, Figure 5.4)	FRIAC (grouping the Highlands Association and another seven irrigators' associations from Tiraque)	By elaborating the alternative Encañada Irrigation Project with the support of NGOs By forming a coalition of eight irrigators' associations from highland communities as FRIAC By mobilising and defending water rights from Yungas de Vandiola By suspending preinvestment study	A territory, including the communities from the eight irrigation associations comprising FRIAC in the project, and excluding Punata	Demanding water-use rights, to build FRIAC's political power (i.e. highland communities) over water control and territories in the river basin

The conceptual framework to analyse hydrosocial territories, in combination with shifts in the legitimacy of water right claims, has important potential for studying water conflicts around the world. The study of the historical processes of hydrosocial

territorialization allows an analysis of the multiple dimensions and arenas where water – and specifically interbasin water transfer and irrigation projects – are developed. This analysis could be applied in order to better understand who, how, and based on what moral grounds or regulations, groups of people claim water or resist water development projects, what conflicts and solutions they yield, and how stakeholders negotiate project design, materialise their infrastructure, and thus change flows of water and power.

CHAPTER 6 DISCUSSION AND CONCLUSIONS

After conflicts and struggles, opposing groups of water users reach negotiated agreements. In the photo, two leaders of opposing WUAs have a friendly conversation at the opening of a dam in the Pucara River Basin (October 8th 2009).

Source: Centro AGUA, 2009

6.1 Introduction

In recent years, irrigation projects worldwide, and in the Andean region of Bolivia in particular, have besides solving water problems, also generated important water conflicts, growing resistance and fierce struggles. This has led to questioning the policies that guide irrigation development plans and projects. Historically, irrigation development in Bolivia has been set up by peasant communities; only more recently this has also happened through government irrigation projects. In particular, it is the peasant communities and families who have been, and continue to be, the protagonists of the construction of hydraulic infrastructure for water control in this country. In parallel with the construction of water infrastructure, peasant communities have established organisational and regulatory frameworks, commonly referred to as 'uses and customs', that regulate access and control of water at the local level.

These normative and regulatory frameworks express the various approaches with which peasant communities conceive, defend and claim their waters. They express the legitimacy of their collective water rights vis-a-vis third parties. Irrigation projects designed by external actors; such as the state, NGOs and private enterprises, all propose changes in the conditions of access to and control of water resources in a given river basin. In this way, they commonly challenge and aim to transform locally established regulatory and water rights frameworks. This becomes particularly problematic within 'closed' or 'closing' river basins, in which the claimed or allocated water rights exceed water availability. Under these conditions, irrigation projects tend to become arenas of even greater conflict.

Consequently, questions arise of how to make irrigation development projects fit better into the logics and principles that regulate water access and control in various socioterritorial spaces of Bolivian water governance. This requires studying the historical processes and local understandings of irrigation development. The approach also needs to pay close attention to the multiple territorial scales at which water use systems are developed and interconnected. Furthermore, it must analyse the various ways and arguments by means of which the different stakeholders define, acquire and defend their water rights in particular river basins. In this sense, focusing on the case study of the Pucara basin, the thesis addresses the following main research question:

> *How have changing approaches to water rights shaped irrigation development and control over water for different stakeholders in the Pucara river basin?*

By answering the four sub-questions set out in Chapter 1 in the different chapters, the thesis has addressed this main research question. This final chapter of the thesis first discusses these four sub-questions in the first four sections. It starts with the presentation of the conceptual framework to analyse the different forms of legitimization of water rights in Section 6.2. Then, Section 6.3 discusses how, throughout the historical process of irrigation development at the scale of the Pucara river basin, different stakeholders have strategically used divergent legitimation languages to claim water rights. After that, Section 6.4 presents a look at the negotiated construction of water networks inside this basin, in the expanding Totora Khocha irrigation system. In Section 6.5, the analysis focusses on the reconfiguration of hydrosocial territories in the

contexts of the plan to further expand the Totora Khocha irrigation system through the Yungas de Vandiola inter-basin water transfer. Subsequently, Section 6.6 reflects on the conceptual framework and the research findings, ending with suggestions for further research. Finally, Section 6.7 elaborates implications for irrigation development projects, based on this study.

6.2 Notions and approaches to legitimize claims to water rights in a river basin

The sub-question answered in Chapter 2 is:

> *What heuristic conceptual framework on water rights can be formulated to analyse the diverse ways in which different actor groups legitimize their claims to water use in a river basin?*

In this chapter I have elaborated on the great diversity of managerial and regulatory frameworks for community irrigation systems in river (sub)basins. To this end, I analysed and categorized the underlying principles and local conceptions of water rights in practice. I analysed the various ways in which stakeholders legitimize their collective claims to water rights vis-a-vis third parties in the same river basin. I proposed a conceptual framework focused on the diverse mechanisms for legitimizing these water rights, their dynamics, and hybrid nature in struggles over water access. These mechanisms are the fundamental pillars of locally established water regulation and control systems, which also give expression to specific sociocultural and power relations. As water becomes scarcer at the scale of river basins, competition and conflicts over water access and control intensify. This is particularly the case when water development involves multiple actors with conflicting claims to water rights.

My international cases baseline study of the diversity of water rights regimes at river (sub) basin scale, identified six basic principles or 'mechanisms' for legitimizing water rights:

i. *Water rights concessions:* are granted by the state to individual or collective users. The state maintains formal ownership over the resource and generally charges fees.
ii. *Historical water rights*: are based on the principle on *"prior appropriation"*, which means that those who come and claim water first acquire prior rights. Most of the time the water has to be actually used to maintain the use right.
iii. *Socioterritorial water rights*: are based on the location of a water source in, or flowing through, a hydrosocial territory (including *"riparian rights"*).
iv. *Transfer of water rights*: originate from the transfer of water rights from one owner to another, for example through sale, rent, barter, donation, exchange, marriage or inheritance.
v. *Acquisition of water rights by force*: Water rights arise from forced expropriation by powerful groups and are locally institutionalized.
vi. *User investment*: Water rights originate from the investment of resources (labour, capital, knowledge, etc.) in the construction, upkeep or rehabilitation of hydraulic infrastructure ("*hydraulic property creation*").

Most often several of these mechanisms are invoked simultaneously by different groups in one river basin. Often one mechanism is dominant, and applied by the dominant user group and sanctioned by the government. The dynamic interplay of the different mechanisms relates to struggles over authority to set rules, granting legitimacy over those water use rights regulations. Groups in society might contest this authority and legitimacy of the water allocation rules.

In Chapter 2, I illustrate the framework by analysing five water rights legitimation mechanisms in river basins, from around the world. In all the analysed cases there is a main mechanism, certified by the authorities and recognized as legitimate by most other user groups. However, the different water users' groups involved strategically use different mechanisms to claim and defend the legitimacy of their water rights. It is important to emphasize that, in response to sociotechnical, legal, and political changes promoted by irrigation intervention projects, different user groups strategically also change their positions and conceptions. They apply and promote alternative forms of creation and legitimization of water rights, according to the historical, political-geographical contexts and normative-discursive environments in which they are negotiated.

6.3 Changing languages to claim water rights

The sub-question answered in Chapter 3 reads:

> *How have different stakeholders, throughout history, strategically used diverse "legitimation languages" to claim water use rights in the Pucara river basin?*

In this chapter I describe the history of the Pucara basin. Comprehending the context and history-based allocation and distribution of water use rights for irrigation, herein, has shown to be crucial for understanding social and agricultural dynamics in this semi-arid region. I explain in this chapter how irrigation water rights are socio-legal constructs that, for their materialization, depend on their acceptance by other parties. I show how the recent conceptual notion of "hydrosocial territories" enables examining water rights claims as expressed in diverse and divergent "legitimation languages". Fundamentally, water rights and their legitimation languages are embedded in site-particular normative dynamics, cultural-political histories and changing socionatural configurations. To understand this, in the Pucara basin, I examined the historical shifts in how water use rights were and are legitimized. I also scrutinized these claims' social acceptance and their factual materialization in terms of water development, i.e. creating hydraulic infrastructure and actual access to water. The chapter has analysed three historical periods in which stakeholders sustain different overarching ways to legitimize and defend their water rights.

As I show in this chapter, over the three periods of irrigation development in the Pucara basin, the prevailing language of legitimization of water rights changed modes: from participation in the construction of hydraulic infrastructure, to ways that emphasize territorial claims. In the first period (1950–1978), acquiring rights was sustained through 'hydraulic property' notions and relationships: water rights were created by families and collectives making investments (principally through labour-power but also other

resources) in infrastructure development. In the second period (1978–1995), a shift took place to more flexible, territorially-oriented claims over water rights. They emerge in response to governmental attempts to reorganize Pucara's hydrosocial territory. In the third period (1995–2017), which was steered by indigenous communities' wider political emancipation processes and government's municipalization policies, more rigid territorial claims over water sources and use rights have become decisive in the struggle over water.

Thus, the territorialization of water claims was increasingly related to changes in national policies and regulations, such as the process of administrative decentralisation, and the empowerment of peasant communities. The latter was reinforced by the MAS government (2006-2019) through a political discourse favouring water rights for indigenous communities and, at the same time, promoting a discourse of respect for 'uses and customs' and territorial rights. Communities in the upper part of the basin (Tiraque) managed to position the socioterritorial discourse to defend and legitimize their claims on water rights. In this way, taking advantage of its strategic location and organisational efforts, they managed to gain greater control over the different highland catchment areas of the basin, which originate in their communal territories. These negotiation processes around the legitimacy of water rights claims have usually led (and continue to lead) to confrontation of interests and conflicts among the actors involved, after which power differences tip the balance to one side or the other.

In the chapter I show how conflicts around irrigation projects can be conceived as struggles to establish new or reconfigure existing hydrosocial territories. In these settings, different groups of actors tend to emerge who conceive and imagine the disputed hydrosocial territories in different ways, and strategically promote alternative forms or languages to legitimize their claims of water rights. In other words, in the context of irrigation development, various forms or languages of legitimizing water rights are created and applied in multi-scalar political arenas of water struggles. In the end, irrigation development processes reflect the changing power structures in the given territorial areas, expressed in specific patterns of access to water and dominant discourses of political control of water.

Through the research in this chapter I show that, to enhance user-oriented irrigation development, it is crucial to understand not just the positions, interests and power structures but also the multiple languages of water rights legitimation. These profoundly underlay water control and trigger either conflict or collaboration. I also conclude that despite the complexity and diversity of water rights (and despite formal lip-service regarding indigenous peasantry's rights and cultural recognition), irrigation development policies and projects continue to conceptualise water rights as strongly uniform legalistic and technical tools for governing and regulating water allocation and use. This classic approach ignores the collective water rights which water users build by investing in hydraulic property, the hydro-territorial and socio-cultural relationships involved, and the languages that value such historical claims.

In this sense, this thesis shows that many of the conflicts surrounding irrigation projects have their origin in the lack of understanding of the divergent languages that actors apply to claim the legitimacy of their water rights. I also conclude that when

development projects attempt to reorder irrigation systems, they modify water access conditions and territorial control over a closing river basin. This promotes responses from different actors who propose alternative ways of reordering their hydrosocial territories and reinforce their water rights by using grounded as well as 'convenient' languages of legitimization.

6.4 Negotiated construction of water networks to control water

The sub-question for Chapter 4 was:

> *How did the expansion of the Totora Khocha irrigation system lead to the negotiated construction of new water networks to control the Totora Khocha reservoir waters in the Pucara river basin?*

In this chapter I have focused on the expansion of the Totora Khocha irrigation system, including an interbasin water transfer from the Chullku Mayu river basin. In the analysis, irrigation systems were conceived as sociotechnical water networks, which join water sources, people, their knowledge and labour, hydraulic infrastructure, and other material and intangible resources. These networks are created and re-created by water users' groups to control and use water. In this line of thinking, irrigation projects constitute attempts to re-order water networks. Since the Pucara basin is a closed basin, any group taking more water will take this away from another group of water users. Re-opening the basin by an inter-basin water transfer to increase water provision for irrigation systems involves the re-engineering of local water networks.

The chapter focusses on what happens when irrigation systems expand in space and across boundaries to capture new water. In such a context, they produce new claims by existing and emergent users. This results in complex processes of design, construction, contestation and negotiated redesign of water networks. In these conditions, the water network is subject to resistance and negotiation. The analysis of the historical trajectory of the Totora Khocha irrigation system, shows the dynamic configuration of sociotechnical water networks around the control and use of a dam.

In the chapter I show that the analysis of the historical expansion process of the Totora Khocha irrigation system allowed to distinguish different phases of life of the system. The origin of the dam dates back at the beginning of the twentieth century, when a landlord commanded the construction of an earthen dam. The water network entered a second phase after the land reforms of 1953 and shifted from monopolistic control to collective control by peasant communities. A third phase developed in the 1960s, when the system has expanded to increase the storage capacity of the reservoir, including new users. As an attempt to reopen the closed river basin, in the fourth phase (1980-1991) the state planned a project that authoritatively designed a new and much larger dam over the original reservoir, which implied an interbasin water transfer. Each project brought specific heavy negotiated and changing *modes of ordering*. This dynamic process of reordering the water network, mostly not or only poorly understood by intervening agencies, was fostered by the actions of new groups of actors: by negotiating their inclusion in the network they achieved alternative forms of water control, in line with their interests. The prescriptive way to develop the irrigation project

in the last phase was resisted and questioned by different users' groups (existing and emerging). These groups negotiated their inclusion in the project and the expansion of the water network.

Therefore, the irrigation design process in a closed river basin is better approached as a dynamic and negotiated process of engineering and hydrosocial weaving and networking than as a prescriptive mode of system building. It is important to change the classic conception of irrigation projects as linear and discrete processes in time and space. Instead, irrigation projects should be conceived as disputed redesign processes in which the water network allows for various degrees of interpretive flexibility.

The case of Totora Khocha illustrates a general trend of the problems of water governance in closed basins worldwide (Falkenmark and Molden 2008; Molle and Wester 2009). In order to ensure the provision of water to meet the growing demand for irrigation water for food production, governments plan to improve and expand traditional irrigation systems, starting with the construction of new hydraulic infrastructure and the capture of new water sources and territories. This planned expansion of traditional irrigation systems rarely follows an orderly and prescribed intervention process. This is mainly due to the emergence of particular groups of actors who resist the inclusion of their territories and waters in the projected water networks, or, at the other side of the table, those who fight for being included. This results in complex struggles, negotiations and redesign processes. The reconfiguration of water networks therefore is a socially contested and politically negotiated process.

6.5 Hydrosocial territorialization: the re-design of the planned Yungas de Vandiola interbasin water transfer project

The sub-question for Chapter 5 was:

> *How did changing hydrosocial territorialization by different stakeholders, lead to the reiterated re-design of the planned interbasin expansion project of the Totora Khocha irrigation system?*

In this chapter I integrate the different scales at which divergent actors strategize and mobilize support to shape their desired hydrosocial territory. The chapter (just as the diverse actors involved) integrates water use system, basin and interbasin scales. For this purpose, I studied the historical development of the Interbasin Transfer Project Yungas de Vandiola (*Proyecto de Riego Trasvase Yungas de Vandiola*). In 2002, the government planned the further expansion of the Totora Khocha irrigation system, but until present the construction has not yet started. Chapter 5 constitutes an analysis of the dynamics of hydrosocial territorialization pursued by rural communities that aimed to strategically claim and create water rights. These communities responded to attempts to reorder local forms of water governance and their territories. The planned water transfer project was a formal attempt to establish new conceptions and approaches to water rights.

Starting with the project's initial design, the chapter describes the four subsequent configurations of alternative hydrosocial territories: the original Yungas de Vandiola

interbasin water transfer project (2002), the alternative plan by the highland communities (2006), the new Yungas de Vandiola interbasin water transfer project (2008), and the new alternative plan proposed by a coalition of expanded highland communities (2009). During this process, groups of communities that were initially not included in the project, crystalized their hydro-territorial imaginaries and forged multi-scalar alliances to materialize their territorial perspectives, in response to wider political and cultural developments at the national level that are related to the Evo Morales' government (2006-2019). This gradually altered the dominant imaginary of the hydrosocial territory as was reflected in the Yungas de Vandiola interbasin transfer project plans.

The Yungas de Vandiola project's reiterated design shows the dynamic process of hydrosocial territorialization, incorporating new water sources, territories and new actors. The multi-scale and interregional analysis show how different groups of actors promoted new forms and particular approaches to claiming water rights. Communities mobilized their projections, designs, and resources to contest control over projects and establish water control. In this sense, configuring alternative hydrosocial territories was a means to dispute representational arrangements and project control. Although the main purpose of the marginalized highland communities, was initially to be included in the project, it ultimately expanded to gain political power to control water resources in the Pucara river basin. The different actors involved established multi-scalar alliances with other groups of actors to negotiate with project designers and their dominant imaginaries of hydrosocial territories. These alliances were established around shared and changing interests. In this sense, along the process, the dominant vision of what constituted the legitimate hydrosocial territory changed. Considering that, the opposition groups were located in the upper region of the basin, where most of the water sources are located, they could exercise increasing pressure on project negotiation, geographically building and politically fortifying their proposed alternative hydrosocial territories.

I assert that, in the last, current phase, the alliance of highland communities increasingly has pressed against the proposed design of the project. In this way, through social mobilization, the opposing communities' alliance gained more and more spaces in the negotiation processes of the project. The final alternative hydrosocial territory proposed by FRIAC (with the exclusion of Punata and the integration of all the communities of Highlands), aimed for total control over the project, which would consolidate their water control in the Pucara river basin as well their political power as the main representative of irrigators in the basin. The hard position of FRIAC, at the end resulted in the cancelation of the project, however for the highland communities, gaining political control over the basin water resources was more important than an interbasin water transfer project that would benefit mainly other communities.

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As a general conclusion regarding the highly diverse water control developments that have coloured the recent history of the Pucara basin, I can state that: Water user communities have historically and dynamically elaborated a grounded repertoire of water rights approaches to respond to prevailing climatological, agro-ecological, demographic and normative-political challenges, thereby entwining, hybridizing and embedding local and outside water governance norms, organizational structures and technological opportunities. This has recently culminated in strategically engaging with the emergent formal policy focus on community water rights and territorial sovereignty. This national framing is used to locally claim such collective, territorial water rights, through discursive legitimization, re-conceptualization of hydrosocial territories, and the negotiated expansion of water control and irrigation development. New languages of legitimation of water rights claims by the basin's highland communities have increasingly resonated with the (indigenist) governments' water laws and policies, but often obstructed more local traditions of negotiated, inter-stakeholder consensual approaches. In the end, in many instances, this has led to a deadlock for irrigation development in the Pucara basin.

However, as I 'project' on the basis of my grounded-historical research, this cannot be considered to be an irrigation-technological 'closure' and normative 'end-of-Pucara-basin-history': in line with my analysis, I foresee new water rights legitimation languages (in direct interaction) with new hydrosocial territorialization imaginaries and projects emerging in the near future. These will, once again, challenge the current state of water affairs.

6.6 Reflections on the conceptual approaches and findings

This thesis shows that irrigation development can be understood from the study of changing approaches to water rights. Irrigation projects in this context should be understood, rather than a linear and prescriptive process, as political endeavours and processes, of shaping hydrosocial relationships around water control and use. This requires studying the historical development processes of the irrigation systems at the multiple scales where they are developed by different groups of actors defending and legitimizing their water right claims.

Analysing the development of irrigation from the perspective of the Actor-Network Theory (Latour 2005; Law 1994), irrigation systems can be understood as sociotechnical networks or water networks (Water-Network, following the Actor-Network Theory). This approach looks at the enacting, interrelating and ordering of the different components (or actors/actants) of the network (water, infrastructure, users, project officers, funds, laws, and other material and intangible resources) in particular configurations to establish a specific form of water control and use. These elements are not fixed entities but constitute each other; the networks are not closed (black-boxed) but constantly may evolve into new associations. From this perspective, irrigation development and irrigation projects are conceived as attempts to create, expand, or rearrange new forms of ordering, and therefore new forms of water control.

The (admittedly, very partial) application of this approach, and the concept of 'Water Network' in particular, in the analysis of the historical trajectory of the Irrigation System

Totora Khocha (Chapter 4), allowed to analyse the interaction between changes in infrastructure and groups of actors involved throughout the different 'life phases' of the irrigation system. The exploration of these multiple interactions allowed the visibility of 'blind spots' in the process of expansion of the system, which, despite not having been considered in the formal intervention processes, marked the final path of the project. These 'blind spots' are related to the emergence and enlistment in the water network, of new groups of actors, of the mobilization and translation of new actants, and of new claims for water rights, which forced the rethinking and redesign of the proposals for reordering the irrigation system.

However, the Actor-Network Theory does not scrutinize explicitly the nature of the power relations to identify, understand and negotiate the re-ordering of the actor-network (see e.g., Elder-Vass 2015; Kanger 2017). In particular its earlier methodological conceptualization constitutes a descriptive approach that maps prescription, translation and negotiation in the formation and maintenance of the networks but is less interested in examining the normative mechanisms, political processes and intentional reasoning that influence, allow and create them. A limitation of this so-called *flat ontology* is that it does not explore the socio-economic and institutional structures behind the network, nor does it investigate the political intentionality of scalar constructions (Collinge 2006). The advantage of the actor-network approach is that it maps the seamless web between human actors and material artefacts that create events. It allows for a thorough ethnographic research methodology that traces all direct relations between human and non-human actors (Callon 2007; Hornborg 2015).

In water studies, this ontology and epistemology of treating human and non-human elements symmetrically are expressed in the idea of, for instance, the hydrosocial cycle (e.g., Linton and Budds 2014; Swyngedouw 2009). This conceptual approach was later expanded to include territory as a multiple entity and dynamic construct, through the concept of the hydrosocial territory (Boelens et al. 2016): an analytical lens to identify water politics and examine power relations in waters' socio-material development and governance. In the hydrosocial territories approach the territory is a contested, constantly changing, and multi-scalar socio-natural space where actors claim authority to take decisions and compete over water systems' techno-political configuration. This authority is based on geographic location, history, institutional and legal structure, identity, and cultural values. Based on this claimed authority they legitimize their claims for the right to take decisions over natural resources management in the territory, deploying specific arguments that sprout from prevailing (but plural and contested) epistemologies, political hierarchies and discourses (see also Kronenburg García and van Dijk 2020). The strength of these claims depends on many factors, but the 'resonance' of the arguments within society plays an important role (Feindt and Oels 2005). This highlights the importance of the discursive dimension of power relations in natural resources control (Escobar 2008; Perreault et al. 2015). The shifts in power in the Pucara basin, from the landlords in Punata, to the communities of Tiraque, and later to the highland communities, are based on the general shift in political power at diverse levels in Bolivian society, from the elites to the indigenous population. This emancipation generated, stimulated and awarded claims from deprived rural peasant and indigenous communities. These communities used threat of physical force (diverting the water and roadblocks), the new legislation (the recognition of "*usos y costumbres*", Perreault

(2008)) and newly forged coalitions to gain influence on decision making about irrigation projects and water allocation.

The main scientific contribution of this thesis is the integration of empirical-theoretical notions of water-user driven normative frameworks (and water rights' legal pluralism) with water networks and hydrosocial territory theoretical approaches, in order to examine and understand the expansion and reconfiguration of irrigation systems in the Pucara basin. To better comprehend these processes, it proved crucial to investigate the discursive dimension of water right claims, scrutinizing the divergent languages of legitimacy deployed by the different stakeholders. This shows the importance of an ethnographic (and 'technographic') research methodology guided by conceptual understanding of the politics of networks, scales, discourses and institutions. This is also highly relevant for practitioners as it helps explain why many irrigation projects fail to deliver on their objectives – and often worsen the hydrosocial configuration for many of the presumed 'beneficiaries' involved. It shows that 'water rights' are tightly linked to, and a fundamental cornerstone of hydrosocial territories: deployed as dynamic governance apparatuses but equally as strategic arms that enable flexible territorial negotiations. They go far beyond static formal tools or legalized customary principles, in order to shape dynamic, hybrid, 'living' waterworlds.

In this respect it is interesting to see how the Pucara basin case study compares to other studies on water rights and irrigation projects in Bolivia, other Andean countries and beyond. Much of the important elements encountered in the Pucara basin also play important roles in other studies on irrigation development in Bolivia and other Andean countries: territorial transformations following from translocal interventions in interaction with national and regional natural resource governance policies (Baud et al. 2019a; de Castro et al. 2015); conflicts between communities and the government (Paerregaard et al. 2016; Seemann 2016b); conflicts over water values and valuation languages (Andolina 2012; Hoogendam and Boelens 2019; Li 2015); contestation and recomposition of diverse hydrosocial territories and scalar patterns after water transfers and system expansion (Hommes et al. 2019a; Hommes et al. 2019b; Perreault et al. 2015); negotiations about hydraulic dam development and irrigation systems' design (Duarte-Abadia et al. 2015; Hidalgo Bastidas 2019; Stensrud 2019); increased irrigation demands in higher parts of the river basin (Lynch 2012; Seemann 2016a); and the complex ways in which water users' organizations form coalitions to defend their waters (Dupuits et al. 2020; Hoogesteger 2013; Hoogesteger and Verzijl 2015). However, the study of the struggles about irrigation development in the Pucara basin is unique as it shows the importance of the connection between the general political climate in the country, the power struggle among the lowland and highland communities, and the way languages of legitimation are deployed to reconfigure water networks and hydrosocial territories.

Based in the above conclusions and reflections a number of recommendations for further research can be formulated:

- Follow-up research should be done on how and why imaginaries of hydrosocial territories change, how they start to resonate with society and policy making at different scales (from the local to the global and viceversa), and how they relate

to changing cultural identities, strategical political practices, and new socio-nature approaches.

- Research could also be conducted on how governmental organisations, NGOs and private sector actors imagine hydrosocial territories and how these are translated into policies and projects, as well as in 'territorial pluralism'.
- It would be socially important to find out how to work with smallholder communities and water user associations to improve water retention in upstream catchment areas (reforestation, etc.) in context of climate change, starting from their hydrosocial territorial claims.
- And also look how governments and support agencies (can) work with divergent languages of legitimation of water rights in a river basin to foster environmental and socio-economic justice, also involving a genuine gender perspective.
- Important follow-up research would also involve how recent globalizing perspectives on nature and water as legal and political subjects ('rights of nature', 'rights of rivers') and Latin American perspectives on territorial autonomies and food sovereignty, play out and translate at the Pucara basin scale in terms of water control, and viceversa.

6.7 Implications for irrigation development projects

The knowledge and understanding gained in the study on the relationship between changing approaches to water rights and the historical irrigation development process in the Pucara basin, have some implications for irrigation development projects:

Irrigation systems are complex and dynamic water networks, configured for particular water control purposes. In this sense, any proposal for change in an element of the water network, by an intervention project, involves the reordering of the entire network. Irrigation projects in general, and inter-basin water transfer projects in particular, constitute settings of deep hydrosocial-territorialization by incorporating new water sources, territories and actors into the expansion of the irrigation system. Hereby different actors have divergent territorial imaginaries about the water network. Accordingly, to avoid unforeseen social and political exclusions, cultural misrecognitions, and the corresponding project failures and costs-for-minorities, women and men, it is recommended that irrigation intervention projects be understood, rather than a prescriptive process, as a negotiated process of redesigning project engineering.

Directly related: understanding divergent notions and approaches to water rights is paramount to understanding water struggles in irrigation development processes, and supporting more user-oriented water governance. In this regard, instead of implementing projects with prescriptive application of a particular mechanism for the acquisition and legitimization of water rights; it is recommended to first study and understand the different ways in which different groups of local actors legitimize their water claims. In the context of the struggles for access and control of water, divergent languages of legitimization of water rights compete. Consequently, understand the changing languages of legitimization of water rights, and how the various groups of

actors promote the reordering and defence of their hydrosocial territories; helps to better understand the positions, interests and power structures that guide and determine the negotiation and redesign of irrigation development projects.

Foreseeing that new hydrosocial territorialization imaginaries, discourses and projects will arise in the near future, in Pucara as in other Andean water arenas, these will test and encounter the current socio-material configuration of water control. For those social and technological support institutions and professionals who intent to accompany bottom-up, water-user driven transformation without repeating the errors of their 'water development' peers in the recent past, they better make sure to profoundly understand the underlying normative dynamics and water rights legitimation languages of Andean peasant communities' irrigation water control rationalities.

REFERENCES

Aarnoudse, E., B. Bluemling, P. Wester, and W. Qu. 2012. The role of collective groundwater institutions in the implementation of direct groundwater regulation measures in Minqin County, China. *Hydrogeology Journal* 20 (7): 1213-1221.

Achi, A. 2010. "El agua como bien comunal: Síntesis de las investigaciones en Bolivia." In *Lo Colectivo y el Agua: Entre los Derechos y las Prácticas*, edited by R. Bustamante, 75-108. Lima: IEP.

Adhikari, K. R. 2001. Diagnosis of the East Rapti River Basin of Nepal. In *Integrated Water-Resources Management in a River-Basin Context: Institutional Strategies for Improving the Productivity of Agricultural Water Management*, edited by B. Bruns, D. J. Bandaragoda and M. Samad. Malang, Indonesia: International Water Management Institute.

Agnew, J. 1994. The territorial trap: The geographical assumptions of international relations theory. *Review of International Political Economy* 1 (1): 53-80.

Akrich, M. 1992. "The de-scription of technical objects." In *Shaping Technology / Building Society: Studies in Sociotechnical Change*, edited by W. Bijker and J. Law, 205-224. Cambridge, Massachusetts: MIT Press.

Alexandratos, N., and J. Bruinsma. 2012. World agriculture towards 2030/2050. The 2012 revision. In *ESA Working Papers 12-03*. Rome: Food and Agriculture Organization (FAO).

Altinbilek, D. 2002. The role of dams in development. *International Journal of Water Resources Development* 18 (1): 9-24.

Andersen, A. O. 2019. Assembling commons and commodities: The peruvian water law between ideology and materialisation. *Water Alternatives* 12 (2).

Andolina, R. 2012. The values of water: Development cultures and indigenous cultures in highland Ecuador. *Latin American Research Review* 47 (2): 3-26.

Assies, W. 2003. David versus Goliath in Cochabamba: Water rights, neoliberalism, and the revival of social protest in Bolivia. *Latin American Perspectives* 30 (3): 14-36.

Aubriot, O., S. Fernandez, J. Trottier, and K. Fustec. 2018. Water technology, knowledge and power. Addressing them simultaneously. *WIREs Water* 5 (1): e1261.

Bakker, K. 2010. *Privatizing water. Gobernance failure and the world's urban water crisis*. Ithaca, New York: Cornell University Press.

———. 2012. Water: Political, biopolitical, material. *Social Studies of Science* 42 (4): 616-623.

———. 2013. Neoliberal versus postneoliberal water: Geographies of privatization and resistance. *Annals of the Association of American Geographers* 103 (2): 253-260.

Baletti, B. 2012. Ordenamento territorial: Neo-developmentalism and the struggle for territory in the lower Brazilian Amazon. *Journal of Peasant Studies* 39 (2): 573-598.

Barnes, K., and J. Torrico. 1971. Cambios socio-económicos en el Valle Alto de Cochabamba desde 1952: Los pueblos provinciales de Cliza, Punata, Tiraque, Arani, Sacaba y Tarata. *Estudios Andinos* 2 (1): 141-171.

Baud, M., R. Boelens, and G. Damonte. 2019a. Presentación. Nuevos capitalismos y transformaciones territoriales en la región andina. *Estudios atacameños* 63: 195-208.

Baud, M., R. Boelens, F. de Castro, B. Hogenboom, C. Klaufus, K. Koonings, and A. Ypeij. 2019b. Commoning Xela: Negotiating collective spaces around a Central American intermediate city. *European Review of Latin American and Caribbean Studies* 108: 267-279.

Baud, M., F. de Castro, and B. Hogenboom. 2011. Environmental governance in Latin America: Towards an integrative research agenda. *European Review of Latin American and Caribbean Studies* 90: 79-88.

Bebbington, A., D. Humphreys Bebbington, and J. Bury. 2010. "Federating and defending: Water, territory and extraction in the Andes." In *Out of the Mainstream. Water Rights, Politics and Identity*, edited by R. Boelens, D. Getches and A. Guevara-Gil, 307-327. London and Washington DC: Earthscan.

Beccar, L., R. Boelens, and P. Hoogendam. 2002. "Water rights and collective action in community irrigation." In *Water Rights and Empowerment*, edited by R. Boelens and P. Hoogendam, 1-19. Assen, The Netherlands: Van Gorcum.

Benda-Beckmann, F. v. 1995. Anthropological approaches to property law and economics. *European Journal of law and Economics* 2 (4): 309-336.

———. 2001. Legal pluralism and social justice in economic and political development. *IDS Bulletin* 32 (1): 46-56.

———. 2007. "Contestations over a life-giving force: Water rights and conflicts, with special reference to Indonesia." In *A World of Water: Rain, Rivers and Seas in Southeast Asian Histories*, edited by P. Boomgaard, 259-277. Leiden, The Netherlands: KITLV Press.

Benda-Beckmann, F. v., K. v. Benda-Beckmann, and H. J. Spiertz. 1997. "Local law and customary practices in the study of water rights." In *Water Rights, Conlict and Policy*, edited by R. Pradhan, F. von Benda-Beckmann, K. von Benda-Beckmann, H.L. Spiertz, S.S. Kadka and K. Haq, 221-242. Colombo: IIMI.

Benford, R. D., and D. A. Snow. 2000. Framing processes and social movements: An overview and assessment. *Annual Review of Sociology* 26 (1): 611-639.

Biswas, A. K., and C. Tortajada. 2001. Development and large dams: A global perspective. *International Journal of Water Resources Development* 17 (1): 9-21.

Bitran, E., P. Rivera, and M. Villena. 2014. Water management problems in the Copiapó Basin, Chile: Markets, severe scarcity and the regulator. *Water Policy* 16: 844-863.

Bleeker, S., and J. Vos. 2019. Payment for ecosystem services in Lima´s watersheds: Power and imaginaries in an urban-rural hydrosocial territory. *Water International* 44 (2): 224-242.

Boelens, R. 2008. *The rules of the game and the game of the rules: Normalization and resistance in Andean water control*. PhD Thesis, Wageningen University, Wageningen.

———. 2009. Aguas diversas. Derechos de agua y pluralidad legal en las comunidades andinas. *Anuario de Estudios Americanos* 66 (2): 23-55.

———. 2014. Cultural politics and the hydrosocial cycle: Water, power and identity in the Andean highlands. *Geoforum* 57: 234-247.

———. 2015a. "Water rights." In *The SAGE encyclopedia of food issues*, edited by K. Albala, 1463-1470. Thousand Oaks, California: SAGE Publications.

———. 2015b. *Water, power and identity: The cultural politics of water in the Andes*. London and New York: Routledge.

Boelens, R., and B. Doornbos. 2001. The battlefield of water rights: Rule making amidst conflicting normative frameworks in the Ecuadorian highlands. *Human Organization* 60 (4): 343-355.

Boelens, R., and P. H. Gelles. 2005. Cultural politics, communal resistance and identity in Andean irrigation development. *Journal of Latin American Research* 24 (3): 311-327.

Boelens, R., J. Hoogesteger, and J. C. Rodriguez. 2014. Commoditizing water territories: The clash between Andean water rights cultures and payment for environmental services policies. *Capitalism Nature Socialism* 25 (3): 84-102.

Boelens, R., J. Hoogesteger, E. Swyngedouw, J. Vos, and P. Wester. 2016. Hydro-social territories: A political ecology perspective. *Water International* 41 (1): 1-14.

Boelens, R., and M. Seemann. 2014. Forced engagements. Water security and local rights formalization in Yanque, Colca Valley, Peru. *Human Organization* 73 (1): 1-12.

Boelens, R., and J. Vos. 2014. Legal pluralism, hydraulic property creation and sustainability: The materialized nature of water rights in user-managed systems. *Current Opinion in Environmental Sustainability* 11: 55-62.

Boelens, R., M. Zwarteveen, and D. Roth. 2005. "Legal complexity in the analysis of water rights and water resources management." In *Liquid Relations. Contested Water Rights and Legal Complexity*, edited by D. Roth, R. Boelens and M. Zwarteveen, 1-20. New Brunswick, New Jersey and London: Rutgers University Press.

Bolding, A. 2004. *In hot water: a study on sociotechnnical intervention models and practices of water use in smallholder agriculture, Nyanyadzi catchment, Zimbabwe*. PhD Thesis, Wageningen University, Wageningen.

Brenner, N. 1998. Between fixity and motion: Accumulation, territorial organization and the historical geography of spatial scales. *Environment and Planning D: Society and Space* 16 (4): 459-481.

Brighenti, A. M. 2010. On territorology: Towards a general science of territory. *Theory, Culture & Society* 27 (1): 52-72.

Bromley, D., D. Feeny, M. McKean, P. Peters, J. Gilles, R. Oakerson, F. Runge, and J. Thomson. 1992. *Making the commons work. Theory, practice and policy*. San Francisco, California: Instititute for Contemporary Studies.

Bruns, B., and R. Meinzen-Dick. 2005. "Frameworks for water rights: An overview of institutional options." In *Water Rights Reform: Lessons for Institutional Design*, edited by B. Bruns, C. Ringler and R. Meinzen-Dick, 3-25. Washington, DC: IFPRI.

Budds, J. 2010. "Water rights, mining and indigenous groups in Chile's Atacama." In *Out of the Mainstream. Water Rights, Politics and Identity*, edited by R. Boelens, D. Getches and A. Guevara-Gil, 197-211. London and Washington, DC: Earthscan.

———. 2012. La demanda, evaluación y asignación del agua en el contexto de escasez: Un análisis del ciclo hidrosocial del valle del río La Ligua, Chile. *Revista de Geografía Norte Grande* 52: 167-184.

Budds, J., and L. Hinojosa. 2012. Restructuring and rescaling water governance in mining contexts: The co-production of waterscapes in Peru. *Water Alternatives* 5 (1): 119-137.

Burness, S., and J. Quirk. 1979. Appropriative water rights and the efficient allocation of resources. *The American Economic Review* 69 (1): 25-37.

Cáceres, W. 2009. Gestion de sistemas de riego cuenca hidrográfica Pucara. Cochabamba: Centro AGUA - UMSS.

Callejo, I. d., F. Quiroz, and V. Cossío. 2012. "Dinámicas organizativas en torno al agua en la cuenca hidrosocial Pucara." In *Aguas Arriba, Aguas Abajo. Luces y Sombras de la Gestión Integral de Recursos Hídricos*, edited by F. Quiroz, O. Delgadillo and A. Durán, 185-228. La Paz, Bolivia: Plural Editores, Centro AGUA-UMSS.

Callejo-Veracc, I. G. d. 2019. *Water control and autonomy. Peasant irrigation strategies in the Bolivian Andes*. PhD Thesis, Wageningen University, Wageningen.

Callon, M. 2007. "Some elements of a sociology of translation." In *Technoscience. The Politics of Interventions*, edited by Kristin Asdal, Brita Brenna and Ingunn Moser, 57-78. Oslo, Norway: Oslo Academic Press, Unipub Norway.

Cariño, J., and M. Colchester. 2010. From dams to development justice: Progress with 'free, prior and informed consent' since the World Commission on Dams. *Water Alternatives* 3 (2): 423-437.

Castro, J. E. 2007. Poverty and citizenship: Sociological perspectives on water services and public-private participation. *Geoforum* 38 (5): 756-771.

———. 2013. Water is not (yet) a commodity: Commodification and rationalization revisited. *Human Figurations* 2 (1): 1-21.

CES-GFA. 1993. Plan general de riego del Valle Alto (Tomo 1). Cochabamba: CORDECO.

———. 2008. Proyecto de Trasvase Yungas de Vandiola. Informe final fase intermedia de medición. Cochabamba, Bolivia: Prefectura Departamental de Cochabamba, KfW.

Cleaver, F. 2000. Moral ecological rationality, institutions and the management of common property resources. *Development and Change* 31 (2): 361-383.

———. 2018. "Everyday water injustice and the politics of accommodation." In *Water Justice*, edited by R. Boelens, T. Perreault and J. Vos, 246-258. Cambridge: Cambridge University Press.

Collinge, C. 2006. Flat ontology and the deconstruction of scale: A response to Marston, Jones and Woodward. *Transactions of the Institute of British Geographers* 31 (2): 244-251.

Coward, E. W. 1983. Property in action. Alternatives for irrigation investment. Khon Kaen, Thailand: University of Khon Kaen.

———. 1986. "State and locality in Asian irrigation development: the property factor." In *Irrigation Management in Developing Countries: Current Issues and Approaches*, edited by K. C. Nobe and R. K. Sampath, 491-508. Boulder and London: Westview Press.

———. 1990. Property rights and network order: The case of irrigation works in the Western Himalayas. *Human Organization* 49 (1): 78-88.

Coward, W. 1980. "Irrigation development: Institutional and organizational issues." In *Irrigation and Agricultural Development in Assia: Perspectives From the Social Sciences*, edited by W. Coward, 15-27. London, United Kingdom: Cornell University.

CPM-CONAM. 2002. Proyecto diseño final "Sistema de riego Yungas de Vandiola". Cochabamba, Bolivia: Prefectura del departamento de Cochabamba.

Crow-Miller, B. L. 2013. *Water, power, and development in twenty-first century China: The case of the South-North Water Transfer Project*. PhD Thesis, University of California, Los Angeles.

Cruz, R. 2010. Asignación del agua en la microregión Tiraque Valle. Cochabamba: Centro AGUA - UMSS.

de Castro, F., B. Hogenboom, and M. Baud. 2015. *Gobernanza ambiental en América Latina*. Buenos Aires: CLACSO - ENGOV.

de Fraiture, C., D. Molden, and D. Wichelns. 2010. Investing in water for food, ecosystems, and livelihoods: An overview of the comprehensive assessment of water management in agriculture. *Agricultural Water Management* 97 (4): 495-501.

De Soto, H. 2000. *The mystery of capital: Why capitalism triumphs in the West and fails everywhere else*. New York: Basic Books.

Delgadillo, O., and N. Lazarte. 2007. Gestión de los sistemas de aprovechamiento de agua en el Municipio de Punata. Cochabamba: Centro AGUA - UMSS.

Dinar, A., M. W. Rosegrant, and R. Meinzen-Dick. 1997. Water allocation mechanisms: Principles and examples. In *Policy Research Working Paper*. Washington DC: The World Bank, IFPRI.

Duarte-Abadía, B., and R. Boelens. 2016. Disputes over territorial boundaries and diverging valuation languages: The Santurban hydrosocial highlands territory in Colombia. *Water International* 41 (1): 15-36.

———. 2019. Colonizing rural waters. The politics of hydro-territorial transformation in the Guadalhorce Valley, Málaga, Spain. *Water International* 44 (2): 148-168.

Duarte-Abadia, B., R. Boelens, and T. Roa-Avendaño. 2015. Hydropower, encroachment and the re-patterning of hydrosocial territory: The case of Hidrosogamoso in Colombia. *Human Organization* 74 (3): 243-254.

Dupuits, E. 2019. Water community networks and the appropriation of neoliberal practices: Social technology, depoliticization, and resistance. *Ecology and Society* 24 (2): 20.

Dupuits, E., M. Baud, R. Boelens, F. de Castro, and B. Hogenboom. 2020. Scaling up but losing out? Water commons' dilemmas between transnational movements and grassroots struggles in Latin America. *Ecological Economics* 172: 106625.

Elden, S. 2010. Land, terrain, territory. *Progress in Human Geography* 34 (6): 799-817.

Elder-Vass, D. 2015. Disassembling Actor-network Theory. *Philosophy of the Social Sciences* 45 (1): 100-121.

Escobar, A. 2008. *Territories of difference: Place, movements, life, redes*. Durham and London: Duke University Press.

Falkenmark, M., and D. Molden. 2008. Wake up to realities of river basin closure. *International Journal of Water Resources Development* 24 (2): 201-215.

FAO. 2000. El riego en America Latina y el Caribe en cifras. In *Informes sobre temas hídricos*. Roma: Organización de las Naciones Unidas para la Agricultura y la Alimentación.

———. 2015. AQUASTAT Perfil de País - Bolivia (Estado Plurinacional de). Roma, Italia: Organización de las Naciones Unidas para la Agricultura y la Alimentación.

Faures, J. M., M. Svendsen, H. Turral, and others. 2007. "Reinventing irrigation." In *Water for food Water for life. Comprehensive assessment of water management in agriculture*, edited by D. Molden, 353-394. London and Colombo: Earthscan and International Water Management Institute.

Feindt, P. H., and A. Oels. 2005. Does discourse matter? Discourse analysis in environmental policy making. *Journal of Environmental Policy & Planning* 7 (3): 161-173.

Fernández, O., C. Crespo, O. Campanini, E. Villarroel, and J. C. Alurralde. 2006. Visiones del desarrollo territorial rural y la ley 2878 de promoción y apoyo al sector riego: La organización de los regantes y la gobernanza ambiental en Bolivia. Cochabamba, Bolivia: FEDECOR, CESU, AGUA SUSTENTABLE.

Funder, M., R. Bustamante, V. Cossio, P. T. M. Huong, B. Van Koppen, C. Mweemba, I. Nyambe, L. T. T. Phuong, and T. Skielboe. 2012. Strategies of the poorest in local water conflict and cooperation - Evidence from Vietnam, Bolivia and Zambia. *Water Alternatives* 5 (1): 20-36.

Gandarillas, H., L. Salazar, L. Sánchez, L. C. Sánchez, and P. d. Zutter. 1994. *Dios da el Agua ¿Que hacen los proyectos? Manejo de agua y organización campesina*. Segunda ed. La Paz, Bolivia: HISBOL-PRIV.

Gearey, M., and P. Jeffrey. 2006. Concepts of legitimacy within the context of adaptive water management strategies. *Ecological Economics* 60 (1): 129-137.

Gelles, P. 2010. "Cultural identity and indigenous water rights in the Andean Highlands." In *Out of the Mainstream. Water Rights, Politics and Identity*, edited by R. Boelens, D. Getches and A. Guevara-Gil, 119-144. London and Washington, DC: Earthscan.

Gelles, P. H. 2000. *Water and power in Highland Peru. The cultural politics of irrigation and development*. New Brunswick, New Jersey and London: Rutgers University Press.

Gerbrandy, G. 1991. Concepción campesina de gestión de agua. Dordrecht, Holanda: Deutsche Gesellschaft Fur Technische Zusammnarbeit (GTZ) GmbH.

Gerbrandy, G., and P. Hoogendam. 1998. *Aguas y acequias. Los derechos al agua y la gestión campesina de riego en los Andes Bolivianos*. La Paz, Bolivia: Plural Editores.

———. 2001. "La materialización de los derechos de agua: La propiedad hidráulica en la extensión y rehabilitación de los sistemas de riego de Punata y Tiraque, en Bolivia." In *Derechos de Agua y Acción Colectiva*, edited by R. Boelens and P. Hoogendam, 63-83. Lima, Perú: IEP.

———. 2002. "Materialising rights: Hydraulic property in the extension and rehabilitation of two irrigation systems in Bolivia." In *Water Rights and Empowerment*, edited by R. Boelens and P. Hoogendam, 36-51. Assen, The Netherlands: Van Gorcum.

Goldman, M., and D. Narayan. 2019. Urban transformation through the analytic of water crisis: A study of Bangalore's hydrosocial regimes. *Water International* 44 (2): 95-114.

Goodwin, G. 2019. The problem and promise of coproduction: Politics, history, and autonomy. *World Development* 122: 501-513.

Gould, G. A. 1989. Transfer of water rights. *Natural Resources Journal* 29 (2): 457-477.

Guevara-Gil, A., R. Boelens, and D. Getches. 2010. "Conclusions: Water rights, power and identity." In *Out of the mainstream: Water rights, power and identity*, edited by R. Boelens, D. Getches and A. Guevara-Gil, 329-339. London and Washington: Earthscan.

Guillet, D. W. 1992. *Covering ground. Communal water management and the state in the Peruvian highlands*. Michigan, USA: University of Michigan Press.

Guimac, M. 2010. "Los extractores del agua en las márgenes del nuevo canal Taymi." In *Riego campesino en los Andes: Seguridad hídrica y seguridad alimentaria en Ecuador, Perú y Bolivia*, edited by J. Vos, 191-206. Lima: IEP.

Gutiérrez, Z. 2005. *Appropriate designs and appropriating irrigation systems. Irrigation infrastructure development and users' management capability in Bolivia*. PhD Thesis, Wageningen University, Wageningen.

Haraway, D. 1991. *Simians, cyborgs, and women: The reinvention of nature*. New York: Routledge.

Harris, L. M., and M. C. Roa-García. 2013. Recent waves of water governance: Constitutional reform and resistance to neoliberalization in Latin America (1990-2012). *Geoforum* 50: 20-30.

Hendriks, J. 1998. "Water as private property. Notes on the case of Chile." In *Searching for Equity: Conceptions of Justice and Equity in Peasant Irrigation*, edited by R. Boelens and G. Davila, 297-310. Assen, The Netherlands: Van Gorcum.

Herner, M. T. 2009. Territorio, desterritorialización y reterritorialización: Un abordaje teórico desde la perspectiva de Deleuze y Guattari. *Huellas* 13: 158-171.

Hidalgo Bastidas, J. 2019. *Agua, poder y tecnología: Una genealogía de tres megaproyectos hídricos en el Ecuador (1954-2017)*. PhD Thesis, University of Amsterdam, Amsterdam.

Hidalgo, J. P., R. Boelens, and J. Vos. 2017. De-colonizing water. Dispossession, water insecurity, and indigenous claims for resources, authority, and territory. *Water History* 9 (1): 67-85.

Hidalgo-Bastidas, J. P., R. Boelens, and E. Isch. 2018. Hydroterritorial configuration and confrontation: The Daule-Peripa multipurpose hydraulic scheme in coastal Ecuador. *Latin American Research Review* 53 (3): 517-534.

Hodgson, S. 2004. Land and Water – The Rights Interface. In *FAO Legal Papers Online*. Rome: Food and Agricultural Organisation of the United Nations.

———. 2006. *Modern water rights. Theory and practice*. Rome: Food and Agriculture Organization of the United Nations.

Hommes, L., and R. Boelens. 2017. Urbanizing rural waters: Rural-urban water transfers and the reconfiguration of hydrosocial territories in Lima. *Political Geography* 57: 71-80.

———. 2018. From natural flow to 'working river': Hydropower development, modernity and socio-territorial transformations in Lima's Rímac watershed. *Journal of Historical Geography* 62: 85-95.

Hommes, L., R. Boelens, S. Bleeker, D. Stoltenborg, B. Duarte-Abadía, and J. Vos. 2019a. Water governmentalities: The shaping of hydrosocial territories, water transfers and rural–urban subjects in Latin America. *Environment and Planning E: Nature and Space*: 1-24.

Hommes, L., R. Boelens, L. M. Harris, and G. J. Veldwisch. 2019b. Rural–urban water struggles: Urbanizing hydrosocial territories and evolving connections, discourses and identities. *Water International* 44 (2): 81-94.

Hommes, L., R. Boelens, and H. Maat. 2016. Contested hydrosocial territories and disputed water governance: Struggles and competing claims over the Ilisu Dam development in southeastern Turkey. *Geoforum* 71: 9-20.

Hoogendam, P. 2019. Hydrosocial territories in the context of diverse and changing ruralities: The case of Cochabamba's drinking water provision over time. *Water International* 44 (2): 129-147.

Hoogendam, P., and R. Boelens. 2019. Dams and damages. Conflicting epistemological frameworks and interests concerning "compensation" for the Misicuni Project's socio-environmental impacts in Cochabamba, Bolivia. *Water* 11 (3): 408.

Hoogesteger, J. 2013. Trans-forming social capital around water: Water user organizations, water rights, and nongovernmental organizations in Cangahua, the Ecuadorian Andes. *Society & Natural Resources* 26 (1): 60-74.

Hoogesteger, J., R. Boelens, and M. Baud. 2016. Territorial pluralism: Water users' multi-scalar struggles against state ordering in Ecuador's highlands. *Water International* 41 (1): 91-106.

Hoogesteger, J., and A. Verzijl. 2015. Grassroots scalar politics: Insights from peasant water struggles in the Ecuadorian and Peruvian Andes. *Geoforum* 62: 13-23.

Hornborg, A. 2015. The political economy of technofetishism: Agency, Amazonian ontologies, and global magic. *HAU: Journal of Ethnographic Theory* 5 (1): 35-57.

Hulshof, M., and J. Vos. 2016. Diverging realities: How framing, values and water management are interwoven in the Albufera de Valencia wetland in Spain. *Water International* 41 (1): 107-124.

Hutchins, W. A. 1971. Water rights laws in the nineteen Western States (Volume I). Washington: Natural Resources Economics Division, Economic Research Service US Department of Agriculture.

Jackson, S. 2018. Water and indigenous rights: Mechanisms and pathways of recognition, representation, and redistribution. *Wiley Interdisciplinary Reviews: Water* 5 (6): e1314.

Joy, K. J., S. Kulkarni, D. Roth, and M. Zwarteveen. 2014. Re-politicising water governance: Exploring water re-allocations in terms of justice. *Local Environment: The International Journal of Justice and Sustainability* 19 (9): 954-973.

Kanger, L. 2017. Mapping 'the ANT multiple': A comparative, critical and reflexive analysis. *Journal for the Theory of Social Behaviour* 47 (4): 435-462.

Kayastha, R. N., and D. Pant. 2003. Institutional arrangements for water management in the East Rapti Basin, Nepal. In *Governance for Integrated Water Resources Management in a River Basin Context*, edited by B. Bruns and D. J. Bandaragoda. Bangkok: IWMI.

Kohl, B. 2002. Stabilizing neoliberalism in Bolivia: Popular participation and privatization. *Political Geography* 21: 449-472.

———. 2003. Democratizing decentralization in Bolivia: The law of pupular participation. *Journal of Planning Education and Research* 23: 153-164.

Komakech, H., B. Van Koppen, H. Mahoo, and P. van der Zaag. 2011. Pangani River Basin over time and space: On the interface of local and basin level responses. *Agricultural Water Management* 98 (11): 1740-1751.

Kooij, S. v. d. 2016. *Performing drip irrigation by the farmer managed Seguia Khrichfa irrigation system, Morocco*. PhD Thesis, Wageningen University, Wageningen.

Kronenburg García, A., and H. van Dijk. 2020. Towards a theory of claim making: Bridging access and property theory. *Society & Natural Resources* 33 (2): 167-183.

Lankford, B., and W. Mwaruvanda. 2007. "A legal-infrastructural framework for catchment apportionment." In *Community-based Water Law and Water Resource Management Reform in Developing Countries*, edited by B. van Koppen, M. Giordano and J. Butterworth, 228-247. Wallingford, UK: CABI Publishers.

Latour, B. 1993. *We have never been modern*. Cambridge, Massachusetts: Harvard University Press.

———. 2005. *Reassembling the social. An introduction to Actor-Network Theory*. New York: Oxford University Press.

Law, J. 1994. *Organizing modernity*. Oxford, United Kingdom: Blackwell Publishers.

Li, F. 2015. *Unearthing conflict: Corporate mining, activism, and expertise in Peru*. Durham, London: Duke University Press.

Linton, J., and J. Budds. 2014. The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water. *Geoforum* 57: 170-180.

Long, N. 2004. "Actors, interfaces and development intervention: Meanings, purposes and powers." In *Development Intervention. Actor and Activity Perspectives*, edited by T. Kontinen, 14-36. Helsinki: University of Helsinki.

Long, N., and J. D. van der Ploeg. 1989. Demythologizing planned intervention: An actor perspective. *Sociologia Ruralis* 29 (3-4): 226-249.

Lynch, B. D. 2012. Vulnerabilities, competition and rights in a context of climate change toward equitable water governance in Peru's Rio Santa Valley. *Global Environmental Change* 22 (2): 364-373.

Maganga, F. P. 2003. Incorporating customary laws in implementation of IWRM: Some insights from Rufiji River Basin, Tanzania. *Physics and Chemistry of the Earth* 28 (20): 995-1000.

Mancano, B. 2009. "Territorio, teoria y politica." In *Las Configuraciones de los Territorios Rurales en el Siglo XXI*, edited by F. Lozano and J. G. Ferro, 35-62. Bogota: Editorial Pontificia Universidad Javeriana.

Marks, D. 2019. Assembling the 2011 Thailand floods: Protecting farmers and inundating high-value industrial estates in a fragmented hydro-social territory. *Political Geography* 68: 66-76.

Martinez-Alier, J. 2002. *The environmentalism of the poor: A study of ecological conflicts and valuation*. Cheltenham, UK: Edward Elgar.

———. 2009a. Lenguajes de valoración. *El Viejo Topo* 253: 94-103.

———. 2009b. Social metabolism, ecological distribution conflicts, and languages of valuation. *Capitalism Nature Socialism* 20 (1): 58-87.

Martinez-Alier, J., G. Kallis, and S. Veuthey. 2010. Social metabolism, ecological distribution conflicts, and valuation languages. *Ecological Economics* 70 (2): 153-158.

Mayta, A. 2012. Disponibilidad de agua subterranea en el Abanico de Punata. Cochabamba: Centro AGUA - UMSS.

Meehan, K. 2013. Disciplining de facto development: Water theft and hydrosocial order in Tijuana. *Environment and Planning D: Society and Space* 31: 319-336.

Mehta, L., G. J. Veldwisch, and J. Franco. 2012. Water grabbing? Focus on the (re)appropriation of finite water resources. *Water Alternatives* 5 (2): 193-207.

Meinzen-Dick, R. 2014. Property rights and sustainable irrigation: A developing country perspective. *Agricultural Water Management* 145: 23-31.

Meinzen-Dick, R., and R. Pradhan. 2002. Legal pluralism and dynamic property rights. In *CAPRi Working Paper*. Washington, DC: International Food Policy Research Institute.

———. 2005. "Analyzing water rights, multiple uses, and intersectoral water transfers." In *Liquid Relations. Contested Water Rights and Legal Complexity*, edited by D. Roth, R. Boelens and M. Zwarteveen, 237-253. New Brunswick, New Jersey and London: Rutgers University Press.

Mena-Vásconez, P., R. Boelens, and J. Vos. 2016. Food or flowers? Contested transformations of community food security and water use priorities under new legal and market regimes in Ecuador's highlands. *Journal of Rural Studies* 44: 227-238.

Meza, C., and G. Sturla. 2015. Escasez y sequía en acuífero del río Copiapo. *Revista de Derecho Ambiental* 5: 81-89.

Ministerio del Agua. 2007. Plan Nacional de Desarrollo de Riego "...para vivir bien" 2007-2011. La Paz, Bolivia: Ministerio de Agua - Viceministerio de Riego - Servicio Nacional de Riego.

MMAyA. 2013. *Inventario nacional de sistemas de riego 2012*. Cochabamba: Ministerio de Medio Ambiente y Agua - Viceministerio de Recursos Hídricos y Riego.

Molden, D. 2007. *Water for food Water for life. Comprehensive assessment of water management in agriculture*. London and Colombo: Earthscan and International Water Management Institute.

Molle, F. 2003. *Development trajectories of river basins: A conceptual framework*. Research Report 72. Colombo, Sri Lanka: International Water Management Institute.

———. 2008. Why enough is never enough: The societal determinants of river basin closure. *International Journal of Water Resources Development* 24 (2): 217-226.

Molle, F., P. P. Mollinga, and P. Wester. 2009. Hydraulic bureaucracies and the hydraulic mission: Flows of water, flows of power. *Water Alternatives* 2 (3): 328-349.

Molle, F., and P. Wester. 2009. "River basin trajectories: An inquiry into changing waterscapes." In *River Basin Trajectories: Societies, Environments and Development*, edited by F. Molle and P. Wester, 1-19. Wallingford: CABI Publishing.

Mollinga, P. P. 2008. Water, politics and development: Framing a political sociology of water resources management. *Water Alternatives* 1 (1): 7-23.

Morales, W. Q. 2011. From revolution to revolution: Bolivia's national revolution and the “re-founding" revolution of Evo Morales. *The Latin Americanist*: 131-145.

Mosse, D. 2006. Collective action, common property, and social capital in South India: An anthropological commentary. *Economic Development and Cultural Change* 54 (3): 695-724.

———. 2008. Epilogue: The cultural politics of water - A comparative perspective. *Journal of Southern African Studies* 34 (4): 939-948.

Murdoch, J. 1998. The spaces of Actor-Network Theory. *Geoforum* 29 (4): 357-374.

Oré, M. T., and E. Rap. 2009. Políticas neoliberales de agua en el Perú. Antecedentes y entretelones de la ley de recursos hídricos. *Debates en Sociología* (34): 32-66.

Orlove, B., and S. C. Caton. 2010. Water sustainability: Anthropological approaches and prospects. *Annual Review of Anthropology* 39: 401-415.

Ostrom, E. 1990. *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.

———. 1993. *Diseño de instituciones para sistemas de riego auto-gestionarios*. San Francisco, California: Institute for Contemporary Studies Press.

———. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939): 419-422.

Paerregaard, K. 2013. Governing water in the andean community of Cabanaconde, Peru. *Mountain Research and Development* 33 (3): 207-214.

———. 2018. Power in/of/as water: Revisiting the hydrologic cycle in the Peruvian Andes. *WIREs Water* 5 (2): e1270.

Paerregaard, K., and A. O. Andersen. 2019. Moving beyond the commons/commodity dichotomy: The socio-political complexity of Peru’s water crisis. *Water Alternatives* 12 (2): 459-469.

Paerregaard, K., A. B. Stensrud, and A. O. Andersen. 2016. Water citizenship. Negotiating water rights and contesting water culture in the Peruvian Andes. *Latin American Research Review* 51 (1): 198-217.

Peralta, J. 2010. "Derechos y conflictos de agua en un sistema estatal de riego." In *Lo Colectivo y el Agua: Entre los Derechos y las Prácticas*, edited by R. Bustamante, 183-200. Lima: IEP.

Perreault, T. 2005. State restructuring and the scale politics of rural water governance in Bolivia. *Environment and Planning A: Economy and Space* 37 (2): 263-284.

———. 2008. Custom and contradiction: Rural water governance and the politics of usos y costumbres in Bolivia’s irrigators’ movement. *Annals of the Association of American Geographers* 98 (4): 834-854.

———. 2014. What kind of governance for what kind of equity? Towards a theorization of justice in water governance. *Water International* 39 (2): 233-245.

Perreault, T., R. Boelens, and J. Vos. 2018a. "Conclusions: Struggles for justice in a changing water world." In *Water Justice*, edited by R. Boelens, T. Perreault and J. Vos, 346-360. Cambridge: Cambridge University Press.

———. 2018b. "Introduction: Re-Politicizing water allocation." In *Water Justice*, edited by R. Boelens, T. Perreault and J. Vos, 34-42. Cambridge: Cambridge University Press.

Perreault, T., G. Bridge, and J. McCarthy. 2015. *The Routledge handbook of political ecology*. London and New York: Routledge.

Perreault, T., S. Wraight, and M. Perreault. 2011. The social life of water. Histories and geographies of environmental injustice in the Onondaga Lake watershed. New York: Justicia Hídrica.

Pfaffenberger, B. 1988. Fetishised objects and humanised nature: towards an anthropology of technology. *Man* 23 (2): 236-252.

Pradhan, R., and R. Meinzen-Dick. 2003. Which rights are rights? Water rights, culture, and underlying values. *Water Nepal* 9/10 (1/2): 37-61.

Preciado, R., E. Rap, and J. Vos. 2015. The politics of land use planning: Gold mining in Cajamarca, Peru. *Land Use Policy* 49: 104-117.

PRIV. 1992. Sistema de riego Tiraque-Punata. Cochabamba, Bolivia: PRIV.

PRONAR. 2000. *Inventario Nacional de Sistemas de Riego*. Cochabamba, Bolivia: Ministerio de Agricultura, Ganadería y Desarrollo Rural.

Rap, E. 2004. *The success of a policy model. Irrigation management transfer in Mexico*. PhD Thesis, Wageningen University, Wageningen.

———. 2006. The success of a policy model: Irrigation management transfer in Mexico. *The Journal of Development Studies* 42 (8): 1301-1324.

Rap, E., and P. van der Zaag. 2019. Engaging with flows: Embodied cognition in water provision. *Water* 11 (9): 1751.

Rasmussen, M. B. 2015. *Andean waterways: Resource politics in Highland Peru*. Washington: University of Washington Press.

Rawson, A., and B. Mansfield. 2018. Producing juridical knowledge: "Rights of nature" or the naturalization of rights? *Environment and Planning E: Nature and Space* 1 (1-2): 99-119.

Reque, D. 1998. *Influencia del proyecto de riego inter-valles en la gestión de riego del sistema Totora Khocha Antiguos*. Tesis de Licenciatura, Universidad Mayor de San Simón, Cochabamba, Bolivia.

Ringler, C., M. Rosegrant, and M. Paisner. 2000. Irrigation and water resources in Latin America and the Caribbean: Challenges and strategies. In *EPTD Discussion Paper 64*. Washington: EPTD, IFPRI.

Roa-García, M. C. 2014. Equity, efficiency and sustainability in water allocation in the andes: Trade-offs in a full world. *Water Alternatives* 7 (2): 298-319.

Rocha López, R., R. Boelens, J. Vos, and E. Rap. 2019. Hydrosocial territories in dispute: Flows of water and power in an interbasin transfer project in Bolivia. *Water Alternatives* 12 (1): 267-284.

Rocha, R., J. Pascual, and J. Iriarte. 2014. "Dinámica de caudales y control de agua para riego en la Cuenca Pucara." In *Sistemas de Información e Instrumentos Técnicos para la Gestión del Agua*, edited by V. Cossio, A. Pérez-Foguet, A. Durán and C. Yacoub, 27-46. Cochabamba, Bolivia: Centro AGUA - UMSS.

Rocha, R., L. Vincent, and E. Rap. 2015. Re-engineering closing watersheds: The negotiated expansion of a dam-based irrigation system in Bolivia. *International Journal of Water Resources Development* 31 (1): 50-63.

Rodríguez-de-Francisco, J. C., and R. Boelens. 2015. Payment for environmental services: Mobilising an epistemic community to construct dominant policy. *Environmental Politics* 24 (3): 481-500.

———. 2016. PES hydrosocial territories: De-territorialization and re-patterning of water control arenas in the Andean highlands. *Water International* 41 (1): 140-156.

Romano, S. T. 2017. Building capacities for sustainable water governance at the grassroots: "Organic empowerment" and Its policy implications in Nicaragua. *Society & Natural Resources* 30 (4): 471-487.

Rosegrant, M. W., and H. P. Binswanger. 1994. Markets in tradable water rights: Potential for efficiency gains in developing country water resource allocation. *World Development* 22 (11): 1613-1625.

Roth, D., R. Boelens, and M. Zwarteveen. 2005. *Liquid relations. Contested water rights and legal complexity*. New Brunswick, New Jersey, London: Rutgers University Press.

———. 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.

Saldías, C., R. Boelens, K. Wegerich, and S. Speelman. 2012. Losing the watershed focus: A look at complex community-managed irrigation systems in Bolivia. *Water International* 37 (7): 744-759.

Salzgitter Consult GmbH. 1991. *Proyecto Punata Fase II. Informe Final*. Cochabamba, Bolivia: MACA, SNDC, PRAV.

Sanchis-Ibor, C., R. Boelens, and M. García-Mollá. 2017. Collective irrigation reloaded. Re-collection and re-moralization of water management after privatization in Spain. *Geoforum* 87: 38-47.

Saravia, R., C. Ortuño, and F. Pericón. 2006. Informe evaluación ex-ante de los estudios a diseño final. Proyecto de riego Yungas de Vandiola. Cochabamba, Bolivia: Componente Riego PROAGRO/GTZ.

Sax, J. L. 1990. The constitution, property rights and the future of water law. *U. Colo. L. Rev* 61: 257-282.

Schlager, E., and E. Ostrom. 1992. Property-rights regimes and natural resources: A conceptual analysis. *Land Economics* 68 (3): 249-262.

Seemann, M. 2016a. Inclusive recognition politics and the struggle over hydrosocial territories in two Bolivian highland communities. *Water International* 41 (1): 157-172.

———. 2016b. *Water security, justice and the politics of water rights in Peru and Bolivia*. Houndmills, Basingstoke: Palgrave Macmillan UK.

Sikor, T., and C. Lund. 2009. Access and property: A question of power and authority. *Development and Change* 40 (1): 1-22.

Spiertz, H. J. 2000. "Water rights and legal pluralism: Some basics of a legal anthropological approach." In *Negotiating Water Rights*, edited by B. Bruns and R. Meinzen-Dick, 162-199. New Delhi: Vistaar Publications.

Stensrud, A. B. 2019. The social embeddedness of hydraulic engineers in the regulation of water and infrastructure in Peru. *Environment and Planning C: Politics and Space* 37 (7): 1235-1251.

Suhardiman, D., A. Nicol, and E. Mapedza. 2017. *Water governance and collective action. Multi-scale challenges*. London and New York: Routledge.

Swyngedouw, E. 1999. Modernity and hybridity: Nature, regeneracionismo, and the production of the Spanish Waterscape, 1890–1930. *Annals of the Association of American Geographers* 89 (3): 443-465.

———. 2004a. Globalisation or "Glocalisation"? Networks, territories and rescaling. *Cambridge Review of International Affairs* 17 (1): 25-48.

———. 2004b. *Social power and the urbanization of water. Flows of power*. Oxford, New York: Oxford University Press.

———. 2007. Technonatural revolutions: The scalar politics of Franco's hydro-social dream for Spain, 1939?1975. *Transactions of the Institute of British Geographers* 32: 9-28.

———. 2009. The political economy and political ecology of the hydro-social cycle. *Journal of Contemporary Water Research & Education* 142 (1): 56-60.

———. 2015. Liquid power: Contested hydro-modernities in 20th century Spain. Cambridge: MIT Press.

Swyngedouw, E., and R. Boelens. 2018. ""... And not a single injustice remains": Hydro-territorial colonization and techno-political transformations in Spain." In *Water justice*, edited by R. Boelens, T. Perreault and J. Vos, 115-134. Cambridge: Cambridge University Press.

Theesfeld, I. 2010. Institutional challenges for national groundwater governance: Policies and issues. *Ground Water* 48 (1): 131-142.

Turral, H., M. Svendsen, and J. M. Faures. 2010. Investing in irrigation: Reviewing the past and looking to the future. *Agricultural Water Management* 97 (4): 551-560.

Valladares, C., and R. Boelens. 2017. Extractivism and the rights of nature: Governmentality, 'convenient communities' and epistemic pacts in Ecuador. *Environmental Politics* 26 (6): 1015-1034.

van der Ploeg, J. D. 1990. *Labor, markets, and agricultural production*. Boulder, San Francisco & Oxford: Westview Press.

———. 1998. "Peasants and power." In *Searching for Equity. Conceptions of Justice and Equity in Peasant Irrigation*, edited by R. Boelens and G. Davila, 39-45. Assen: Van Gorcum.

———. 2006. *El futuro robado. Tierra, agua y lucha campesina*. WALIR. Lima: IEP.

———. 2008. *The new peasantries. Struggles for autonomy and sustainability in an era of empire and globalization*. London: Earthscan.

van Koppen, B. 1998. Water rights, gender, and poverty alleviation. Inclusion and exclusion of women and men smallholders in public irrigation infrastructure development. *Agriculture and Human Values* 15 (4): 361-374.

van Koppen, B., V. Cossio, and T. Skielboe. 2012. Project politics, priorities and participation in rural water schemes. *Water Alternatives* 5 (1): 37-51.

Veldwisch, G. J., A. Bolding, and P. Wester. 2009. Sand in the engine: The travails of an irrigated rice scheme in Bwanje Valley, Malawi. *Journal of Development Studies* 45 (2): 197-226.

Verzijl, A., J. Hoogesteger, and R. Boelens. 2017. "Grassroots scalar politics in the Peruvian Andes: Mobilising allies to defend community waters in the upper Pampas Watershed." In *Water Governance and Collective Action. Multi-scale Challenges*, edited by D. Suhardiman, A. Nicol and E. Mapedza, 34-45. London and New York: Routledge.

Vincent, L. 2001. "Struggles at the social interface: Developing sociotechnical research in irrigation and water management." In *Resonances and Dissonances in Development: Actors, Networks and Cultural Repertoires*, edited by P. Hebinck and G. Verschoor, 65-81. Assen, The Netherlands: Royal Van Gorcum.

Vos, H. d., R. Boelens, and R. Bustamante. 2006. Formal law and local water control in the andean region: A fiercely contested field. *International Journal of Water Resources Development* 22 (1): 37-48.

Vos, J. 2002. *Metric matters: The performance and organisation of volumetric water control in large-scale irrigation in the North Coast of Peru*. PhD Thesis, Wageningen University, Wageningen.

Vos, J., and R. Boelens. 2014. Sustainability standards and the water question. *Development and Change* 45 (2): 205-230.

———. 2015. "Water in global agrifood chains." In *The SAGE Encyclopedia of Food Issues*, edited by K. Albala, 1459-1463. Thousand Oaks: SAGE Publications.

Vos, J., R. Boelens, J.-P. Venot, and M. Kuper. 2020. Rooted water collectives: Towards an analytical framework. *Ecological Economics* 173: 106651.

Vos, J., and L. Hinojosa. 2016. Virtual water trade and the contestation of hydrosocial territories. *Water International* 41 (1): 37-53.

Vos, J., and A. Marshall. 2017. "Conquering the desert: Drip irrigation in the Chavimochic systems in Peru." In *Drip Irrigation for Agriculture: Untold Stories of Efficiency, Innovation and Development*, edited by J.P. Venot, M. Kuper and M. Zwarteveen, 134-150. London and New York: Routledge.

VRHyR. 2013. Agenda del Riego 2025. Cochabamba, Bolivia: Ministerio de Medio Ambiente y Agua - VRHyR.

Watkins, K. 2006. Human development report 2006. Beyond scarcity: Power, poverty and the global water crisis. New York: United Nations Development Programme.

Wester, P. 2008. *Shedding the waters: Institutional change and water control in the Lerma-Chapala Basin, Mexico*. PhD Thesis, Wageningen University, Wageningen.

Wester, P., T. Shah, D. J. Merrey, and M. Svendsen. 2005. "Providing irrigation services in water-scarce basins: Representation and support." In *Irrigation and River Basin Management. Options for Governance and institutions*, edited by M. Svendsen, 231-246. Oxon, UK and Cambridge, USA: CABI Publishing.

Wilson, N. J., and J. Inkster. 2018. Respecting water: Indigenous water governance, ontologies, and the politics of kinship on the ground. *Environment and Planning E: Nature and Space* 1 (4): 516-538.

Zwarteveen, M., D. Roth, and R. Boelens. 2005. "Water rights and legal pluralism: Beyond analysis and recognition." In *Liquid Relations. Contested Water Rights and Legal Complexity*, edited by D. Roth, R. Boelens and M. Zwarteveen, 254-268. New Brunswick, New Jersey, London: Rutgers University Press.

Summary

In recent years, irrigation projects worldwide, and in the Andean region of Bolivia in particular, have besides solving water problems also generated water conflicts. Historically, most irrigation systems in Bolivia have been set up by peasant communities, and only more recently some government irrigation projects have been established. As part of these processes, peasant communities developed their own organizational and regulatory frameworks to arrange access and control of water. These are manifested in the ways they conceive, defend and claim water rights. The lack of understanding of this water rights frameworks, by planners and designers of irrigation development, commonly results in the implementation of prescriptive, top-down irrigation projects, which commonly aim to transform locally established water rights and governance frameworks. In many instances, these proposals for re-ordering local irrigation systems are fiercely resisted by groups of actors who are adversely involved in or bluntly excluded from these processes. Therefore, the research problem of this thesis focuses on the lack of knowledge about the interaction between irrigation development and the changing and divergent approaches to water rights that the actors involved apply. Focusing on the case study of the Pucara basin, the thesis addresses the following main research question:

> How have changing approaches to water rights shaped irrigation development and control over water for different stakeholders in the Pucara river basin?

The main research question has been investigated by scrutinizing and answering the following four sub-questions:

- What heuristic conceptual framework on water rights can be formulated to analyse the diverse ways in which different actor groups legitimize their claims to water use in a river basin?
- How have different stakeholders, throughout history, strategically used diverse "legitimation languages" to claim water use rights in the Pucara river basin?
- How did the expansion of the Totora Khocha irrigation system lead to the negotiated construction of new water networks to control the Totora Khocha reservoir waters in the Pucara river basin?
- How did changing hydrosocial territorialization by different stakeholders, lead to the reiterated re-design of the planned interbasin expansion project of the Totora Khocha irrigation system?

Through the integration of empirical-theoretical notions of water-user driven normative frameworks, with water networks and hydrosocial territory theoretical approaches; the thesis examines the expansion and reconfiguration of irrigation systems in the Pucara river basin. It does so through the identification and analysis of diverse and divergent languages of water rights legitimation as deployed by the different stakeholders.

This thesis is based on the study of irrigation development in the Pucara river basin, located in Cochabamba, Bolivia. Herein, it focuses in-depth on the study of historical development of the Totora Khocha irrigation system. The theoretical knowledge, discussed in this study, is developed inductively from empirical data collected through

qualitative methods, at three analytical scales: river basin, irrigation system and interbasin scales.

A conceptual framework to analyse the divergent forms of water rights legitimation in river basins is discussed in chapter 2. The conceptual framework focusses on the water rights dynamics and hybrid nature in struggles over water access. Through the exploration of five river basin cases, six basic principles or 'mechanisms' for legitimizing water rights were identified. In all the analysed cases, there is a main mechanism, certified by the authorities and recognized as legitimate by most other user groups. However, the different water user groups, strategically, also use other, competing mechanisms to claim and defend the legitimacy of their water rights. Next, in response to sociotechnical, legal, and political changes as those promoted by irrigation intervention projects, different user groups strategically also tend to change their positions and conceptions.

Starting with the analysis at river basin scale, chapter 3 explores the historical development of irrigation in the Pucara river basin. This chapter shows how the recent conceptual notion of "hydrosocial territories" enables examining the diversity of water rights claims. Over the three periods of irrigation development in the Pucara basin, the prevailing language of legitimation of water rights changed: from modes based on the creation of hydraulic property, to forms that emphasize territorial claims. In the first period (1950–1978), acquiring rights was sustained through "hydraulic property" notions and relationships: water rights were created by families and collectives making investments (principally through labour-power but also other resources) in infrastructure development. In the second period (1978–1995), a shift took place to more flexible, territorially-oriented claims over water rights. They emerged in response to governmental attempts to reorganize Pucara's hydrosocial territory. In the third period (1995–2017), which was steered by indigenous communities' wider political emancipation processes and government's municipalization policies, more rigid territorial claims over water sources and use rights have become decisive in the struggle over water. In this era, the territorialization of water claims was increasingly related to changes in national policies and regulations, such as the process of administrative decentralisation, and the empowerment of peasant communities.

In chapter 4, the thesis focusses on the system scale, exploring the historical expansion of the Totora Khocha irrigation system. When Totora Khocha irrigation system expanded in space and across boundaries to capture new water, new claims emerged by existing and emergent users. The origin of the dam dates back to the beginning of the twentieth century, when a landlord commanded the construction of an earthen dam. The water network entered a second phase after the land reforms of 1953 and shifted from monopolistic control to collective control by peasant communities. A third phase developed in the 1960s, when the system expanded to increase the storage capacity of the reservoir, including new users. As an attempt to reopen the closed river basin, in the fourth phase (1980-1991) the state planned a project that authoritatively designed a new and much larger dam over the original reservoir, which also implied an interbasin water transfer. The prescriptive way to develop the irrigation project in this last phase was challenged by different user groups, both existing and emerging. These groups struggled for their inclusion in the project and the expanding water network. This

resulted in complex processes of negotiated system re-engineering. Therefore, the irrigation design process and results in a closed river basin, beyond following from prescriptive system building, is better understood as a dynamic and negotiated process of engineering and hydrosocial weaving and networking.

Chapter 5 focusses on interbasin scale, analysing the historical development of the Interbasin Transfer Project Yungas de Vandiola (Proyecto de Riego Trasvase Yungas de Vandiola). This project was designed with the purpose to expand, again, the Totora Khocha irrigation system. This chapter integrates the different scales at which divergent actors strategize and mobilize support to shape their desired hydrosocial territory. Starting with the project's initial design, the chapter describes the four subsequent configurations of alternative hydrosocial territories: the original Yungas de Vandiola interbasin water transfer project (2002), the alternative plan by the highland communities (2006), the new Yungas de Vandiola interbasin water transfer project (2008), and the new alternative plan proposed by a coalition of expanded highland communities (2009). During this process, groups of communities that were initially not included in the project, crystalized their hydro-territorial imaginaries and forged multi-scalar alliances to materialize their territorial perspectives, in response to wider political and cultural developments at the national level. This gradually altered the dominant imaginary of the hydrosocial territory as was reflected in the Yungas de Vandiola interbasin transfer project plans, resulting in the cancelation of the project.

The conclusions of my thesis on the recent history of the Pucara river basin, first of all, point at how water user communities have historically and dynamically elaborated a grounded repertoire of water rights approaches to respond to prevailing climatological, agro-ecological, demographic and normative-political challenges. Rather than being 'indigenous' or 'traditional', they entwine, hybridize and embed locally born and outside water governance norms, organizational structures and technological opportunities. Next, my thesis shows how this has recently culminated in a strategic ploy whereby some actor alliances engage with the emergent formal policy focus on community water rights and territorial sovereignty. They use this national framing to locally claim collective, territorial water rights, through discursive legitimization, re-conceptualization of hydrosocial territories, and the negotiated expansion of water control and irrigation development. As happens in other places in Bolivia, new languages of legitimation of water rights claims by highland communities have increasingly resonated with the (indigenist) governments' water laws and policies. For the moment, this has tended to obstruct local traditions of negotiated and more consensual inter-stakeholder approaches. The result is a contemporary deadlock for irrigation development in the Pucara basin. Nevertheless, given the dynamism and (literally) creative capacity of water rights legitimation languages, it is to be awaited that new hydrosocial territorialization imaginaries and projects will emerge soon. These will, once again, challenge the irrigation and water governance status quo in the Pucara basin.

Resumen

En los últimos años, los proyectos de riego en todo el mundo, y en la región andina de Bolivia en particular, además de resolver problemas de agua han generado también conflictos hídricos. Históricamente, la mayoría de los sistemas de riego en Bolivia han sido establecidos por comunidades campesinas, y sólo recientemente se han establecido algunos proyectos de riego gubernamentales. Como parte de estos procesos, las comunidades campesinas desarrollaron sus propios marcos organizativos y reglamentarios para organizar el acceso y control del agua. Estos se manifiestan en la forma en que conciben, defienden y reclaman los derechos de agua. La falta de comprensión de estos marcos de derechos de agua, por parte de los planificadores y diseñadores del desarrollo del riego, comúnmente resultan en la implementación de proyectos de riego prescriptivos, de arriba hacia abajo, que comúnmente tienen como objetivo transformar los derechos de agua y los marcos de gobernanza localmente establecidos. En muchos casos, estas propuestas para reordenar los sistemas de riego locales son duramente resistidas por grupos de actores que fueron negativamente involucrados o directamente excluidos de estos procesos. Por lo tanto, el problema de investigación de esta tesis se centra en la falta de conocimiento sobre la interacción entre el desarrollo del riego y los cambiantes y divergentes enfoques de derechos de agua que los actores involucrados aplican. Centrándose en el estudio de caso de la cuenca Pucara, la tesis aborda la siguiente pregunta principal de investigación:

> ¿Cómo, los cambiantes enfoques de derechos de agua, han configurado el desarrollo de riego y el control sobre el agua para los diferentes grupos de interés en la cuenca del río Pucara?

La pregunta principal de investigación ha sido estudiada, examinando y respondiendo las siguientes cuatro sub-preguntas:

- ¿Qué marco conceptual heurístico sobre los derechos de agua se puede formular para analizar las diversas formas en que los diferentes grupos de actores legitiman sus reclamos de uso de agua en una cuenca hidrográfica?
- ¿Cómo, a lo largo de la historia, los diferentes grupos de interés han utilizado estratégicamente diversos “lenguajes de legitimación” para reclamar derechos de uso de agua en la cuenca del río Pucara?
- ¿Cómo condujo la expansión del sistema de riego Totora Khocha a la construcción negociada de nuevas redes de agua para controlar las aguas del reservorio Totora Khocha, en la cuenca del río Pucara?
- ¿Cómo llevó la cambiante territorialización hidrosocial por parte de los diferentes grupos de interés, al re-diseño reiterado del proyecto de expansión entre cuencas previsto del sistema de riego Totora Khocha?

Mediante la integración de nociones empírico-teóricas de marcos normativos orientados al usuario de agua, con enfoques teóricos de redes de agua y de territorio hidrosocial; la tesis examina la ampliación y reconfiguración de los sistemas de riego en la cuenca del río Pucara. Lo hace mediante la identificación y el análisis de diversos y divergentes lenguajes de legitimación de derechos de agua desplegadas por los diferentes grupos de actores interesados.

Esta tesis se basa en el estudio del desarrollo del riego en la cuenca del río Pucara, ubicada en Cochabamba, Bolivia. Este documento se centra en profundidad en el estudio del desarrollo histórico del sistema de riego Totora Khocha. Los conocimientos teóricos, discutidos en este estudio, se desarrollan inductivamente a partir de datos empíricos recolectados a través de métodos cualitativos, en tres escalas analíticas: cuenca hidrográfica, sistema de riego y entre cuencas.

En el capítulo 2 se examina un marco conceptual para analizar las formas divergentes de legitimación de derechos de agua en cuencas hidrográficas. El marco conceptual se centra en la dinámica de los derechos de agua y la naturaleza híbrida en las luchas por el acceso al agua. Mediante la exploración de cinco casos de cuencas hidrográficas, se identificaron seis principios básicos o 'mecanismos' para legitimar los derechos de agua. En todos los casos analizados, existe un mecanismo principal certificado por las autoridades y reconocido como legítimo por la mayoría de los demás grupos de usuarios. Sin embargo, los diferentes grupos de usuarios de agua, estratégicamente también utilizan otros mecanismos para reclamar y defender la legitimidad de sus derechos de agua. A continuación, en respuesta a los cambios sociotécnicos, legales y políticos, como los promovidos por los proyectos de intervención de riego, los diferentes grupos de usuarios también tienden a cambiar sus posiciones y concepciones.

Comenzando con el análisis a escala de cuenca hidrográfica, el capítulo 3 explora el desarrollo histórico del riego en la cuenca del río Pucara. Este capítulo muestra cómo la reciente noción conceptual de "territorios hidrosociales" permite examinar la diversidad de los reclamos de derechos de agua. Durante los tres períodos de desarrollo de riego en la cuenca Pucara, el lenguaje predominante de legitimación de los derechos de agua cambió: de modos basados en la creación de propiedad hidráulica, a formas que enfatizan las reivindicaciones territoriales. En el primer período (1950-1978), la adquisición de derechos se sostuvo mediante nociones y relaciones de "propiedad hidráulica": los derechos de agua fueron creados por familias y colectivos que realizaban inversiones (principalmente a través de mano de obra, pero también de otros recursos) en el desarrollo de la infraestructura. En el segundo período (1978-1995), un cambio tuvo lugar a reclamos por derechos de agua más flexibles y territorialmente orientados. Estos reclamos surgieron en respuesta a los intentos gubernamentales de reorganizar el territorio hidrosocial de la cuenca Pucara. En el tercer período (1995-2017), que fue orientado por los procesos de emancipación política más amplios de las comunidades indígenas y las políticas gubernamentales de municipalización; los reclamos territoriales más rígidos sobre las fuentes de agua y los derechos de uso se volvieron decisivos en la lucha por el agua. En esta época, la territorialización de los reclamos de agua estuvo cada vez más relacionada con los cambios en las políticas y normativas nacionales, como ser el proceso de descentralización administrativa y el empoderamiento de las comunidades campesinas.

En el capítulo 4, la tesis se centra en la escala de sistema, explorando la expansión histórica del sistema de riego Totora Khocha. Cuando el sistema de riego Totora Khocha se expandió en el espacio y a través de los límites para capturar nuevas aguas, surgieron nuevos reclamos por parte de los usuarios existentes y emergentes. El origen de la represa se remonta a principios del siglo XX, cuando un hacendado dirigió la construcción de una represa de tierra. La red de agua entró en una segunda fase después

de la reforma agraria de 1953, y cambió del control monopolístico, al control colectivo por parte de las comunidades campesinas. Una tercera fase se desarrolló en la década de 1960, cuando el sistema se expandió para incrementar la capacidad de almacenamiento del reservorio, incluyendo nuevos usuarios. Como un intento de reabrir la cuenca hidrográfica cerrada, en la cuarta fase (1980-1991) el estado planeó un proyecto que autoritativamente diseñó una nueva y mucho más grande represa sobre el reservorio original, el cual además implicó un trasvase de agua entre cuencas. La forma prescriptiva de desarrollar el proyecto de riego en esta última fase fue desafiada por diferentes grupos de usuarios, tanto existentes como emergentes. Estos grupos lucharon por su inclusión en el proyecto y en la expansión de la red de agua. Esto dio lugar a complejos procesos de reingeniería negociada del sistema. Por lo tanto, el proceso de diseño de riego y sus resultados en una cuenca hidrográfica cerrada, más allá de seguir una construcción prescriptiva del sistema, es mejor entendida como un proceso dinámico y negociado de ingeniería y creación de redes hidrosociales.

El capítulo 5 se centra en la escala entre cuencas, analizando el desarrollo histórico del Proyecto de Riego Trasvase Yungas de Vandiola. Este proyecto fue diseñado con el propósito de extender, nuevamente, el sistema de riego Totora Khocha. Este capítulo integra las diferentes escalas en las que los divergentes actores diseñan estrategias y movilizan apoyos para configurar su territorio hidrosocial deseado. Comenzando con el diseño inicial del proyecto, el capítulo describe las cuatro configuraciones posteriores de territorios hidrosociales alternativos: el proyecto original de trasvase de agua entre cuencas Yungas de Vandiola (2002), el plan alternativo de las comunidades de altura (2006), el nuevo proyecto de trasvase de agua entre cuencas Yungas de Vandiola (2008), y el nuevo plan alternativo propuesto por una coalición ampliada de comunidades de altura (2009). Durante este proceso, grupos de comunidades que inicialmente no fueron incluidas en el proyecto, cristalizaron sus imaginarios hidro-territoriales y forjaron alianzas multi-escalares para materializar sus perspectivas territoriales, en respuesta a desarrollos políticos y culturales más amplios a nivel nacional. Esto alteró gradualmente el imaginario dominante del territorio hidrosocial como se reflejó en los planes del proyecto de trasvase entre cuencas Yungas de Vandiola, dando como resultado la cancelación del proyecto.

Las conclusiones de mi tesis sobre la historia reciente de la cuenca del río Pucara, en primer lugar, apuntan a cómo las comunidades de usuarios de agua han elaborado histórica y dinámicamente un repertorio fundamentado de enfoques de derechos de agua para responder a los desafíos climatológicos, agroecológicos, demográficos y normativo-políticos prevalecientes. En lugar de ser 'indígenas' o 'tradicionales', ellos entrelazan, hibridizan e incorporan normas de gobernanza del agua originadas localmente y en el exterior, estructuras organizativas y oportunidades tecnológicas. Luego, mi tesis muestra cómo esto ha culminado recientemente en una estratagema estratégica mediante la cual algunas alianzas de actores se involucran con la política formal emergente centrada en los derechos de agua comunitarios y la soberanía territorial. Estas alianzas utilizan este marco nacional para reivindicar localmente derechos colectivos, territoriales del agua, a través de la legitimación discursiva, la re-conceptualización de los territorios hidrosociales y la expansión del control del agua y el desarrollo del riego negociados. Como sucede en otros lugares de Bolivia, los nuevos lenguajes de legitimación de reclamos de derechos de agua por parte de las

comunidades de tierras altas han resonado cada vez más con las leyes y políticas de agua gubernamentales (indigenistas). Por el momento, esto ha tendido a obstruir las tradiciones locales de enfoques negociados y más consensuados entre los grupos de interés. El resultado es un estancamiento contemporáneo para el desarrollo de riego en la cuenca Pucara. Sin embargo, dado el dinamismo y (literalmente) la capacidad creativa de los lenguajes de legitimación de derechos de agua, es de esperar que pronto surjan nuevos imaginarios y proyectos hidrosocio-territoriales. Estos, una vez más, desafiarán el status quo de la gobernanza del riego y del agua en la cuenca Pucara.

About the author

Rígel F. Rocha López was born in Cochabamba (Bolivia) on October 12, 1971. After graduating from high school (1989), he studied agronomy engineering at Universidad Mayor de San Simón (UMSS, Cochabamba), following a specialization on soils, where he graduated in 1994. After his graduation, he got a fellowship to realize a thesis research on Land Evaluation at PEIRAV, a research and teaching cooperation program on Andean irrigation, financed by NUFFIC and executed between UMSS (Agronomy Faculty) and Wageningen University (Irrigation and Water Engineering group). Meanwhile, he started working as teaching assistant first, and then as Junior researcher at PEIRAV since 1997. During this period, Rigel became interested in irrigation and particularly in community managed irrigation systems.

In 2000, PEIRAV became the Andean Center for Water Management and Water Use (Centro AGUA) continuing the academic cooperation between Wageningen University and UMSS, and Rigel was invited to be part of the team of researchers. As part of Centro AGUA, between 2001 and 2002, he followed a MSc program at Wageningen University on Soil and Water (Specialization Irrigation). During this study period, Rigel deepened his knowledge on irrigation and particularly on the "sociotechnical approach" in irrigation, which came materialized in his MSc. thesis research on Peasant Irrigation Scheduling.

Since 2003, Rígel was involved in diverse teaching and research activities at Centro AGUA. He was invited to lecture in various undergraduate and postgraduate courses at Agronomy Faculty and Centro AGUA: Management of Irrigation Systems, Water Balance, Agro-hidrology, Integrated River Basins Management and Research Approaches for Water Management and Water Use. As researcher, he got engaged in various national and international research projects, among others: Coordinator for Bolivia of Program CONCERTACION (2006-2012), Coordinator for Bolivia of Program PARAGUAS - RAP GIRH (2012-2014), and Coordinator and main researcher of Project Changing Paradigms of Irrigation Development in Bolivia (2016-2020). In Centro AGUA, he got the position of Postgraduate Coordinator (2013-2019), and since 2019 he got the position of General Coordinator.

His research topic focuses on water management and water use at field level, technology and irrigation efficiency, and irrigation development. In 2008, he won a PhD scholarship (Sandwich) from the CONCERTACION Program and started working on his PhD with the Water Resources Management Group at Wageningen University. He published various articles, book chapters, and research reports on: irrigation development, water rights and hydrosocial territorialization, and research methodologies.

List of publications

Rocha, R., I. del Callejo, and S. Vásquez. 2010. "En busca de la seguridad hídrica: Dinámica de los sistemas de riego campesinos en el Valle de Punata." In *Riego Campesino en los Andes. Seguridad Hídrica y Seguridad Alimentaria en Ecuador, Peru y Bolivia*, edited by Jeroen Vos, 283-308. Lima, Perú: IEP.

Rocha, R., L. Vincent, and E. Rap. 2015. Re-engineering closing watersheds: The negotiated expansion of a dam-based irrigation system in Bolivia. *International Journal of Water Resources Development* 31 (1): 50-63.

Rocha, R., and A. Durán. 2016. "Investigación-acción participativa como soporte a la política hídrica en Bolivia: El caso de la cuenca pedagógica Pucara." In *La Investigación Acción Participativa. Referente Inspirador de Investigación y Docencia sobre el Agua en América Latina*, edited by Gerardo Damonte and Mariela García, 211-225. Lima, Perú: Justicia Hídrica, PARAGUAS.

Rocha, R., J. Vos, and R. Boelens. 2016. "Territorios hidro-sociales y valoración del agua: Perspectivas divergentes sobre los derechos de agua en la Cuenca Pucara, Bolivia." In *Gobernanza del Agua. Una Mirada desde la Ecología Política y la Justicia Hídrica*, edited by Bibiana Duarte-Abadia, Cristina Yacoub and Jaime Hoogesteger, 153-176. Quito, Ecuador: Abya-Yala, Justicia Hídrica.

Rocha López, R., R. Boelens, J. Vos, and E. Rap. 2019. Hydrosocial territories in dispute: Flows of water and power in an interbasin transfer project in Bolivia. *Water Alternatives* 12 (1): 267-284.

Rocha López, R., P. Hoogendam, J. Vos, and R. Boelens. 2019. Transforming hydrosocial territories and changing languages of water rights legitimation: Irrigation development in Bolivia's Pucara watershed. *Geoforum* 102: 202-213.

Rocha López, R.F. Forthcoming 2020. "Formas de legitimación de derechos colectivos de agua en el Sur Global." In *Hacia la Justicia Hídrica: Ecología y Movimientos Sociales*, edited by Ludwing Bernal and Alicia Guzmán. Cusco: CBC.

Rigel Félix Rocha López
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
CERES orientation programme	CERES	2008/2009	5.5
Workshop "How to study supra-local grassroots organizations and federations struggling for water security"	IWE	2008	3
IWE PhD Research discussion Group	IWE	2008	1.5
Writing proposal	IWE	2009	6
Sustainable land and water management	Wageningen University	2013	5
B) General research related competences			
A practical course on the methodology of fieldwork	CERES	2008	2
"Dinámica de sistemas de riego campesinos en Bolivia: Entre la seguridad e inseguridad hídrica"	Simposio "Riego Campesino: Seguridad hídrica y seguridad alimentaria en Bolivia", Cochabamba-Bolivia	2009	1
Techniques for writing and presenting scientific papers	Wageningen Graduate Schools	2010	1.2
"Territorios hidrosociales y valoración del agua: Perspectivas divergentes sobre los derechos de agua en la cuenca Pucara, Bolivia"	Congreso "Regadío, Sociedad y Territorio. Homenaje a T. F. Glick", Valencia-España	2014	1
"Agua y Poder: La política del desarrollo del riego en Bolivia. El caso del proyecto de riego Trasvase Yungas de Vandiola"	VII Encuentro de investigadores de Justicia Hídrica, Cali-Colombia	2015	1
C) Career related competences/personal development			
Working with EndNote X	Wageningen UR Library	2009	0.5
I Taller PARAGUAS	Red Andina de Posgrados en GIRH	2012	1
II Encuentro de docents PARAGUAS	Red Andina de Posgrados en GIRH	2013	1
VI Encuentro de investigadores de Justicia Hídrica y III Encuentro de Docentes PARAGUAS, Cusco-Perú	Red Andina de Posgrados en GIRH	2014	1
Total			**30.7**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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